The Colorado Agricultural Experiment Station 1987 Annual Report

A Century of Essential Investment

Colorado State University

COLORADO STATE UNIVERSITY

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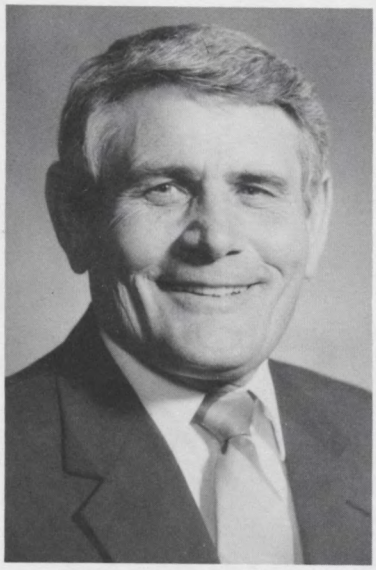
About the Cover. The cover photograph shows the early years of the Colorado State University campus when the Oval was an alfalfa field providing forage for the College livestock.

"OUR MISSION HAS NOT CHANGED --BUT THE RESEARCH AGENDA HAS"

"A PROUD HISTORY, A BRIGHT AND CHALLENGING FUTURE"



Dr. R. D. Heil, Director
Agricultural Experiment Station

The Colorado Agricultural Experiment Station is celebrating it's 100th year in 1988. We are using the occasion to issue this special annual report not only to highlight some of our activities this past year but also to commemorate 100 years of research contributions and to reflect on a research agenda for the future. We acknowledge, too, the many folks around the state who help guide our research programs by giving their valuable time to serve on advisory committees.

It is appropriate this year to reflect on the foresight and wisdom of President Lincoln and Congress in establishing the Land Grant Colleges in 1862. Congress passed the Hatch Act in 1887 which provided the foundation for a nationwide agricultural experiment station system; and shortly thereafter, the Sixth Colorado General Assembly joined in a partnership with the federal government to create the Colorado Agricultural Experiment Station. These actions recognize not only that agriculture was important to our nation's well-being then, but also was important to future generations. Although our research agenda has changed - and must continue to change in order to serve agriculture - the mission of the agricultural experiment station has not changed and today is still in keeping with the vision of our forefathers.

This station has a proud history. I cannot begin to describe all of its accomplishments. Many of you are aware of the major research contributions in soil and water use and management; crop development, management and quality; plant disease, insect and weed control; animal health, disease, nutrition, breeding, and management; food safety; and floriculture, as well as in many other areas. In events planned throughout this year, we hope to highlight some of the people whose research has made a significant contribution to the economic development of Colorado agriculture.

Agriculture today in some ways is quite unlike (but in other ways very similar to) that of 1888 when the agricultural experiment station was founded. Agriculture is similar in that keeping abreast of disease, insects, weeds and other management problems is as essential today as then; different in that labor to a large extent has been replaced by

capital and technology. And of further significance, the economic and technological environments are changing more rapidly and are influenced more and more by global decisions.

The research agenda of the future must be scientifically sound, socially responsive and environmentally acceptable. These factors are not incompatible, but mutually supportive as we find ways to stabilize and enhance the socioeconomic fabric of rural Colorado.

I would like to share several statements from the 1988 National Agricultural Research and Extension Users Advisory Board report to the President and Congress:

> To make its maximum contribution to the American economy, the U. S. agricultural system not only must solve a variety of critical problems, but also must make the best and most intelligent use of the myriad opportunities stemming from this era of technological breakthroughs. To do so will require an important shift in philosophy on the part of research, extension, industry and producers.
>
> The research agenda must be adjusted to place higher priority on finding new, inexpensive technologies to support today's inexpensive commodities.
>
> Before being implemented on a wide scale, potential biotechnological tools must be analyzed carefully to determine whether they can contribute to increased profitability on a long-term basis regardless of the nature of Federal programs.
>
> The key to making the best use of available new technology will be to select for transfer only those innovations which will be of continuing economic benefit not only to the agricultural industry but also to consumers and taxpayers.

Researchers now and in the future will have to find answers to a wide array of questions. The research agenda will require close cooperation and communication among researchers, extension personnel, industry and producers. Like our forefathers, let us accept the challenge with vision and the conviction that the future of agriculture is exciting and greater than ever.

We hope to see many of you at our planned exhibit at the State Fair, research center field days, and the symposia to be held on campus September 27-28, 1988. All of these events are focused on agriculture and the relationship of research to agriculture.

Best regards.

Excerpt from the Agricultural Experiment Station 1988-89 Legislative Request:

A SPECIAL INITIATIVE
for
ENHANCING THE ECONOMY OF AGRICULTURE AND RURAL COLORADO
through
RESEARCH AND TECHNOLOGY

THE SITUATION

For now and into the next century the agricultural sector, paradoxically, appears to have both unparalleled economic opportunities and unparalleled problems. History has shown that responding effectively to problem situations depends upon a knowledge base that is scientifically valid and conceptually integrated. Research and technology can lead to new products, new uses for existing agricultural products, and new efficiencies. However, the economic potential from such developments can be realized only if we have in place a system through which that technology can be transferred to the producer.

This initiative proposes a comprehensive research and educational outreach infrastructure to address broadening the economic base of agriculture in Colorado. To achieve this goal, the initiative specifically proposes to build on the current programs of the Agricultural Experiment Station and cooperative Extension to (1) increase utilization of the products of agriculture in commerce and industry, thereby diversifying enterprise potential, (2) increase the value added to agricultural products through processing within Colorado, and (3) increase the economic efficiency of both agricultural production and processing enterprises.

Several factors make the above both realistic and achievable. First, the supply of petroleum for fuels and a myriad of industrial products has an uncertain future. Second, advances in biotechnology for both agricultural production and processing enhance the economic feasibility of a variety of products derived from plants. Biotechnology also can enhance the value added component associated with food processing. A third factor evolves from advances in computer technology, especially computer modelling which yields integrated systems, and other technologies that provide opportunities for increasing the economic efficiency of agricultural production, processing, and marketing.

The potential impact of such developments can be far reaching. Currently, the on-site value of farm and ranch products in Colorado is $3.2 billion and the processing component adds value estimated at about $3.0 billion. While these figures are impressive, other states enjoy value added through processing that is two or three times as great as the on-farm value. By increasing this ratio for Colorado, perhaps from 1:1 to 2:1, not only the agricultural sector but the entire economy of the state would benefit.

Another area of potential improvement for agriculture is in production efficiency. By increasing the efficiency of agricultural production by 20 to 25 percent -- considered a realistic goal -- annual net farm and ranch income would increase by approximately $125 million. But perhaps the greatest long term potential for agriculture is in using raw agricultural products for such diverse goods as fuels, chemical feedstocks, commercial solvents, biodegradable plastics, high density plastics, industrial oils, organic acids and proteins. Any one of these products would provide added revenues in the millions; the products collectively could represent multibillion dollar increases from industrial uses.

The potential clearly exists and we need to act upon it. For even with a strong research effort, many years may pass before agriculture or the state benefits from new products. From five to ten years can be required to make a discovery, develop and test the necessary processes, and market the product. Yet, to hesitate because of the length of the process only delays the realization of the goal.

A further challenge to use comes from the nature of agriculture itself. Just to maintain current productivity levels requires continuous, long term investigations. This base program in agricultural research and the accompanying endeavors in educational outreach require all available resources. If new issues are to be addressed, resources must be added. This initiative describes an agenda for maintaining an efficient agricultural industry in Colorado and enhancing the contributions of this vital industry to the welfare of all Coloradoans, particularly those in rural Colorado.

OBJECTIVE

In addition to the programs that must be sustained to meet the continuous, long term needs in agricultural research and educational outreach, the Agricultural Experiment Station and Cooperative Extension propose:

> through research and technology transfer, to increase economic efficiency, develop processing capabilities for value-added opportunities, and diversify agricultural enterprises.

JUSTIFICATION

Considerable diversity in climate, soils and terrain in Colorado has led to diverse agricultural enterprises. In addition, Colorado agriculture is supported by a complex agribusiness infrastructure. Strengthening of the infrastructure can come from improvement in the per unit profitability as well as from the establishment of new enterprises. New enterprises may result either from new crops or from developing businesses or industries which perform functions in the intermediate stages between the farm gate and the consumer. By processing raw agricultural products within the boundaries of Colorado, value is added that yields returns to the industry and to the state. By broadening the economic base for agriculture, the industry becomes less susceptible to market fluctuations.

A new product not only must be produced but also a market created for it. Resources now employed in so-called traditional enterprises may yield greater returns by being redirected into alternative uses. This is not to suggest that success can come only from new ventures. Existing enterprises can be strengthened by increasing economic efficiencies and producing more wisely than in the past. Technological developments hold considerable promise for agriculture. This is particularly true with respect to computer technology as well as for advances that have come to known as biotechnology.

The integration of recombinant DNA and tissue culture techniques in the plant sciences offers not only production efficiencies but potential for new products and important breakthroughs for reducing our dependency on chemical pesticides. This takes on special meaning as more and more of the "standard" agricultural chemicals such as fungicides, herbicides and nitrogen fertilizers are being questioned and may not be available to producers in the future.

Similar technological advances are occurring with respect to animal growth, development, reproduction and disease resistance. Biotechnology not only is enhancing agriculture but also spawning new investment opportunities and new industries with associated job growth.

The development of computer assisted modelling makes it possible to integrate the results from several separate disciplines into management models for production, processing and/or marketing systems. An example of such development is the Integrated Resource Management (IRM) program, a cooperative effort of the Agricultural Experiment Station and Cooperative Extension. Scientists at Colorado State University working cooperatively with eight livestock producers across the state have applied research simulation and linear programming models with the objective of increasing the profitability of ranching enterprises.

Through modelling, scientists have determined the appropriate application of technology given the production and marketing alternatives. This integrated approach has resulted in significant adjustments in the areas of reproductive performance, herd nutrition, feeding costs and market timing, each contributing to the economic efficiency of the operations.

The IRM program was recently described by a USDA research review team as innovative, on the cutting edge of technology development, effective in transferring research and technology in a timely manner and, most importantly, an excellent approach for improving the economic well-being of agriculture. The program's effectiveness was dependent upon expertise from several of the agriculture sciences as well as expertise in mathematical modelling and information management. Similar interdisciplinary efforts are needed to respond to other less favorable situations that prevail in agriculture today.

Not only the agricultural industry in Colorado but the entire state can benefit from technological advances along with other proven measures that increase economic efficiencies and diversify the state's agricultural base. At Colorado State University, the Agricultural Experiment Station and Cooperative Extension have important roles in the development of technology and facilitating its adaptation to successful enterprises. Private industry and agribusiness enterprises are important partners in technology transfer in that they make the capital investments necessary for commercial ventures, and ultimately, receive the benefits.

PROPOSED PROGRAM

Opportunities to support rural development through research and educational outreach are described in the following categories:

Increasing economic efficiencies in production and processing enterprises
Developing processing capabilities for value-added opportunities
Diversifying agricultural enterprises

Increasing economic efficiencies in production and processing enterprises

Some of the competitive advantage enjoyed earlier by Colorado producers has been lost and profits have declined. To restore profitability to production agriculture, we must enhance revenues, reduce costs and manage risks. Revenue enhancement requires strong demand and prices. These factors are influenced by the type of goods produced and their quality in relation to buyer preferences. What to produce, when to commence production and management of the production process are factors that affect the price the product will command.

Controlling costs is more that just shopping wisely for supplies. To control the costs in agriculture one must know the present and future impacts of different cultural practices and various treatments, their costs and levels of effectiveness. The availability of computer technology is a key factor in being able to analyze multiple costs elements of a production system. Not only is it important for the producer to know the cost of inputs but also to understand the impact that changes in input levels will have on product yield and/or quality.

Most risks faced by farmers and ranchers are well known. Some risks can be insured or hedged through market devices such as futures. Others can be spread by broadening the economic base of a given enterprise. One reduces risks whenever the fullest possible knowledge is available for making decisions. This underscores the increasing importance of information management.

As more and more information is organized into databases, accessibility and currency become key factors in its value. Electronic transmission of information can be quite valuable if adequate networks and/or linkages have been devised. The need to retrieve information from a variety of sources requires the design of readily accessible databases. Thus, expertise to design and manage databases and information systems is important to the implementation of this initiative.

Studies are underway and need to be broadened to develop the information and enterprise models that enable the decision maker to weigh a variety of options simultaneously. Both production and market factors are important to an analysis. Well-developed computer programs and linkages to databases can lead to truly informed decisions rather than guesswork.

Developing processing capabilities for value-added opportunities

Economic growth in the agricultural sector can be enhanced through conscious development of industries that convert raw commodities into consumer and industrial goods. Technologies need to be developed and tested for efficiency and enhancement of product quality that, when adopted, can improve a firm's competitive position.

The real need is to develop uses that expand the demand for agricultural products and/or enhance returns to producers and processors. Means for doing so include the development of technologies that add value through processing of primary agricultural commodities into intermediate or end products for food or industrial uses. Assessment of the economic viability of such processing ventures is needed along with evaluation of new and emerging products.

Studies will include identifying specific product attributes and how these are affected by different processing techniques; development and testing of processing systems for converting raw materials; development and/or adaptation of production processes to yield new products or enhance product quality; development of packaging and storage methods to maintain product quality and extend shelf life.

Diversifying agricultural enterprises

Efforts to expand markets for goods now being produced may not be sufficient for enhancing the economic base of agriculture and rural Colorado. Farmers and ranchers must necessarily devise ways to vary their enterprises. Enterprises now devoted to a single commodity may need a mixture of commodities to generate adequate return. Land resources of farmers and ranchers usually have been employed to meet our needs for food, clothing, and shelter. A variety of such ventures have been undertaken; yet, information on their economic potential is limited.

Deteriorating prices of major commodities such as wheat and corn suggest a need for crop diversification. Plants that can provide not only food but also nonfood products may offer diversification potential for Colorado agriculture, provided the plants are adaptable to Colorado environmental conditions, are suitable for commercial production, and can be marketed effectively.

Each crop requires several types of studies to determine its adaptability, breeding characteristics, disease resistance, required cultural practices and processing characteristics. All of these elements are essential to defining the production system for the crop. Equally important is the determination of market prospects for the commodity.

COLORADO AGRICULTURAL EXPERIMENT STATION CHRONOLOGY

1862 The Morrill Act is signed into law by President Abraham Lincoln, establishing a national system of Colleges, devoted to agriculture and the mechanic arts and partially funded by federal land grants.

1870 Territorial Governor Edward M. McCook signs legislation designating Fort Collins as the site of Colorado's Morrill Act College.

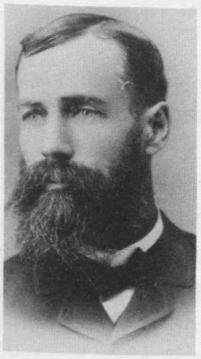
1876 Colorado becomes a state.

1877 The State Agricultural College of Colorado, governed by a State Board of Agriculture, is formally organized; the board institutes an experimental farm at the Fort Collins campus.

1879 Classes begin at the College.

1881 The Experimental Department, headed by Ainsworth Blount, is established at the College.

1887 The Hatch Act is passed by Congress. This legislation promotes agricultural research by supporting a system of State Agricultural Experiment Stations, most of which are associated with the Morrill-Act Colleges. Soon thereafter the Association of American Agricultural Colleges and Experiment Stations, composed of representatives from each state's land-grant College and Experiment Station, is formed.



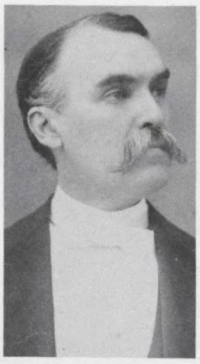
Charles L. Ingersoll

1888 An Agricultural Experiment Station is established at Colorado's Morrill-Act College in accordance with Hatch Act provisions. It is based at Fort Collins, but operates regional sub-stations at Rocky Ford and Del Norte. Charles L. Ingersoll, the president of the College, serves as the station's first director.

1890 The second Morrill Act becomes law, providing additional federal funding for the land-grant Colleges and establishing institutions of this kind for black students in southern states.

1891 Walter J. Quick, professor of agriculture at the College, succeeds Charles Ingersoll as director of the Colorado Agricultural Experiment Station. In addition, a sub-station is established at Table Rock, Colorado.

Walter J. Quick



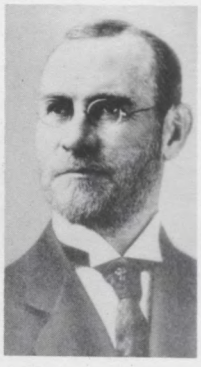
Alston Ellis

1892 Alston Ellis, president of the College, concurrently assumes the position of station director.

1893 The Rainbelt sub-station is established at Cheyenne Wells in Colorado's semi-arid eastern plains region.

1896 Problems emanating from the Panic of 1893 and a related national economic depression necessitate suspension of all sub-station work in Colorado except for limited activity at Cheyenne Wells and Rocky Ford.

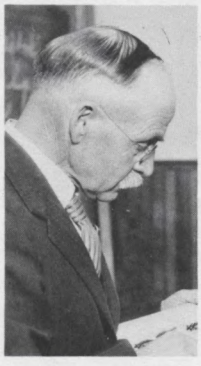
1899 Louis G. Carpenter, head of the College's department of Civil and Irrigation Engineering, becomes director of the Experiment Station.



Louis G. Carpenter

1906 Congress passes the Adams Act, providing supplemental funding to State Agricultural Experiment Stations to support "original" theoretical research; heretofore, virtually all station investigations had had a practical application (i.e., solving an actual local problem).

1910 Regional sub-station work is resumed fully at Cheyenne Wells and Rocky Ford, and subsequently expanded to new installations at Fort Lewis, Austin, and Avon.



Clarence P. Gillette

1911 Clarence P. Gillette, head of the College's department of Entomology and Zoology, becomes director of the Experiment Station.

1914 The USDA, in response to an appeal by local potato growers, establishes a research station in Greeley, to investigate diseases harmful to this commodity. In 1924, the College takes charge of this facility, and cooperates with the USDA in conducting various research programs. Early in 1968 CSU assumes exclusive control and renames the facility, the Northern Colorado Research-Demonstration Center.

1916 Research is instituted near Hesperus to test the adaptability of selected crops and forest trees to high altitude conditions. Scientific investigations at what will become the San Juan Research Center subsequently includes activity at the Yellow

Jacket unit near Cortez (1962) and the Arriola unit (1976). Notable research activity include development of the San Juan Select pinto bean and drylands environmental impact studies related to the Dolores River Reclamation Project and the Animas-La Plata Project.

1917 Congress enacts the Smith-Lever Act, establishing a federally coordinated cooperative extension service at the Morrill-Act Colleges. This legislation formally and tangibly acknowledges the Morrill-Act College's threefold mission of teaching, research, and extension work. Moreover, it encourages station scientists to concentrate on experimental work.

1917 The Colorado Seed Laboratory is established by the state legislature as a component of the station's botany section, in order to certify the purity of existing seed and to conduct related research.

1917 The United States becomes a combatant in World War I.

1917 Home Economics section is added to Experiment Station.

1920 Agronomy farm is established at USDA Horse Breeding project site, one half mile east of main campus.

1922 The Austin branch station (known as the Austin-Rogers Mesa unit after an addition in 1961) is established to conduct deciduous tree fruit research. Centers at Fruita (1952, 1964) and at Orchard Mesa (1961), furthering this work and irrigated field crops inquiries, eventually become the Western Slope Branch Stations.

1923 A Rural Economics and Sociology section is added to the Experiment Station.

1925 Congress passes the Purnell Act expanding Experiment Station investigations into the areas of agricultural economics and rural sociology.

1933 Emil P. Sandsten, head of the department of Horticulture, becomes director of the Experiment Station.

1935 Congress enacts the Bankhead-Jones Act significantly expanding federal support for Experiment Stations, but making most funding contingent on matching state appropriations and varying distributions to reflect a state's relative percentage of rural population. This law also provides for a special research fund for the USDA to use in establishing and maintaining regional agricultural laboratories.

Emil P. Sandsten

Charles L. Kick

1939 Charles L. Kick, head of the animal husbandry department, becomes director of the Experiment Station, but dies shortly after assuming office. Isaac E. Newsom, head of the pathology department, serves as acting director.

1941 The United States enter World War II.

Isaac E. Newsom

Homer J. Henney

1943 Homer J. Henney, dean of the division of agriculture, becomes director of the Experiment Station.

1946 Congress passes the Research and Marketing Act in part to avert problems that had afflicted the agricultural economy following World War I. In addition to encouraging marketing research projects, the new law supports cooperative regional work (with a special administrative "committee of nine" to plan and oversee agreed upon investigations) and studies pertaining to rural society.

1949 The Mountain Meadow Research Center is instituted as a cooperative undertaking involving the College and the USDA's Soil and Water Research Division. Work is headquartered at Grand Junction until 1969 when it is moved to Gunnison. Studies involving high altitude hay production, cattle growing, and poisonous range plants receive emphasis.

1950 After helping to operate a demonstration farm since 1940, the San Luis Valley Potato Improvement Association donates this facility, located near Center, Colorado, to the College. Subsequent research includes studies to develop new potato varieties, mechanize production, and compare center pivot sprinkler irrigation with more traditional flood and furrow methods.

1951 Sherman S. Wheeler, dean of the division of agriculture, becomes director of the Experiment Station.

Sherman S. Wheeler

1952 Eastern Colorado Branch later known as Eastern Colorado Research Center near Akron is established.

1954 The Southeastern Colorado Branch, later known as the Southeastern Colorado Research Center, is established by act of the state legislature to conduct research on soils subject to wind erosion and associated management problems. This work begins on a 2,360-acre leased site of abandoned crop land at Springfield, Colorado. In 1966, an additional state-supported site was established at Walsh, mainly to investigate the management of crops, soils, and water under pump irrigation in a hitherto drylands region.

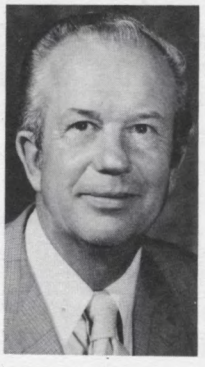
1955 Congress passes the amended Hatch Act which consolidates the law of 1887 and all subsequent supplementary legislation.

1959 Agronomy and Animal Sciences begin move to Rigden Farm.

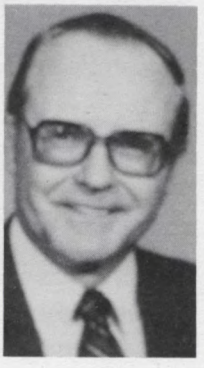
1962 Congress passes the McIntire-Stennis Forestry Research Act to encourage investigations involving forest regeneration and management.

1965 Congress orders that a part of Hatch appropriations be earmarked for studying ways to reduce the threat of pesticides to the environment (IR-4 Program: National Program of Clearances of Pesticides for Minor and Specialty Uses).

Rue Jensen



Donald F. Hervey



John Patrick Jordan

1966 Rue Jensen of the department of Bacteriology and Pathology becomes director of the Experiment Station.

1969 Donald F. Hervey of the department of Range Science becomes director of the Experiment Station.

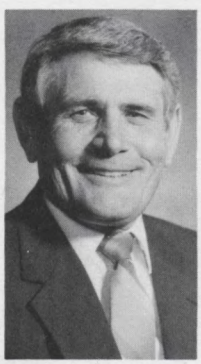
1972 John Patrick Jordan, associate dean of the College of Natural Sciences and professor of Biochemistry, becomes director of the Experiment Station.

1972 Congress passes the Rural Development Act "to consolidate federal loan, industrial assistance, health facilities, and waste management programs aimed at upgrading services in rural areas." Essentially, stations are expected to find ways "of making rural areas more attractive to residents and businesses".

1977 Congress passes the National Agricultural Research, Extension, Teaching Policy Act (NARETPA), which continues and increases federal support for existing research, extension, and teaching work at Morrill-Act institutions along with special research emphasis involving alternate energy sources, and poultry and livestock investigations. This measure also seeks to identify a common core of research initiatives and improve coordination among various agencies involved in creating and disseminating agricultural knowledge.

1977 President Jimmy Carter's administration presents a "new agenda" for agriculture, emphasizing centralized administration of all federal programs, the small family farm, organic farming, nutrition studies, natural resource conservation, international agricultural projects, and farm labor. The traditional cornerstone of agricultural research, the augmentation of production efficiency, is accorded relatively less attention.

1981 Congress amends NARETPA of 1977 renewing programs of the original law for four years, but placing productivity maintenance and enhancement at the top of the list of "major needs and challenges" for the future. Many "new agenda" programs receive continued support, however.



Robert D. Heil

1983 Robert D. Heil of the Agronomy department becomes director of the Experiment Station.

1985 Congress amends NARETPA of 1977 providing a four-year renewal of the original law and emphasizing productivity (in response to the Food Security Act of 1985) and biotechnology studies.

1987 In response to encroaching urbanization of Fort Collins, a new 493-acre North Agricultural Campus (approximately eight miles northeast of CSU) is proposed for legislative funding.

THE COLORADO AGRICULTURAL EXPERIMENT STATION: A CENTURY OF ESSENTIAL INVESTMENT

BY:
JAMES E. HANSEN II
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"Light up gentlemen!" Cigars had been passed out to a delegation of Colorado legislators visiting the State Agricultural College during the late 1880s. This was a significant occasion because the tobacco for these cigars had been grown in Colorado at the College's recently-established Agricultural Experiment Station. Soon the visitors were exhaling clouds of sickly-sweet, bluish smoke. Unfortunately, the effects did not prove pleasing; in fact, some of the smokers became ill. This incident, along with moral misgivings about the nicotine habit, abruptly ended serious research involving tobacco. Colorado thus lost its opportunity to become the Havana of the West.

At this time, insufficient knowledge of Colorado's environment clearly justified such experimentation. In 1820 Major Stephen H. Long, heading an army expedition to explore the largely unknown region between the Missouri River and the Rocky Mountains, had been profoundly impressed by the arid and virtually treeless terrain east of the snow-capped ranges. In his official report he called it a "Great American Desert," unsuited for agriculture and best left to "remain the unmolested haunt of the native hunter, the bison, and the jackal." This gross oversimplification contributed to some serious misconceptions about the true nature of Colorado.

Actually, remarkable geographical diversity characterizes this land of mountains, plains and plateaus. Mountains dominate the landscape, for in Colorado the Rockies assume their greatest dimensions. Fifty-four peaks exceed 14,000 feet, and over a thousand top 10,000 feet. Their snows feed rivers that irrigate soil for hundreds of miles to the east and southwest. Their towering majesty beckons to persons seeking recreation or spiritual renewal as once they lured searchers of silver and gold. Eastward from the Rockies stretch the gently rolling Great Plains where rainfall is generally less than twenty inches per year. Plateaus mark Colorado's western confines in a series of mesas that descend gradually in step-like intervals toward Utah. Here, high tabular sections of land are cut deeply by stream valleys and canyons, some of which support vegetable growing and fruit orchards.

This heterogeneous environment presented difficult challenges for pioneering agriculturalists from humid eastern states. What kinds of crops could be grown here? What were the properties of the soil? How could farming and stockgrowing be conducted without an adequate supply of water? These questions held a genuine relevance because a demand existed for agricultural products. Although mining provided the initial impetus for large-scale occupation of the region, prospectors required a

supporting population of at least five times their own number. Thus, in addition to Gregory Gulch gold or Leadville silver, farming and ranching attracted persons with the industry, luck, and knowledge to exploit Colorado's agrarian potential.

I

This option was enhanced by the State Agricultural College of Colorado at Fort Collins, which officially opened in 1879 and embodied a relatively new concept in American higher education. Under the federal Morrill Act of 1862, grants of public land were assigned to states for the support of schools promoting "the liberal and practical education of the industrial classes in the several pursuits and professions in life." This legislation reflected a fundamentally democratic purpose: higher learning would no longer be restricted to a privileged minority studying a classical curriculum of philosophy, Latin and Greek, and religion; rather, it would provide all interested Americans with exposure to liberal culture and training in useful economic skills.

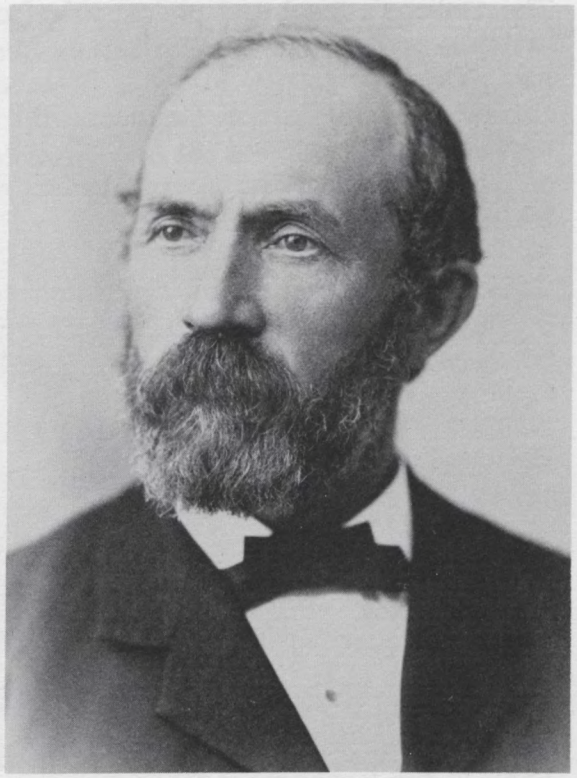
The establishment of the State Agricultural College was partially motivated by agriculturalists seeking assistance with actual problems. Not only would the school train their sons and daughters but, ideally, its scientists would supply information of immediate benefit to working farmers and ranchers. This was certainly an expectation of agrarian-minded legislators who established the College, notwithstanding skepticism among some constituents about the practicality of academic learning.

The College's first administrators and faculty generally appreciated this need for tangible knowledge and, even before classes began, encouraged research involving local weather conditions and Colorado-grown varieties of grain. For, despite the burgeoning of biology, chemistry, engineering, and other sciences, their direct application to agricultural questions had been minimal. Through much of the late nineteenth century, Morrill-Act colleges lacked established curriculums, accepted teaching methods, or reliable textbooks. The need for new information was clearly imperative.

One solution entailed establishing agricultural experiment stations. Conceived in Germany, the station was a publicly funded research center, which first appeared in the United States during 1875 at Wesleyan College in Middletown, Connecticut. Agricultural educators elsewhere quickly recognized the concept's potential and promoted passage of the Hatch Act of 1887 which provided $15,000 annually in federal funds to support these centers at Morrill-Act institutions. The stations were to conduct "experiments bearing directly on the agricultural industry of the United States. . . having due regard for the varying conditions and needs of the respective States or Territories," and research results were to be published in bulletins and progress reports for dissemination to interested agriculturalists. Although the U.S. Department of Agriculture would exercise general supervision and coordination, participating states and territories would determine project selection and contribute principal funding for the construction and upkeep of facilities.

Prior to the Hatch Act, which became effective in Colorado during 1888, the State Agricultural College had supported its own experimental department. It was here, for example, that the aforementioned tobacco-growing research first received serious

consideration. More significant, however, was the work of Ainsworth E. Blount of the school's original three-man faculty. A towering individual, exceeding six feet four inches, Blount was an experienced agricultural researcher and noted small grains specialist. In 1886 he summarized seven years of experimental work at Fort Collins, reporting on tests encompassing more than 55 different plants, including 343 varieties of wheat, 132 of corn, 70 of beans, and 47 of oats.



Ainsworth E. Blount

Blount's most notable contribution was the development of Defiance Wheat. By the early 1890s, Defiance had become the predominant spring wheat in Colorado, and between 1886 and World War I it added nearly $14 million to the wealth of Colorado--almost 60 times the amount of money appropriated by the state to support experimental work at the College.

Blount was also an early advocate of locating agricultural experiment sub-stations in various parts of Colorado as a way of dealing with the state's tremendous geographical diversity. He favored beginning with four research centers, including one at Fort Collins. In this way, a variety of information could be accumulated and appropriate methods devised for solving the agricultural problems of highly different regions.

Another notable contributor to experimental work at the College, before the Station's formal organization, was Elwood Mead. The majority of Colorado's early agriculturalists had come from eastern regions characterized by abundant rainfall. In a humid environment application, of the traditional Anglo-American Doctrine of Riparian Rights made sense. There, a steam's velocity (for hydraulic power) and depth (for navigation) represented its primary value; and the law, therefore, restricted use altering the level or flow. In addition, the Riparian doctrine limited proprietary rights to the water by generally confining use to persons whose lands bordered rivers or streams.

This legal principle seemed ill-suited to the needs of farmers living in semi-arid Colorado where "every drop of water that runs into the sea without rendering a commercial return is a public waste." An arrangement was therefore developed to safeguard the rights of the person who invested capital and labor in diverting water for irrigation or drinking purposes. Adapting a practice followed in western mining camps, Coloradans sanctioned the diversion of water for beneficial purposes by granting priority of right to the individual making the earliest diversion, or appropriation, and incorporated this concept into their original state constitution in 1876.

The College's legal and philosophical commitment to serving Colorado's agricultural interests made irrigation research an important concern--at least, to Elwood Mead who had joined the faculty in 1882. Ironically, the man who would achieve international renown as an irrigation engineer--and have the huge storage reservoir, Lake Mead, named in his honor--was at first hired as a mathematics instructor and mainly because of his willingness to accept lower compensation than another, more qualified, mathematician.

Although an Indiana native who lacked direct knowledge of semi-arid environment conditions, Elwood Mead quickly recognized the potential importance of water resources research and found himself drawn to it. In 1884, while continuing his affiliation with the College, he accepted an appointment to work under Colorado's state engineer, E.S. Nettleton. In describing this work, Mead recalled that he "tramped the streams and measured the capacity of all the ditches in northern Colorado." He thus learned about irrigation by acquiring practical experience.

In 1886 Mead established the first irrigation engineering course of study to be offered by an American college. Additionally, he worked closely with the school's experimental department, authoring the first bulletin published under its auspices, "Report of Experiments in Irrigation and Meteorology." Although Mead left the College in 1888, his legacy remained. Irrigation engineering would constitute a significant aspect of the school's regular academic program, and irrigation investigations would become a primary focus of the Experiment Station.

II

Barely a month after the Hatch Act's passage, the Colorado Sixth General Assembly enacted a measure calling for the establishment of experiment sub-stations in El Paso, Bent, and Delta counties, and another in the San Luis Valley. This action reflected the principle of locating research centers to accommodate Colorado's geographical diversity as well as some active political logrolling. Unfortunately, the legislators neglected to allocate funds to support the sub-stations, apparently assuming that the annual Hatch Act appropriation of $15,000 would suffice.

This action placed the College in a difficult position. Funding for experimental work would have to be spread thinly, thereby inhibiting a substantive, long-term research program. Also, there were doubts about the legality of using Hatch Act moneys to underwrite sub-stations. Nonetheless, the school attempted to comply by establishing branch research centers at Del Norte and Rocky Ford in 1888; and at Table Rock and Cheyenne Wells in 1891 and 1893, respectively.

The main station was located at the College, where a director--the first being school president, Charles L. Ingersoll--provided overall supervision for the entire research operation. Initially, experimental work was organized under five sections: agriculture, botany and horticulture, chemistry, meteorology and irrigation engineering, and veterinary medicine. As scientific knowledge became more specialized or the state's economic conditions demanded particular lines of inquiry, the number and research emphases of the sections would be adjusted accordingly.

Agricultural Hall and College Barn - 1890s

Economic conditions during the 1890s created some serious problems for the Colorado Agricultural Experiment Station. Devastating blizzards in the late 1880s had annihilated thousands of cattle on crowded open ranges with ruinous consequences for the stockgrowing industry. Simultaneously, a series of drought years, coinciding with deflated market prices and high interest rates, brought crop failures and financial collapse to many Colorado farmers. In addition, a steady erosion in the value of silver--culminating in a precipitous drop from 83 to 62 cents an ounce in four days during June 1893--proved disastrous to mining activity and, concomitantly, to Colorado's economy as a whole. Mines closed, businesses failed, and mortgage foreclosures became rampant. By September 1893, an estimated 45,000 people had lost their jobs. Moreover, Colorado's troubles were representative of difficulties elsewhere. The entire nation had succumbed to a major economic depression.

The Experiment Station could hardly escape the effects of this crisis. In 1893 the legislature authorized an appropriation to support work at the Cheyenne Wells sub-station, situated in the parched eastern plains region. Nowhere had suffering related to aberrant weather and financial reverses been more acute. Unfortunately, this proved to be the only state assistance provided for Experiment Station work during the nineteenth century. The College thus found itself in an extremely difficult position. It wanted to help Colorado by solving problems through research and it appreciated that the state's geographical diversity often required experimental work at locations other than Fort Collins. However, without state aid the school could not meet these responsibilities except by resorting to means of dubious legality or by drawing upon funds desperately

needed for regular classroom instruction. Thus, despite considerable criticism, it was decided to suspend or substantially curtail sub-station activity until the legislature provided adequate fiscal support.

Nevertheless, the Station made some worthwhile contributions to Colorado during this period. Important surveys of the state's flora, fauna, and irrigation potential were conducted. Also, from 1893-99 the Station published some 34 separate bulletins, many of which responded to immediate, practical problems of Colorado's agriculturalists. For example, in 1894 Charles S. Crandall, head of the botany and horticulture section, described and suggested means of controlling a troublesome weed, the Russian Thistle; while in 1898, Clarence P. Gillette presented a bulletin entitled, "Colorado's Worst Insect Pests and Their Remedies."

Among the most distinguished scientists to be associated with the Experiment Station was William P. Headden, chief of the chemistry section from 1892-1931. Reserved and scholarly, Headden had come to Fort Collins with an impressive academic background, including a Ph.D. degree from Germany's University of Giessen. Research was his all-consuming interest. He maintained a full work load at the Station past his eightieth birthday, and by the end of a 38-year career at Fort Collins had published more than 60 technical and popular bulletins, as well as numerous scientific articles.

Some of Dr. Headden's most worthwhile publications were written during the 1890s. One bulletin on alfalfa issued in 1896 provided "the most exhaustive study of the plant made by any experiment station up to that time" and directly influenced its increased use in Colorado. Stockgrowers and dairymen came to appreciate the plant as an economical and nutritious source of feed while farmers experienced great success rotating it with corn, sugar beets, and other crops because of its exceptional fertilizing properties. By 1926 alfalfa represented 60 percent of the state's tame hay acreage and had annual monetary return of approximately $15 million.

The work of Dr. Headden and his colleagues at the College involving sugar beets held special significance. In fact, one of the Station's first bulletins dealt with this crop. Other publications soon followed, based upon tests run at Fort Collins, Del Norte, and Rocky Ford, and information drawn from observing a beet sugar factory in Nebraska. Also, in 1897 the Station distributed 700 pounds of beet seed to 611 farmers in 47 Colorado counties and demonstrated that sugar could be grown commercially in most parts of the state.

Without question, the Experiment Station lent major impetus to the sugar beet industry, which emerged as a vital component of Colorado's economy during the late 1890s. Acreage committed to this crop rapidly expanded, and processing factories sprang up throughout the state, including one in Fort Collins during 1902. By 1925 the sugar beet industry had become Colorado's greatest source of agricultural income, exceeding in value all of the gold and silver extracted from Colorado's mines up to that time.

Sugar beets and alfalfa both affected the stock finishing industry that emerged after 1890. The use of feeding pens as an alternative to open range grazing became increasingly significant to lamb and cattle growers at this time due to overstocking and competition for land from homesteaders. Feedlots required little space and expedited effective

Sugar Beets for Shipment

management. Livestock consumed alfalfa and sugar crop by-products, such as beet tops, while manure from the closely confined animals provided valuable fertilizer. Since the 1890s the Experiment Station has regularly encouraged feedlot operations through feeding and disease control studies.

III

When Colorado's economy recovered around the turn of the century, stockgrowers became influential advocates of state financial support for the Experiment Station. However, they believed that both instructional and experimental work should be directed toward immediate, practical results. By contrast, Louis G. Carpenter, a respected irrigation engineer who served as Station director from 1899-1911, contended that true knowledge required "breadth as well as depth... a 'liberal' background as preparation for intensive specialization," and both pure and applied research. It was not enough to feed steers two different rations of unknown nutritional composition and observe that one ration produced larger animals. New knowledge of lasting value could only be achieved if one understood the physiological process by which this growth occurred. Carpenter was encouraged in this outlook by the Adams Act of 1906, a federal measure that provided $15,000 annually for the support of "original research" at each of the state experiment stations.

But this type of inquiry was clearly fraught with political hazards. Farmers and ranchers wanted workable solutions to immediate problems, not seemingly abstract academic exercises. Through the years, Experiment Station leaders would repeatedly face the challenge of defending the value of pure research without which many "immediate" problems could never be remedied.

IV

Tractor Demonstration

Colorado grew steadily during the early twentieth century. Agriculture and related industries, such as the Great Western Sugar Company, sustained the economy, but other manufacturing contributed. The Colorado Fuel and Iron Company, for example, flourished as the only steel production facility between the Mississippi River and the West Coast. These years also featured the introduction of electricity, telephone service, and public transportation systems for many of the state's smaller cities and towns.

World War I, which began in 1914 and directly involved the United States three years later, created numerous economic opportunities. An unprecedented demand for food produced a sharp rise in prices for agricultural commodities, while manufacturers found

themselves besieged with orders for military material. Even Colorado's long depressed mining industry experienced a brief boom.

Principal leadership of the Agricultural Experiment during much of this period was provided by Clarence P. Gillette who in 1910 replaced Louis G. Carpenter as director. A graduate of the Michigan Agricultural College, Gillette became associated with Colorado's Morrill-Act institution in 1891 where he established a new academic department of zoology and entomology and a new entomology section for the Station.

His tenure as director began with a frustrating personnel problem. "A large part of the work of the field, "he observed, "that has gone under the name of experiment station work is really...demonstration...." Years earlier, James E. Payne, superintendent of the desolate eastern plains sub-station at Cheyenne Wells, had reported that "a personal acquaintance with some experiment station worker who can give [needed] information will do far more to educate [farmers and ranchers of the region] than any quantity of [scientific bulletins]. Scientists had often found themselves functioning as extension specialists, taking time from research to meet personally with agriculturalists and show them how to remedy some problem. Director Gillette strongly believed that this important service could best be performed by a separate department of the college, an arrangement that would enable researchers to concentrate on research.

Administrators at other land-grant colleges and within the U.S. Department of Agriculture shared this view, and in response to their lobbying, Congress in 1914 enacted the Smith-Lever Act. This law supported a distinct cooperative extension service at the Morrill-Act schools and officially confirmed the threefold land-grant institutional mission of teaching, research, and extension. Although the Station would never entirely forsake demonstration work or personalized instruction for farmers and ranchers, the main burden of these obligations would now be borne by others.

V

World War I ended somewhat abruptly in 1918 creating unanticipated problems for farmers and ranchers. Having responded to economic opportunities and patriotic imperatives, many Colorado agriculturalists, especially those who had borrowed to purchase new land or machinery, found themselves overextended. European battlefields were restored to farmland and normal maritime commerce resumed, promoting multi-national competition for world markets and creating agricultural surpluses that depressed commodity prices and threatened farm income. During the post-war years and throughout the 1920s, farmers urgently needed management and marketing advice. Also, in an increasingly urban nation--with its modern attractions of industrial opportunity, electrical appliances, and manifold entertainments--they needed to find ways of enhancing the quality of rural life.

Fortunately, Colorado had anticipated the need for research addressing these issues. Since 1916 the Station had participated in state marketing studies and subsequently established home economics (1917) and rural economics and sociology (1923) sections. Home economics and social science research were significant because they reflected a concern for problems beyond the traditional focus of improving agricultural productivity.

College Farm - 1920s

If production efficiencies led to surpluses that depressed prices and decreased the number of farmers, what would become of those displaced individuals and of the rural businesses, schools, and churches that served them? While by no means forsaking the goal of productivity, the Station necessarily began to examine the impact and context of agricultural output. Moreover, in adopting this approach, it anticipated a national concern. In 1925 Congress passed the Purnell Act, encouraging Experiment Station research related to agricultural economics, rural sociology, and home economics.

An important example of agricultural economics research in Colorado involved the state's antiquated and inequitable tax system. Throughout the 1920s, farmers had been plagued by both declining agricultural prices and rising taxes. Between 1925 and 1929, the market price of wheat dropped from $1.41 to $.98 per bushel, while between 1913 and 1929 property taxes rose 221 percent. In 1925 real estate bore 63 percent of all state taxes, and although farm property constituted 22 percent of Colorado's total wealth, it paid 35 percent of the general property tax. Clearly, this inequity burdened agriculturalists disproportionately. In response, the Experiment Station undertook a series of tax studies to improve the existing system--controversial and time consuming work that eventually contributed to significant reforms during the 1930s.

Home economics investigations also yielded important knowledge at this time. Inga M. K. Allison, for example, pioneered research involving the impact of high altitude on recipes developed at lower elevations. A makeshift apparatus--consisting of an air pump, a bell jar resting atop an electric hot plate, and a manometer--enabled her to gauge the cooking times of foods in water at various levels of atmospheric pressure, providing useful knowledge about preparing such items as potatoes and eggs. More sophisticated

equipment was required, however, to fathom the behavior of ingredients for baking breads and cakes--ideally, a proper laboratory in which heat, temperature, and pressure could all be systematically controlled. Unfortunately, no such facility was provided until 1927, so during the interim, Allison and her colleagues conducted experiments characterized more by expediency than scientific precision. One aborted proposal entailed touring Colorado in a car, with a portable stove in tow, and attempting test bakings at various altitudes. Another idea, that did receive a trial, involved experiments at the Shelter House on the Fall River Road approximately twelve miles northwest of Estes Park. Here, at an elevation of 11,797 feet, Allison engaged in exploratory baking, following recipes proven satisfactory for Fort Collins' altitude of 5,000 feet. The results featured "popovers that would not pop" and "angel food cakes that clung soggily to the bottoms of their pans."

The advent of the high altitude cooking laboratory in 1927, however, radically changed this situation. There, over the years, scientists such as Allison, Mark A. Barmore, and Elizabeth Dyar Gifford, conducted high altitude cooking and baking experiments that proved invaluable not only for food preparation in the home, but for commercial flour and cake mix manufacturers as well.

High-Altitude Laboratory - 1927

Research involving home economics, rural economics and sociology, represented new departures for the Experiment Station, particularly after World War I. Concurrently, though, the Station's older sections continued notable experimental work. The horticultural section, for example, played a major role in helping the state's $4 million carnation industry. In 1930 the Colorado Carnation Growers Association solicited Station assistance in combating a highly destructive root rot organism, which in some greenhouses was devastating 25 percent of the crop. After a thorough study, plant pathologist E. J. Starkey devised methods of sanitary control that swiftly eradicated the problem. In fact, during 1931, Lee Holberg, a grower who had applied these recommendations, won first prize at a national flower show for producing the best carnations in the United States. Subsequent investigations yielded new varieties of the flower, and marketing studies pioneered by W.O. Holley, contributed to modern merchandising techniques.

Water resource management represented another established research area rendering valuable results. For many years, the Station had engaged in cooperative work with the Irrigation Investigations Office of the U.S. Department of Agriculture, which in 1912 authorized building a hydraulics laboratory on the Ft. Collins campus. The facility's construction was largely overseen by Ralph Parshall, a 1904 alumnus of the College. At this laboratory and another subsequently erected at nearby Bellvue, Colorado, Parshall

Parshall Flume

developed a water flow measuring device, the Parshall Flume, which after its invention about 1925, became a standard instrument for irrigation engineers throughout the world. The water law doctrine of prior appropriation, which Colorado had done so much to advance, depended on a means for measuring the amount of water to be diverted from rivers and streams for irrigation purposes. The Parshall Flume brought an unprecedented precision to this process, thereby providing a fairer distribution of water to users than had ever been possible. Moreover, the flume was so basically simple in design that its widespread utilization became readily feasible.

Parshall's achievements were not limited to this single invention. He also developed devices for keeping irrigation canals free of sand, participated in some of the earliest Colorado mountain snow surveys to forecast the availability of irrigation water, and helped in planning the irrigation aspects of the monumental Colorado-Big Thompson Project.

Experiment Station research addressed immediate needs by improving water resources management or remedying carnation root rot, while pioneering experimental inquiry,

such as work at the High Altitude Baking Laboratory. The revival of sub-stations, located to accommodate the state's diverse geography, served both of these purposes. Insufficient state funding had caused most sub-station operations to be phased out by the turn of the century. However, field agents--men combining experimental and extension duties--continued to carry on limited work at several locations. For example, based at Rocky Ford Philo K. Blinn, using reduced facilities of the sub-station and supported partially by Arkansas Valley farmers, engaged in highly productive research involving cantaloupes and alfalfa.

Gradually, governmental support for regional branches was renewed. Dry land research on the eastern plains received a boost when in 1907 the U.S. Department of Agriculture established a field station at Akron to develop scientific data for the guidance of farmers. Although the federal government managed this facility the Experiment Station regularly participated in cooperative projects, including one to test the growth potential of various trees. In 1910 operations were resumed at Cheyenne Wells; and, eventually, Director Gillette saw work extended to new branches at Fort Lewis, Austin, and Avon. Since the time of their revitalization under Gillette, sub-stations and federal regional research centers have played a key role in Experiment Station work. Advisory committees, composed of local agriculturalists, make suggestions for investigations, and demonstration days facilitate public understanding of this activity.

Onion Crop Demonstration - 1928

By the 1930s, a well defined foundation had been established by Colorado's Agricultural Experiment Station. This, however, was the era of the Great Depression. The stock market crash of 1929 and the ensuing collapse of the American economy affected Colorado as it did the rest of the United States. Crop and livestock prices plummeted, while drought and decades of careless tillage practices caused tremendous dust storms that turned day into night, suffocated victims of respiratory illness, and blew away fertile topsoil. The Dust Bowl and the agricultural crisis brought ruin to many eastern Coloradans, forcing them off of their farms and ranches. Unfortunately, town dwellers fared little better. Banks and businesses failed, including large enterprises, such as the Denver and Rio Grande Railroad, which went into receivership.

Dust Bowl Conditions, Eastern Colorado - Early 1930s

The federal government responded to this crisis with a multitude of New Deal programs. These included public works employment projects, incentives for reducing agricultural output to boost prices, and resettlement of farmers and ranchers from depleted to more productive lands. Decades of experience in dealing with urgent local problems enabled the Agricultural Experiment Station to react appropriately. In describing his agency's position, Director Gillette declared:

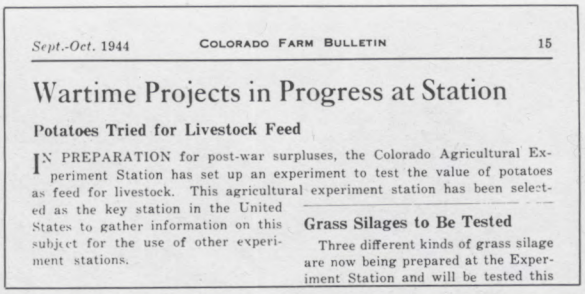
> Because of the financial stress which the country is experiencing and which must find its relief very largely in the improvement of conditions on the farms of the country, there has been a special effort...to push these investigations that promise to give the most immediate and practical economic results, and also to publish information bulletins upon subjects that are of immediate practical value to the farmers and stockmen of the state.

Accordingly, the Station addressed such pressing matters as the aforementioned antiquated state tax system, drought related water shortages, devastated rangelands, a massive grasshopper infestation, and a serious outbreak of Peach Mosaic that threatened orchards in and around Palisade, Colorado. Fortunately, the federal government fathomed the enormity of these burdens and in 1935 enacted the Bankhead-Jones Act, which distributed new money under a formula reflecting a state's relative percentage of rural population and requiring recipients to contribute a matching amount; at the outset, this law added approximately $25,000 in federal funding to Colorado Station work.

Feeder's Day

Despite these efforts, true improvement of economic conditions, particularly for farmers and ranchers, did not occur until the outbreak of World War II, which ended unemployment and created an enormous demand for food and fiber. During the 1940s, agricultural production hit an all-time high, mainly because of improved mechanization. Farmers thus prospered, but fewer of them were needed--a situation that accelerated urban growth. The war years featured the establishment of numerous military and defense related installations in Colorado, such as the Remington Arms Plant in Denver, Rocky Mountain Arsenal, Camp Carson, and Lowry Air Field. As a result, the state's population, during this period, increased by more than 200,000.

These circumstances compelled the Station to emphasize applied research. The ultimate objectives involved increasing production and preserving food, and despite serious personnel shortages caused by wartime service, excellent results were achieved. Unlimited demand, attractive market prices, and patriotism all contributed to greater output. In Colorado, during 1943-45, agricultural production far exceeded that of



Sept.-Oct. 1944 COLORADO FARM BULLETIN 15

Wartime Projects in Progress at Station

Potatoes Tried for Livestock Feed

IN PREPARATION for post-war surpluses, the Colorado Agricultural Experiment Station has set up an experiment to test the value of potatoes as feed for livestock. This agricultural experiment station has been selected as the key station in the United States to gather information on this subject for the use of other experiment stations.

Grass Silages to Be Tested

Three different kinds of grass silage are now being prepared at the Experiment Station and will be tested this

previous years, and the Station contributed impressively to this success. Research efforts were reflected in representative bulletins of the time which included: "Wartime Food Processing Aids," "Vegetable Storage Will Help Win the War...," and "Soil Test and Soil Fertility Discussed--'Salvage Manure' is War-Vital Slogan Now."

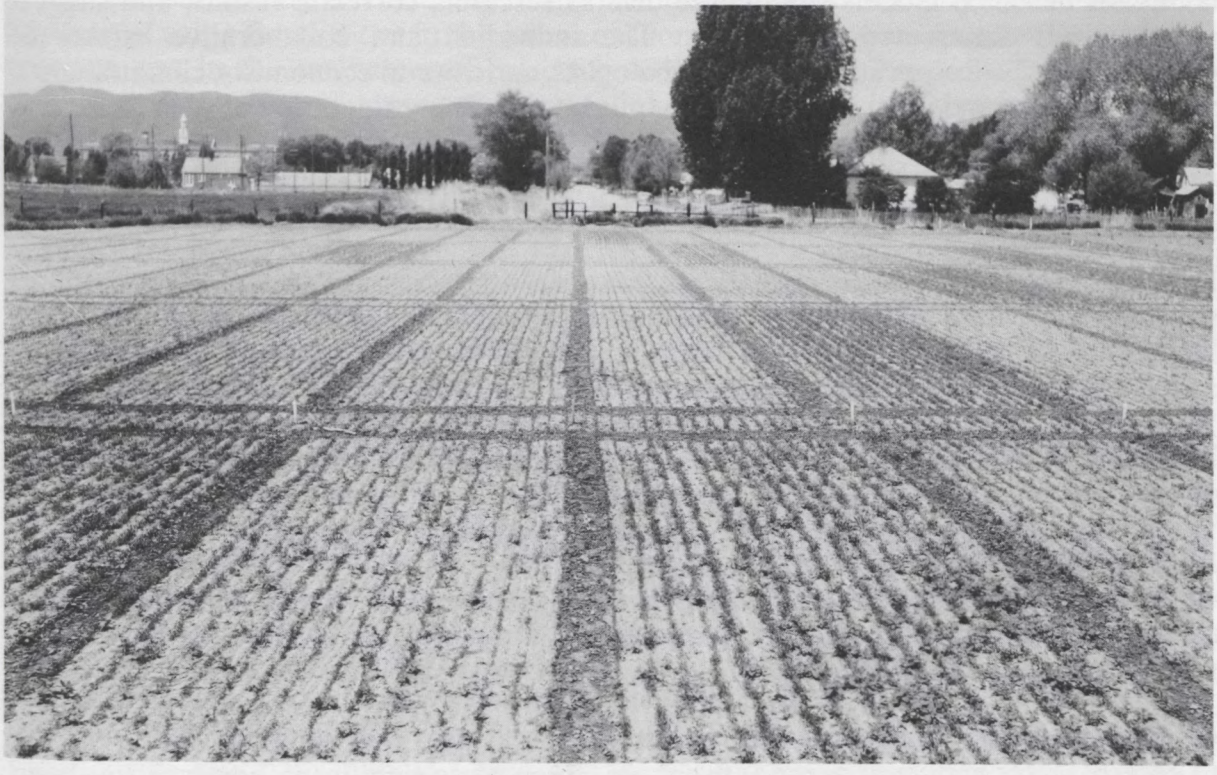
VI

Trends set in motion by World War II continued after 1945. The state's economy became increasingly diverse as numerous federal agencies and large corporations located headquarters or branch offices in Colorado. Tourism also flourished in response to improved mountain highways and a skiing boom. Mining remained a major source of state income as did agriculture, but the number of farmers and ranchers diminished markedly. Between 1940 and 1970, Coloradans directly involved in growing food and fiber declined from nearly 23 percent to approximately 4 percent of the state's population, which doubled during this period. Moreover, those who stayed on the land generally survived by expanding operations to gain maximum advantage from federal support programs and efficiencies related to lower unit costs.

Colorado Agricultural Experiment Station programs, during the post-war decades, generally addressed these changes through research stressing more efficient production. Projects involving increased mechanization, pesticide applications, fertilizers, transmontane water diversions, improved livestock breeds and new crop varieties were representative responses. Long-term theoretical research received increased emphasis in agronomist David W. Robertson's internationally recognized achievements involving barley and plant genetics. Branch stations also experienced revitalization, at this time, with new lands and facilities being purchased, constructed, or leased at such diverse locations as Fruita, Grand Junction, Center, and Springfield.

The latter development encouraged investigations responsive to the needs of specific regions. Hail damage to crops, for instance, is an unchanging reality of high plains agriculture. It concerned Ainsworth Blount, it concerned David W. Robertson, and it concerns modern grain growers who must calculate hail insurance as an unavoidable farming expense. Beginning in 1973, agronomist James S. Quick began research to develop a new variety of hail-tolerant, hard red winter wheat. Observing that the long, lax heads of a semi-dwarf plant withstand hail damage better than others, he experimented with it and eventually produced a new variety. Appropriately named, "Hail," this wheat is resistant to prevalent diseases, has acceptable milling and baking qualities, and provides good yields under both dry-land and irrigation conditions. Quick's highly successful work reflects the singular affinity that Station scientists possess in confronting Colorado's distinctive environmental challenges.

Fieldwork of David W. Robertson



Agronomy Farm East of Campus - 1950

VII

During the 1880s, the ill-fated cigars research at the College simplistically addressed the question, what will grow here? Ignorance of Colorado's environment and the relative newness of agricultural science justified this approach. Related investigations concerning soil fertility, irrigation, and insect and blight controls were similarly appropriate and narrowly focused. Essentially, farmers and ranchers needed to know which crops or livestock were best suited to the region and how these commodities might be produced most efficiently. But improved productivity alone was no panacea, as the marketing crises and rural community problems of the 1920s and 1930s later revealed. Increasingly, research responsive to the entire natural and social context demanded attention.

For example, the unprecedented effectiveness and relatively low cost of pesticides, such as DDT, led to their widespread use in Colorado's agricultural and forest lands after World War II. In 1962, however, Rachel Carson's bestselling book, Silent Spring, aroused public concern about the potential dangers of pesticides--in particular, toxicity which threatened contamination of the entire food chain and intolerable costs to human and animal health. Vastly increased governmental supervision of chemical pest-control technologies ensued, along with numerous bureaucratic regulations.

Accordingly, in recent years the Station has broadened the focus of entomological and crops research by means of an Integrated Pest Management Program (IPM), which combines cost effective controls with environmental protection. Bringing together various agencies and scientists from numerous disciplines, the IPM program uses computer designed models to analyze diverse research, correlate results, and suggest appropriately "integrated" solutions. The individual and collaborative efforts of entomologists, soils specialists, plant pathologists, agricultural economists, climatologists, wildlife experts, and other researchers permit systematic consideration of such issues and truly comprehensive responses. Although not inexpensive, the resulting accuracy is certainly cost effective since 15 percent of all food and fiber production costs is spent on pest management each year.

Few fields of inquiry have elicited greater scientific attention in Colorado, with its predominately semi-arid climate, than water resources management. Indeed one of the Station's most significant research legacies involves work pioneered by Elwood Mead and Louis G. Carpenter and carried forward by Ralph Parshall.

For many years it was assumed that augmenting irrigation through major reclamation efforts, such as the Colorado-Big Thompson Project, constituted a positive step toward "modifying the environment to suit the crop." But just as widespread applications of DDT produced unforeseen consequences, so did increased irrigation. In western Colorado's Grand Valley, for example, excessive application of water to the land caused salt to be leached out of the underlying Mancos shale, contaminating root zone soil as well as water eventually flowing back into the Colorado River.

One response was provided by agricultural engineers who redesigned irrigation ditches to control water applications more precisely. Even more significant, however, has been research involving "modification of the plant to suit the environment." Plant pathologist

Murray W. Nabors has observed that normal plant cells, when grown under laboratory conditions in small flasks and deliberately exposed to various stresses, such as salty water, fail to grow. There are, though, stress resistant mutant cells that do survive. These mutants, for a crop such as oats or rice, can be isolated, regenerated into plants, and then tested in greenhouses. Ultimately, salt tolerant plants might be cultivated on lands whose current salinity precludes agricultural use, while waters of now-dubious quality might suffice for irrigation.

Murray W. Nabors

Knowledge of this kind is essential because in an increasingly crowded and interdependent world, the actions of individuals are more than ever likely to affect natural surroundings and other people. In fact, these connections have become so profuse that a new generation of science and technology has often become essential to rescue us from an earlier one.

VIII

These pressures have seemed especially manifest in Colorado since the mid-1970s because of acute fluctuations in the state's economy. An energy crisis precipitated by an extreme rise in the international price for oil launched what appeared to be a new mining boom. Energy companies located branch offices in Denver, coal mining operations resumed in southeastern Colorado, and vast oil shale deposits in the northwestern plateau region attracted a burst of speculative development. Farmers and ranchers, however, suffered because of higher fuel and petroleum-based fertilizer costs.

Complex global economic influences adversely affected agriculturalists in other ways as well. In the early 1970s, governmental policies in the United States and Europe contributed to a decline in the dollar's value relative to other currencies. A cheaper dollar encouraged purchases of American goods abroad and inspired agriculturalists to expand output. Later in the decade, though, federal efforts to curb inflation abruptly reversed the currency balance, leaving farmers and ranchers dangerously overextended.

Meanwhile, expansion was also promoted by a mid-1970s Club of Rome study, predicting acute shortages of all raw materials by 1985, and a subsequent Carter Administration report, projecting a 20-year pattern where the worldwide demand for food would outstrip production and cause a twofold rise in prices. Encouraged by governmental incentives, agriculturalists increased production only to experience disastrous consequences. Not only did expansion coincide with suddenly unfavorable currency exchange rates, but the official forecasts proved to be grossly miscalculated. Gradual improvements in productivity--especially in India, China, and the rice-growing countries of Southeast Asia--signaled the beginnings of the long-awaited "green revolution" in third-world countries.

American agriculturalists who had reacted to governmental encouragement by borrowing to expand operations were unexpectedly faced with vast surpluses, a dearth of markets, high interest debts, and a future marked by burgeoning competition--difficulties that bore an ominous similarity to the hard times that followed World War I. Farm income in Colorado dropped 48 percent between 1975 and 1978, and hundreds of farmers and ranchers were forced to abandon the agrarian way of life. Representative of this distress was the collapse of the sugar beet industry, long a major component of Colorado agriculture. Antiquated factories, harmful corporate maneuverings, worldwide surpluses, and cheap foreign imports combined to bring down the Great Western and the Holly Sugar companies--with attendant hardship for a multitude of small growers.

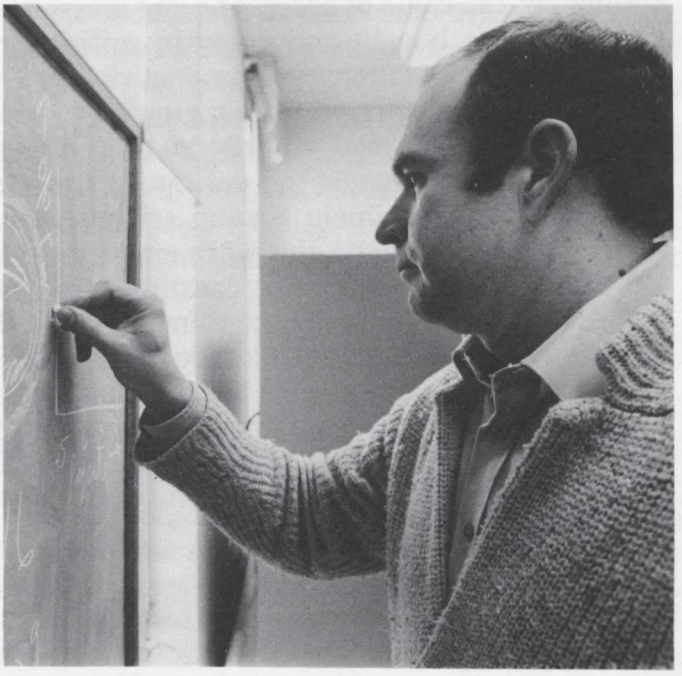
IX

As it had during countless earlier times of difficulty, the Experiment Station responded, but now with a greater sense of perspective. Commodity surpluses emanating from the "green revolution" in developing nations were usually quantitative rather than qualitative. For example, the export demand for Colorado wheat has remained high because of its exceptional milling and baking characteristics. Station research has accordingly emphasized ways of making this state's commodities superior.

Equally important are efforts to exploit new opportunities for agriculture. If, in the foreseeable future, foreign competition seems likely to reduce the profitability of some traditional commodities, might not American agriculturalists benefit by developing specialized crops and technologies? This approach has received increasing emphasis in various projects, including a pinto bean seed program in Mesa, Montrose, and Delta counties. In 1982, with pinto beans selling at $14 per hundredweight, compared to $45 per hundredweight for the Olathe variety of seed, the Fruita Research Center, assisted by the Extension Service, promoted a certified seed program among local bean growers. This program featured a profitable shift in emphasis by cooperating farmers, and the successful development of several new, high yielding, disease resistant seed varieties by Station scientists.

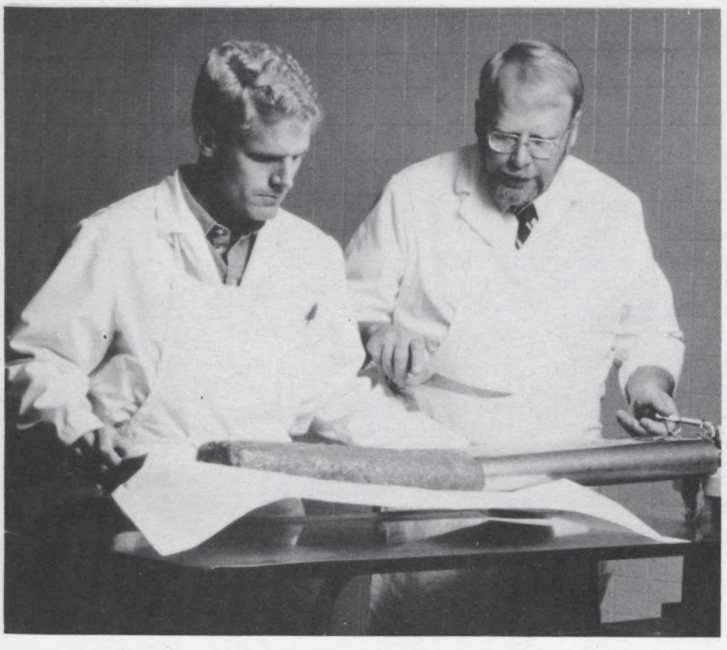
Opportunistic specialization, however, has been complemented by the comprehensive spectrum of recent Experiment Station research. To paraphrase avian scientist Jack Avens, agricultural inquiry extends from "conception to consumption." The subject of conception has perhaps been most spectacularly examined by George Seidel. Concerned with improving the reproductive efficiency of animals, such as cattle, Seidel has developed a procedure that, with thread-like blades, microsurgically splits a fertilized embryo to produce genetically identical twins. The embryos can then be replaced in the mother's womb or frozen for later thawing and implantation in either the natural mother or a surrogate. In this way genetically desirable traits can be transmitted with unprecedented efficiency. Seidel's cloning, embryo transfer, and freezing achievements have brought him and Colorado State University's Animal Reproduction Laboratory

international renown. In 1983, for example, he earned the highly prestigious Alexander Von Humboldt Award for his contributions to agricultural science. The implications of this "spare copies" research are manifold, and Seidel continues to pursue it--seeking ways to increase the speed of surgery, improve the success rate of animal transfers, and divide embryos into triplets or quadruplets.



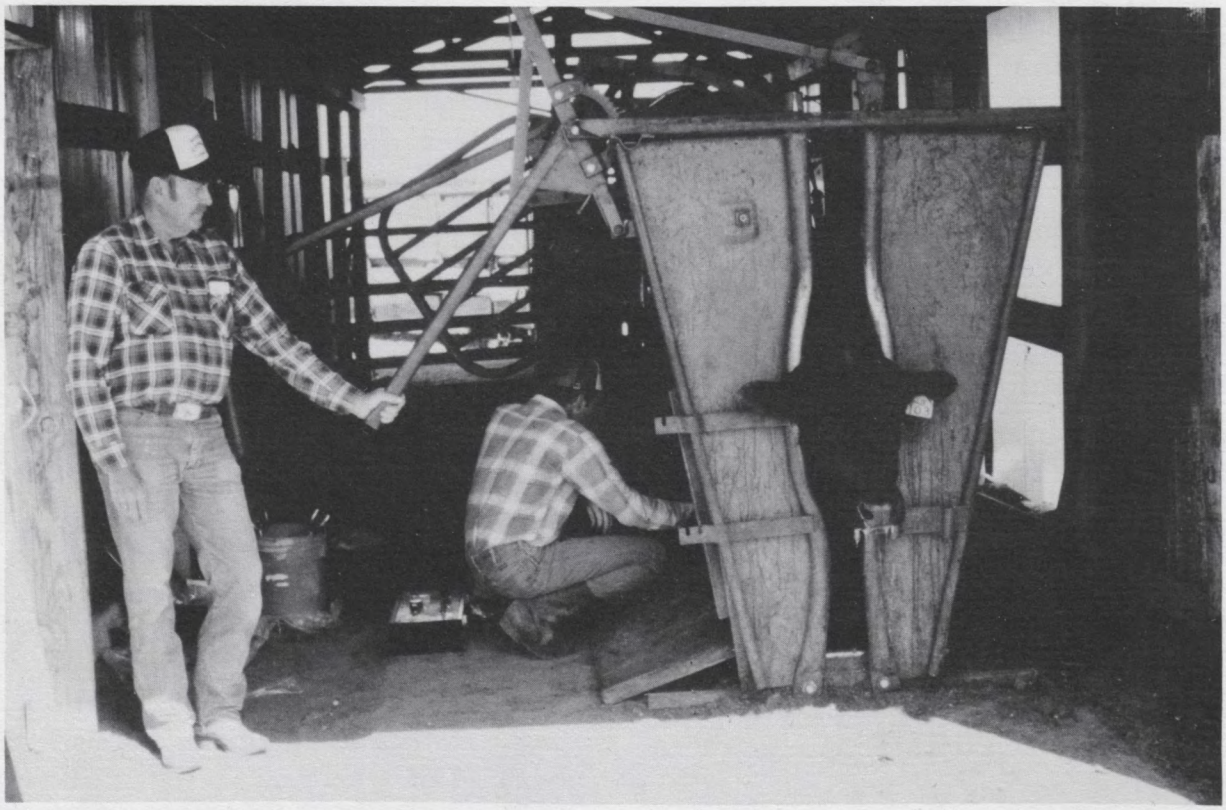
George Seidel

The value of producing genetically desirable cattle is limited by their marketability--a problem that has periodically troubled Colorado agriculture. Accordingly, the Experiment Station supports research to improve beef processing. Recently, a project directed by Glenn R. Schmidt has resulted in a process that may revolutionize the meat industry by significantly augmenting the marketability of carcass trimmings. Previously, restructured meat products were treated with salts and phosphates in order to induce binding and avoid rancidity and discoloration. These products, however, met with consumer resistance not only because of undesirable additives, but because they had to be precooked or frozen before being marketed. Schmidt's discovery, which employs a nutritionally superior algin/calcium gel binder, permits the meat to be presented in the raw, refrigerated state preferred by consumers. "There's no limit to the diversity," observes Schmidt. It can be molded into any desired shape, frozen, and shipped to retailers. Then, it can be thawed, sold in a fresh form, and even frozen again until used. Moreover, it can be cooked in any way that fresh meat is cooked. This relatively inexpensive and convenient product holds significant potential for use in both restaurants and homes.



Glenn Schmidt (r) and Graduate Assistant Stuart Ensor analyze restructured beef

Ultimately, the value of processing and breeding research is determined by consumption. Unless beef is bought and eaten in sufficient volume to justify its production costs, scientific augmentations of productivity are meaningless. In recent years beef consumption has suffered from a growing public perception that a diet high in fats and serum cholesterol may contribute to illnesses such as heart disease and cancer. Moreover, to some extent this perception has been promoted by basic nutrition research pioneered by Experiment Station scientists, such as Jacqueline Dupont and Melvin Mathias. At first glance, this work may appear to hold negative implications for two of the Station's most important constituencies, cattle growers and the beef processing industry. But, historically, consumers, as well as producers, have commanded the attention of researchers at Colorado State University--an emphasis evident, for example, in Inga Allison's notable high altitude cooking studies. Moreover, this commitment to scientific integrity may, in the long run, benefit the cattle and beef industries by encouraging production of leaner grades of meat and by uncovering information about beef's nutritional advantages that may result in increased consumer demand.



Fertility testing for IRM Cooperator

The Agricultural Experiment Station's comprehensive perception of individual research, of how one activity relates to another, is further reflected in increasing applications of collating the results of specific scientific inquires and integrating their related possibilities through computerized analysis. The Integrated Pest Management Program, for example, has a counterpart for the cattle industry in the Integrated Reproductive Management Program (IRM). The latter, which draws upon such disciplines as animal science, management economics, veterinary medicine, range science, agronomy, and wildlife management, reinforces the reality that, more than ever, sound beneficial research is inseparable from the vitality of its individual parts.

X

During its first century of existence, the Agricultural Experiment Station has effectively demonstrated its ability to respond to the changing needs of Colorado and the surrounding world. Additionally, these responses have exhibited increasing sophistication, both in addressing specific problems and in fathoming how one scientific study often has implications for many others. Despite a diminishing number of farmers and ranchers, agricultural productivity has continued to increase--an achievement of real significance in a world economy where American manufactured goods, such as automobiles and electronic appliances, have difficulty in competing with foreign imports and where balance of payment deficits threaten national stability. In Colorado, agriculture, with mining and manufacturing, ranks as one of the state's top three industries. At present, the value of farm and ranch products totals $3.2 billion, while related processing generates an additional $3.0 billion. Also notable is the Station's close association with Colorado State University where many research projects provide hands-on training and employment for graduate students, thereby ensuring that new generations of agricultural scientists will be available to meet future problems.

Past research has made it possible for Colorado agriculturalists to know what will grow here--perhaps not tobacco--but certainly wheat and alfalfa and sugar beets and melons and a multitude of other crops. Past research has made possible a vigorous livestock industry; it has helped to restore balance between human development and the natural environment; it has addressed problems related to economic fluctuations and community decline. And, above all, it has made possible an abundant, healthful, and inexpensive food supply. As the economist-philosopher Kenneth Boulding observed, "It was not until agriculture had improved so that man no longer had to devote all of his time to survival, that organized knowledge was possible." This realization truly makes agriculture "the essential investment" as the Colorado Agricultural Experiment Station enters its second century.

COLORADO AGRICULTURAL EXPERIMENT STATION
RESEARCH DEPARTMENTS

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Agricultural and Resource Economics
S. Lee Gray, Acting Head

Agronomy
Lee E. Sommers, Head

Animal Sciences
David R. Ames, Head

Entomology
Frank B. Peairs, Acting Head

Horticulture
Kenneth M. Brink, Head

Plant Pathology and Weed Sciences
Gary A. McIntyre

COLLEGE OF APPLIED HUMAN SCIENCES
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Consumer Sciences and Housing
Carole J. Makela, Head

Food Science and Human Nutrition
G. Richard Jansen, Head

Human Development and Family Studies
Joseph G. Turner, Head

Apparel, Interior Design and Merchandising
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Fishery and Wildlife Biology
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Forest and Wood Sciences
A. Allen Dyer, Head

Natural Resource Ecology Laboratory
Robert G. Woodmansee, Director

Range Science
Harold Goetz, Head

Recreation Resources and Landscape Architecture
Glenn E. Haas, Acting Head

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Biology
Bruce A. Wunder, Acting Chairman

Chemistry
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COLLEGE OF VETERINARY MEDICINE AND BIOMEDICAL SCIENCES
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Microbiology
Carol D. Blair, Acting Head

Physiology
Charles W. Miller, Acting Head

RESEARCH CENTERS

The system of research centers located strategically around the state is an integral part of a diverse agricultural research program which is designed to meet the basic, applied and developmental research needs of agriculture. Each producer, processor and marketer of agricultural products and the agri-business sector which serves agriculture relies on research conducted either at a national, regional, state or local level to meet their needs. Research is conducted by both the public and private sector.

The role of the research centers as part of this research system is to ensure that newly developed technologies are adapted to local conditions and/or to modify or develop new technologies which are specific to the physical, biological and socio-economic conditions of the area each of the centers represents. This is a very large responsibility in that this is the point in the process where new research findings and technologies are transformed into economic reality for the agricultural producer.

The role of the research centers is as or more critical today than ever before and this importance is best described by Dr. Don Holt, Director of the Agricultural Experiment Station at the University of Illinois in a recent article in "Science". The article had as it's main focus the question of a competitive strategy for U.S. agriculture and had this to say which concerns research centers:

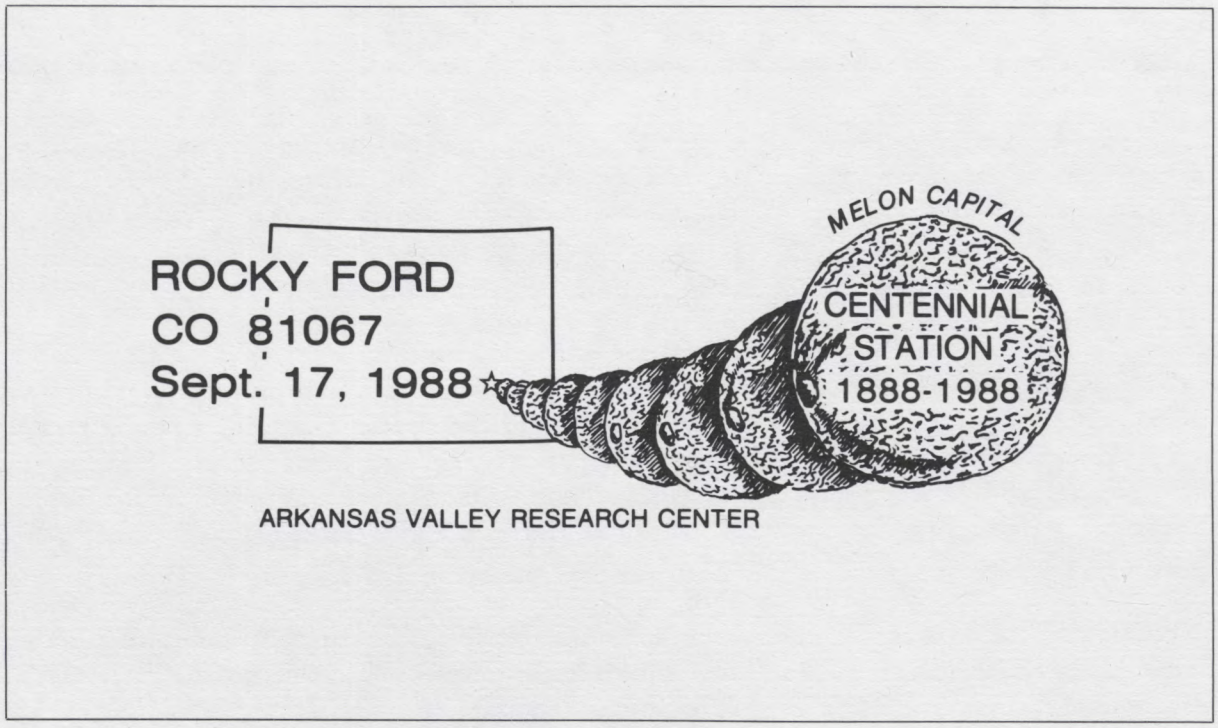
> There should be much stronger programs of site and situation specific agricultural research, designed to yield information on which farmers can plan, implement and manage profitable production and marketing systems in each of the specific soil climatic, and socio-economic situations of the nation's agricultural regions.

The above statement is based, in part, on the concept that site and situation specific research benefits other nations very little. With this research, we can capture the greatest competitive edge. To ensure this capacity is a major responsibility of the Agricultural Experiment Station system.

Almost immediately after the passage of the Hatch Act in 1887, Colorado's Sixth General Assembly authorized the establishment of experiment sub-stations in El Paso, Bent and Delta Counties and the San Luis Valley. Although the Agricultural Experiment Station's research centers can trace their history back to this legislation, only the Arkansas Valley Research Center and the San Luis Valley Research Center can show a direct lineage to the original sub-stations.

Arkansas Valley Research Center

The Arkansas Valley Research Center, established in 1888 at Rocky Ford, is the oldest center. Melons were among the first crops tested at the center, but research on alfalfa, onions, sugar beets, cereal and feed grains, and fruits and vegetables soon followed. Soil,



water, insect, disease, crop development and cultural management associated with major economic crops are major research thrusts at this station.

Also located at this center is the animal diagnostic laboratory to identify critical herd health management problems in livestock.

Eastern Colorado Research Center

The Eastern Colorado Research Center was purchased in 1952. The center, located midway between Akron and Sterling, consists of more than 3,700 acres of range and crop land. The research program concentrates on beef and range management including reproduction, nutrition, breeding and forage utilization.

Fruita Research Center

Agronomic research was started by the Agricultural Experiment Station in the Grand Valley in 1953, but it was not until 1964 that the Fruita Research Center was established. At that time, the Agricultural Experiment Station leased 40 acres of land near Fruita. In 1976 the leased acreage plus another 40 acres was purchased.

Research at the Fruita center emphasizes production efficiency and quality improvement of traditional crops; plant varietal development; identification and evaluation of new and alternate crops; conservation tillage; and water and soil management.

Field Day at Eastern Colorado Research Center

Field Day at Fruita Research Center

Mountain Meadow Research Center

Mountain Meadow Research Center Field Day, 1987

The Mountain Meadow Research Center, one of the newest centers to be added to the system, is located on the Western State College campus in Gunnison. This center is different from the rest of the research facilities in the Agricultural Experiment Station's research system. Colorado State neither owns or leases any land for research at this center. All research is conducted on lands of cooperating producers.

Research at the Mountain Meadow Research Center focuses on domestic and native grass variety selection, soil fertility, disease and insect control measures and improved management practices. Livestock management, in particular with relation to "high altitude disease" in cattle, has also been a part of the program at this center.

Rogers Mesa and Orchard Mesa Research Centers

Rogers Mesa Research Center is located 17 miles east of Delta near Hotchkiss. Orchard Mesa Research Center is located seven miles east and south of Grand Junction. The centers provide research and education services to fruit growers in Mesa, Delta and Montrose counties as well as to smaller fruit districts throughout the state.

Fruit Research Field Day

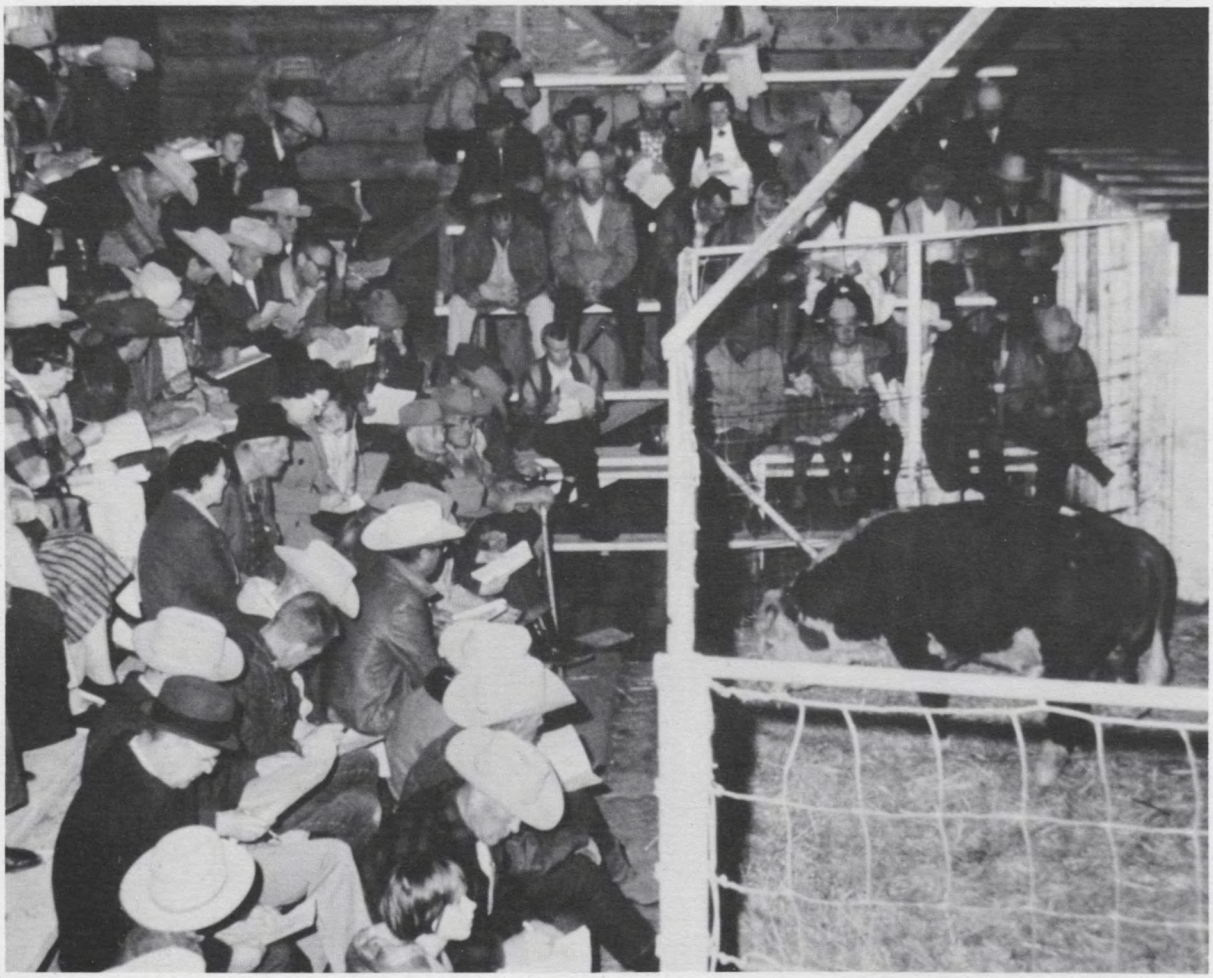
The fruit research program in Western Colorado goes back to 1922 when a 40 acre facility was established in Austin. In 1961 legislative approval was given to the Agricultural Experiment Station to purchase 80 acres of land on Rogers Mesa and an 80 acre fruit farm on Orchard Mesa.

During the last 25 years, researchers at the two centers have tested more than 400 varieties of apples, peaches, apricots, pears, nectarines, plums and sweet and sour cherries for their adaptability to Colorado conditions. The fruit research centers also led the way in Colorado in testing and recommending dwarfing and semi-dwarfing rootstocks.

Research center scientists have identified major economic pests and diseases that attack fruit and developed effective control strategies. The fruit research centers have contributed significantly to improved management practices that have helped producers improve their net income.

San Juan Basin Research Center

The San Juan Basin Research Center is located four miles south of Hesperus on the original site of Fort Lewis. In 1911, the federal government transferred the property to Colorado for a school of agriculture, mechanics and household arts. The school, Fort



Bull Sale at San Juan Basin Research Center at Hesperus

Lewis College, was relocated in 1956 to Durango. Since then the original site of Fort Lewis has served as the San Juan Basin Research Center.

Beef cattle and range improvement are the primary focus of research at this center. The main emphasis of the range science projects has been the evaluation of various methods of oakbrush control. Research efforts also concentrate on the improvement of beef-cattle performance. A 275-cow herd is used for this research. About one-third of the herd is comprised of 11 inbred lines of Hereford cattle and two inbred lines of Angus and Red Angus cattle.

This is the most highly inbred herd of beef cattle in the world. This herd has served needs in breeding, nutrition, disease and management research.

San Luis Valley Research Center

San Luis Valley Research Center Field Day

The San Luis Valley Research Center also traces its heritage to the 1888 legislation. The first San Luis Valley Research Center was established on 200 acres of state land seven miles east of Del Norte. Three years later it was moved to a location 4.5 miles north of Monte Vista.

In 1896 federal funds were reduced, the station could not be funded, and the program at the center was eliminated. It was not until 1940 that the San Luis Valley Potato Improvement Association and the San Luis Valley Potato Board of Control rented the present site of the research center located nine miles north of Monte Vista and started activities as the San Luis Valley Demonstration Farm. The improvement association purchased the farm in 1950 and turned it over to Colorado State University as a permanent research center for the Valley.

Research at the San Luis Valley Research Center concentrates on potato production, management practices and storage. However, research also is conducted on agronomic crops, other vegetable crops and new alternative crops. Plant development, disease, insect, water and soil management are major areas of research.

Southeastern Colorado Research Centers

Producers in the Southeastern corner of the state are served by the Southern Colorado Research Center near Springfield. The center was established in 1954 on 3,800 acres

Minimum Tillage Demonstration, Walsh

of land, a part of Comanche National Grassland, southwest of Springfield. In 1964, agronomic research under pump irrigation was begun in the Walsh area. In 1976 the agronomic research was moved to 40 acres near Walsh leased by the Plainsman Agri-Search Foundation.

Research at the Southeastern Colorado Research Center is concentrated in two main areas--agronomy and range management. Agronomy research includes studies to determine the best adapted crops and varieties for Southeastern Colorado. Work in range management includes a study of grazing value of native, seeded and "go-back" range and reseeding of rangeland with Russian wild rye to determine which row width is most satisfactory; alternative grazing systems; and the economics of rangeland management.

Southwestern Research Center at Yellow Jacket

Crop research began in Southwestern Colorado at the San Juan Basin Research Center near Hesperus in 1921. The major emphasis was to identify crops and varieties adapted to the high altitudes of Southwestern Colorado. By the mid-1940s, the drylands of Southwestern Colorado had developed into a major pinto bean producing area, and an extensive edible-dry bean program was developed. San Juan Select was developed at the center and released in 1946. This variety was grown almost exclusively in Southwestern Colorado until 1986 when Cahon, another variety developed by the Agricultural Experiment Station, took over first place.

Field Plots at Southwestern Colorado Research Center, Yellow Jacket

In 1962 a unit of the San Juan Basin Research Center was opened to study management of dryland soils and crops. The agronomy section of the San Juan Basin Research Center separated from animal science in 1971 and leased a farm 10 miles northwest of Cortez. The present 159 acre research center, located 15 miles north of Cortez at Yellow Jacket, was purchased by Colorado State in 1981.

One of the primary purposes of the Southwestern Colorado Agricultural Research Center is to collect data that will enhance the conversion of dryland farms to irrigated farms as water is provided by the Dolores River and the Animas-LaPlata projects. Research has concentrated on the selection of appropriate irrigation systems, irrigation water application practices, development of fertilization standards, pollution control measures, crop variety development and cultural practices.

COLORADO AGRICULTURAL EXPERIMENT STATION
RESEARCH CENTERS

Main Station, Fort Collins
Mark A. Brick, Agronomy Coordinator
Gary Greathouse, Animal Sciences Coordinator
Kenneth W. Knutson, Horticulture Coordinator

Arkansas Valley Research Center, Rocky Ford
Frank C. Schweissing, Superintendent (Agronomy)

Eastern Colorado Research Center, Akron
David N. Schutz, Manager (Animal Sciences)

Fruita Research Center, Fruita
Harold M. Golus, Superintendent (Agronomy)

Mountain Meadow Research Center, Gunnison
Eugene G. Siemer, Superintendent (Agronomy)

Orchard Mesa Research Center, Grand Junction
A. Richard Renquist, Superintendent (Horticulture)

Rogers Mesa Research Center, Hotchkiss
Kenneth S. Yu, Superintendent (Horticulture)

San Juan Basin Research Center, Hesperus
Alfred H. Denham, Superintendent (Animal Sciences)

San Luis Valley Research Center, Center
David G. Holm, Superintendent (Horticulture)

Southeastern Colorado Research Center, Springfield
Blaine Horn, Superintendent (Range Science)

Southwestern Colorado Research Center, Yellow Jacket
Adrian G. Fisher, Superintendent (Agronomy)

AGRICULTURAL EXPERIMENT STATION
Research Centers Advisory Committees

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Harry E. Blackburn
Sam Bourne
Tom Bregar
Earlin Bush
Dennis Caldwell
Don Cooper
Joey DeGarbo
Bill Elder
Glen Ermel
Joe Farmer
Robert Gerler
Hans Hansen
George Idler
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Allen Nicol
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Dean Rusher
John Tomky
Jim Valliant
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Eastern Colorado Research Center, Akron

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Herman Hettinger
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Don Koester
Bob LaBore
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Fruita Research Center, Fruita

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Vevarelle Esty
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Gordon Headlee
Eddie Howard
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Duane Phelps
Bill Sanderson
Bernard Smith
Cindy Smock
Lee Spann
Bill Trampe

Orchard Mesa Research Center, Grand Junction

Larry Fuller
Fritz Gobbo
Aaron Hall
Charles McKim
Dean Phillips
Richard Pobirk
Bruce Talbott
Rob VanDeusen

Rogers Mesa Research Center, Hotchkiss

Gary Broughton
Harold Broughton
Scott Ellis
Dean Phillips
Bill Tembrock
Dan Williams

San Juan Basin Research Center, Hesperus
Southwestern Research Center, Yellow Jacket

Loren Alexander
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Howard Richards
Bob Seaton
Kenneth Seibel
Betty Shanah
Terry Snyder
Noel Wellborn
Bill Whyman
Bill Wilcox
Dean Winward

San Luis Valley Research Center, Center

Dwight Freeman
James R. Myers
Steven Myers
Jerry Smith
Robert E. Wright

Southeastern Colorado Research Centers, Springfield and Walsh

Rex Barlow
Tim Brann
Forrest Burns
Mike Carroll
Roy Dunn
John Ebright
James Ellenberger
Don Fowler
Virgil Grabeal
Merle Hall
Chip Hines
Frank Jacobs
Rogers Johnson
A. C. Ming
Bernard Neill
Dean Nichols
Bob Pursley
Mike Reystead
Robert Shannon
Linly Stun
Terrill Swanson
Harold Unwin

U.S. Central Great Plains (USDA), Akron

Ronald Boyd
Ed Cecil
James Donnelly
Fred Fassler
Jan Fritch
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John Holtorf
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Gilbert LIndstrom
Warren McCue
Don Mais
ilton Mekelburg
Rob Pachner
Lowell Sonnenberg
Jay Spiers
Mark Wagers
Rick Zion

COLORADO AGRICULTURAL EXPERIMENT STATION
STATEMENT OF REVENUES AND EXPENDITURES

	1986-87 ACTUAL	1987-88 BUDGET ESTIMATE
REVENUES:		
State General Fund	$6,805,367	$6,494,319
Federal Appropriations	1,500,531	1,500,843
Cash Sales	240,000	240,000
Total	$8,545,898	$8,235,162
EXPENDITURES:		
Administration - Director's Office	$ 227,348	$ 215,346
Program	6,971,734	6,761,868
Utilities	414,855	381,988
Colorado State University Plant and Administration	931,961	875,960
Total	$8,545,898	8,235,162
Supplemental Request*		235,725
Total		$8,470,887

*The Colorado General Assembly approved a supplemental request for 1987-88 with a recommendation for continuing funding for 1988-89 to address the statewide Russian Wheat Aphid infestation.

Pedigree of Blount's Regenerated Defiance Wheat

PROF. A. E. BLOUNT, Agriculturist and Plant Breeder of the Colorado Experiment Station from 1879 to 1891, obtained from E. C. Pringle, in 1879, a small sample of Defiance wheat which Mr. Pringle claimed to have originated. From this foundation stock, Prof. Blount obtained a large number of average heads, the largest of which were not quite three inches in length, containing an average of 21 kernels each.

By following his rule, of "selecting the best to cross on the best to get a better off-spring, Prof. Blount, in 1885, had heads five to six inches long, each containing an average of 43 kernels. From 94 grains in 1886 he produced 3.15 lbs. of superior quality wheat from which foundation stock he increased for distribution to the wheat districts of Colorado, under the irrigation ditch.

This became the dominant spring wheat of Colorado early in the '90's, millers finding flour made from this wheat had a ready sale as superior biscuit flour all through the south. By 1903, through lack of seed selection, careless methods of threshing, seeding and irrigating, as well as following grain with grain, this Defiance wheat, in many sections of the state, had become seriously mixed.

Mr. A. H. Danielson, assistant Agriculturalist at Colorado Agricultural college, in 1903, found a bottle of the foundation stock of Defiance left by Prof. Blount, when he left the Colorado Station in 1891. This wheat was known to be at least 12 years old but was seeded hoping to obtain from this seed, plants to renew and regenerate this spring wheat which had given such excellent satisfaction to MILLER, FARMER and BAKER.

Three plants grew, one sending up 14 spikes. This superior plant was saved and the other two destroyed. From this foundation plant of the 1903 harvest, the best quality heads and most desirable kernels were saved and each year planted. By 1907 enough wheat was gathered to seed a scant ten-acre field. This field yielded a harvest of 650 bushels of good quality wheat for distribution By use of a seed grader we separated out the best quality, most desirable wheat kernels for seed purposes and found we had 300 bushels of the Regenerated Blount's Defiance wheat for distribution to Colorado farmers. We sent this wheat out in small lots varying from 25 lbs. to 100 lbs. per farmer in the spring of 1908.

This wheat has been approved by the Secretary of the Colorado Grain and Seed Growers Association and been given registration number as per following letter:---

"I hereby affirm that a sample of the Regenerated Blount's Defiance Wheat has been submitted to my inspection, as prepared for distribution to the wheat growers of Colorado. I am thoroughly familiar with the careful manner in which this grain has been developed and hereby assign this grain No. 1 on the registration books of the Colorado Association. All farmers receiving this wheat and complying with the requirements of this Association can maintain registration of this Wheat No. 1, Blount's Regenerated Defiance, by each year sending some of that year's harvest. Those purchasing this grain can have registered extension of pedigree on approval of pound sample of the wheat together with record of transfer from party making last registration, on payment of fees."

Very truly yours,

F. KNORR,

Secy. Colo. Grain & Seed Growers' Assn.

PEDIGREE

Wheat No. 1., Blount's Regenerated Defiance, Developed by the Colorado Experiment Station, 1903-1907, from foundation seed stock of Defiance Wheat developed by Prof. A. E. Blount from pure Defiance obtained from the originator of the wheat ---Mr. E. C. Pringle in 1879.

Seed from E. C. Pringle, 1879
Prof. A. E. Blount, 1879-1891
Colo. Experiment Station, 1903-1907
_____ 1908

W. H. OLIN,
Agronomist,
Colorado Experiment Station.

Reports to Industry

College of Agricultural Sciences

Department of Agricultural and Resource Economics

DALSTED, N.L., GUTIERREZ, P.H., SCHAUBERT, D., SHARP, R., and HOLMAN, K.L. 1987. Selected 1986 Crop Enterprise Budgets for Colorado. Agric. & Res. Econ. Information Report Number IR:87-6. Colo. State Univ., Fort Collins. 102 p.

DALSTED, N.L. 1987. Farm Management Update. Colorado Agri-Business Roundup. Winter 1987:7-8.

DALSTED, N.L. 1987. Northern Colorado Yearling Enterprise Analysis. 1987 Proceedings Yearling Cattle Management. 1:1-11.

GUTIERREZ, P.H., SHARP, R.L., SCHAUBERT, D.L., DALSTED, N.L., and HANSEN, J. 1987. Selected Livestock Enterprise Budgets for Colorado, 1986. Agric. & Res. Econ. Information Report IR:87-3. Colo. State Univ., Fort Collins. 61 p.

GUTIERREZ, P.H., HANSEN, H., DALSTED, N.L., SHARP, R.L., and SCHAUBERT, D.L. 1987. Backgrounding Enterprise Budgets for Colorado 1986. Agric. & Res. Econ. Information Report IR:87-7. Colo. State Univ., Fort Collins. 65 p.

GUTIERREZ, P.H. and GARLAND, F. 1987. Worksheet Template for Microcomputer Applications of Marketing Strategies for Beef Cattle Workbook. Dept. of Agric. & Res. Econ. Colo. State Univ., Fort Collins.

JONK, Y.C. 1987. Chapter 12: An Alternative for Financially Distressed Farmers and Ranchers. Colorado Agri-Business Roundup. Winter 1987:13-14.

JONK, Y.C. The Tax Reform Act of 1986: Overview of Major Provisions. Colorado Agri-Business Roundup. Winter 1987:14-15.

LEWIS, R.L., and LEWIS, J.H. 1987. Colorado Dairy Production Strategy under Milk Supply Management Constraints. Agric. & Res. Econ. Research Report Number AR:87-3. Colo. State Univ. September. 24 p.

LYBECKER, D.W. 1987. Feed and Grain Outlook. Colorado Agri-Business Roundup. Spring 1987:13-14.

LYBECKER, D.W. 1987. Colorado Corn Outlook. Colorado Rancher and Farmer. 41(No. 4):10.

LYBECKER, D.W. 1987. Feed and Grain Situation. Colorado Agri-Business Roundup. Winter 1987:23-24.

MANN, R., SPARLING, E., and YOUNG, R. 1987. Regional Economic Growth from Irrigation Development. Agric. & Res. Econ. Working Paper WP:87-1. Colo. State Univ., Fort Collins. 23 p.

MCKEAN, J.R. and TAYLOR, G.R. 1987. The Dilemma of the World Mercantilist Gridlock: A Commentary. Colorado Agri-Business Roundup. Winter. Colo. State Univ. 2 p.

MILLER, T.A., GRAY, S.L., and TROCK, W.L. 1987. Colorado's Farm and Food System: Economic Contributions to Rural and Metropolitan Counties. Res. Rpt. AR:87-5, Dept. of Agric. and Res. Econ., Colo. State Univ., Fort Collins. 41 p.

RADOSEVICH, G.E. and COPPLE, K.S. 1987. Understanding the Producer's Rights under Chapter 12 of the Bankruptcy Code. Dept. of Agric. & Res. Econ. Research Report Number AR:87-1. Colo. State Univ., Fort Collins. 14 p.

SCHNITTKER, J.M. 1987. Proposed Changes to Present Farm Policies. Colorado Agri-Business Roundup, Colo. State Univ., Fort Collins. Winter. pp. 11-12.

SHAUBERT, D.L., SHARP, R.L., GUTIERREZ, P.H., and DALSTED, N.L. 1987. The Colorado Farm/Ranch Business Management Program: 1983-1985 Annual Summary. Agric. & Res. Econ. Information Report Number IR:87-4. Colo. State Univ., Fort Collins. 35 p.

SPARLING, E.W. 1987. Sugar Outlook. Colorado Agri-Business Roundup. Spring 1987:20.

SPARLING, E.W. 1987. Sugar Situation. Colorado Agri-Business Roundup. Winter 1987:25.

SPENCER, W.P. 1987. Grain Flow Survey: 1987. Agric. & Res. Econ. Research Report Number AR:87-7. Colo. State Univ., Fort Collins. September. 11 p.

TINNERMEIER, R.L. AND GARLAND, F. 1987. Agricultural Credit Situation. Colorado Agri-Business Roundup. Colo. State Univ., Fort Collins. Winter. pp. 4-5.

TROCK, W. 1987. Midcourse Correction in Agricultural Policy. Colorado Agri-Business Roundup. Colo. State Univ., Fort Collins. Spring. pp. 8-9.

TROCK, W., BRADLEY, E., and ANDERSEN, J. 1987. Outlook for U.S. Agriculture Under Policy Scenarios. Wyoming Stockman Farmer. January. pp. 14-17.

Department of Animal Sciences

ANDERSON, K.J., BRINKS, J.S., LEFEVER, D.G., ASBURY, W.C., SCHAFER, D.W., and MOON, J.L. 1987. Reproductive Performance of Angus Heifers. Colo. State Univ. Beef Program Report, pp. 71-75.

ASBURY, W.C. and BRINKS, J.S. 1987. A Look at Serving Capacity. Colo. State Univ. Beef Program Report, pp. 67-70.

BIRKELO, C.P., JOHNSON, D.E., and PHETTEPLACE, H.P. 1987. Maintenance Requirements of Beef Cattle as Affected by Season on Differing Planes of Nutrition. Colo. State Univ. Beef Program Report, p. 1.

BLASI, D.A., LAMM, W.D., BRINKS, J.S., and TATUM, J.D. 1986. An Evaluation of Calves Sired by Piedmontese, Gelbvieh and Red Angus Breeds of Cattle. I. Growth Traits. Colo. State Univ. Beef Program Report.

CARSTENS, G.E., JOHNSON, D.E., HOLLAND, M.D., and ODDE, K.G. 1987. Basal Metabolism in Newborn Beef Calves. Colo. State Univ. Beef Program Report, p. 13.

HOLLAND, M.D., ODDE, K.G., and JOHNSON, D.E. 1987. Effects of Dietary Protein Intake in Two-year-old Heifers on Gestation Length, Birth Weight and Colostral, and Calf Serum Immunoglobin Levels. Colo. State Univ. Beef Program Report, p. 7.

SCHAFER, D.W., BRINKS, J.S., LEFEVER, D.G., ASBURY, W.C., ANDERSON, K.J., and MOON, J.L. 1987. Effects of Management and Treatment on Estrus Synchronization and Pregnancy Rate in Mature Angus Cows. Colo. State Univ. Beef Program Report, pp. 61-65.

SCHMIDT, G.R., MEANS, W.J., and SOFOS, J.N. 1987. Restructuring Beef with the Algin/Calcium Gelation Mechanism. Colo. State Univ. Beef Program Report, pp. 53-59.

SOFOS, J.N. 1987. Weight Losses and Shelf-Life of Low Salt Meat Products with Combinations of Phosphates and Sorbates. Colo. State Univ. Beef Program Report, pp. 45-51.

STANTON, T.L., LISCO, D.J., LISCO, C.E., and BIRKELO, C.P. 1987. Effect of Whole and Dry Rolled Corn Combinations on Growing-Finishing Steer Performance. Colo. State Univ. Beef Program Report, pp. 19-20.

STANTON, T.L., FLACK, D.E., BIRKELO, C.P. and BENNETT, B.W. 1987. Effect of Abortion on Individually Fed Finishing Heifer Performance. Colo. State Univ. Beef Program Report. pp. 25-29.

TATUM, J.D., GRONEWALD, K.W., LAMM, W.D., and BRINKS, J.S. 1987. Composition and Quality of Beef Steers Sired by Piedmontese, Gelbvieh, and Red Angus Bulls. Colo. State Univ. Beef Program Report, pp. 31-38.

Journals

College of Agricultural Sciences

Department of Agricultural and Resource Economics

HOLMAN, D.M., SKOLD, M.K., and HEERMANN, D.F. 1987. Monitoring and Control of Center Pivot Spinklers with Microcomputers. Water Resources Bulletin. 23:903-909.

HUSSAIN, R.Z. and YOUNG, R.A. 1987. Salinity Damages to Irrigated Crops: Economic Measurements from a Farm Survey in Pakistan. In Bellamy, M. and Greenshields, B. (eds.) Agriculture and Economic Instability. Gower Publishing, Aldershot (UK).

MANN, R., SPARLING, E., and YOUNG, R. 1987. Regional Economic Growth from Irrigation Development: Evidence from Northern High-plains Ogallala Groundwater Resource. Water Resources Research. 23(9):1711-1716.

RAFSNIDER, G.T., SKOLD, M.D., and SAMPATH, R.K. 1987. Range Survey Cost Sharing and the Efficiency of Rangeland Use. Land Economics 63:92-101.

SKOLD, M.D. 1987. Agricultural Price Policies, Policy Goals, and Methods of Estimating Costs of Production. Agricultural and Economic Instability. Margot Bellamy and Bruce Greenshields (eds.). Inter. Assoc. of Agr. Economists. Gower. London. pp. 338-342.

YOUNG, R.A. 1987. Market vs. Non-market Management of Irrigation Water: A Review of the Issues. Water and Water Policy in World Food Supplies. Wayne R. Jordan (editor). Texas A & M University Press. College Station, Texas. Chapter 32.

Department of Agronomy

ADAMSEN, F.J. and SABEY, B.R. 1987. Ammonia Volatilization from Liquid Digested Sewage Sludge as Affected by Placement in Soil. Soil Sci. Soc. Am. J. 51:1080-1082.

BARBARICK, K.A. and WORKMAN, S.M. 1987. Ammonium Bicarbonate - DTPA and DTPA Extractions of Sludge-amended Soils. J. Environ. Qual. 16:125-130.

CARREN, C.J., WILSON, A.M., CUANY, R.L., and THOR, G.L. 1987. Caryopsis Weight and Planting Depth of Blue Grama. I. Morphology, Emergency, and Seedling Growth, J. Range Manage. 40(3):207-211.

CARREN, C.J., WILSON, A.M., and CUANY, R.L. 1987. Caryopsis Weight and Planting Depth of Blue Grama. II. Emergence in Marginal Soil Moisture. J. Range Manage. 40(3):212-216.

ELRASHIDI, M.A. ADRIANO, D.C., WORKMAN, S.M. and LINDSAY, W.L. 1987. Chemical Equilibrium of Selenium in Soils: A Theoretical Development. Soil Sci. 144:141-152.

ELRASHIDI, M.A. and LINDSAY, W.L. 1987. Effect of Fluoride on pH, Organic Matter, and Solubility of Elements in Soils. Environ. Pollution 47:123-133.

FIELDER, R.J., SANDER, D.H., and PETERSON, G.A. 1987. Predicting Winter Wheat Grain Yield Response to Applied P with Different Soil P Tests and Sampling Depths. J. Fert. Issues. 4:19-28.

FOLLETT, R.H., WESTFALL, D.G., ECHOLS, J.W., CROISSANT, R.L., and QUICK, J.S. 1987. Integration of Soil Fertility Trials into On-going Cultivar Testing Programs. J. Agron. Ed. 16(2).

FOLLETT, R.H., WESTFALL, D.G., and CROISSANT, R.L. 1987. Soil Test Recommendation Comparison Study. J. Agron. Ed. 16:73-76.

FOLLETT, R.H., WESTFALL, D.G., QUICK, J.S., and ECHOLS, J.M. 1987. Integration of Soil Fertility Trials into On-going Cultivar Testing Programs. J. Agron. Ed. 16:81-84.

KENNO, H., BRICK, M.A., and TOWNSEND, C.E. 1987. Establishment of Cicer Milkvetch with Four Cool-season Grasses. Crop Sci. 27:810-812.

LAMB, J.A., DORAN, J.W., and PETERSON, G.A. 1987. Nonsymbiotic Dinitrogen Fixation in No Till and Conventional Wheat-Fallow Systems. Soil Sci. Soc. Am. J. 51:356-361.

LINDSAY, W.L. 1987. Solubility and Redox Equilibria of Fe Compounds in Soils. In Iron in Soils and Clay Minerals, pp. 37-62, eds. Stucki, J.W., Goodman, B.A., and Schwertmann, U. Proc. NATO Adv. Study Inst. on Iron in Soils and Clay Minerals, Bad Windsheim, West Germany, July 13, 1985. Reidel Pub., The Netherlands. December, 1987.

NASON, D., CUANY, R.L., and WILSON, A.M. 1987. Recurrent Selection in Blue Grama. I. Seedling Water Uptake and Shoot Weight. Crop Sci. 27:847-851.

REDDY, K.J. and LINDSAY, W.L. 1987. Availability and Uptake of Trace Elements from Recarbonated Retorted Shale. J. Environ. Sci. 16:168-171.

REUSS, J.O., COSBY, B.J., and WRIGHT, R.F. 1987. Chemical Processes Governing Soil and Water Acidification. Nature 329:27-31.

REUSS, J.O. and WALTHALL, P.M. 1988. Soil Reactions and Acid Deposition. In Advances in Environmental Sciences. (Eds.) Adriano, D. and Salomons, W. Springer-Verlag, NY. (In press)

REUSS, J.O. 1987. The Transfer of Acidity from Soils to Water. In Soil Acidity. (Eds.) Ulrich, B. and Sumner, M. Springer-Verlag, Heidelberg. (In press)

RUSSELL, R.E., WESTFALL, D.G., and BARBARICK, K.A. 1987. Spring N Fertilization of Dryland Winter Wheat. J. Fert. Issues 4:73-78.

SCHWARTZ, H. F., CASCIANO, D.H., ASENGA, J.A., and WOOD, D.R. 1987. Field Measurement of White Mold Effects Upon Dry Beans with Genetic Resistance or Upright Plant Architecture. Crop Science 27:699-702.

SHAHLA, A. and TSUCHIYA, T. 1987. Cytogenetic Studies in Barley Chromosome 1 by Means of Telotrisomic, Acrotrisomic, and Conventional Analysis. Theor. Appl. Genet. (In press).

SHANAHAN, J.F. and NIELSEN, D.C. 1987. Influence of Growth Retardants (anti-gibberellins) on Corn Vegetative Growth, Water Use, and Grain Yield. Agron. J. 79:103-109.

SIMEONI, L.A., LINDSAY, W.L., and BAKER, R. 1987. Critical Iron Level Associated with Biological Control of Fusarium Wilt. Phytopath. 77:1057-1061.

STILLWATER, R. and KLUTE, A. 1987. Improved Methodology for the Measurement of Water Content and Soil Bulk Density Using a Collinear Dual Energy Gamma Radiation System. Water Resources Research. (Accept for pub.)

TSUCHIYA, T. 1987. Recent Progress in Chromosome Engineering in Barley and Sugarbeet. In: Recent Advances in Breeding 28:51-61.

VOOS, G. and SABEY, B.R. 1987. Nitrogen Mineralization in Sewage-Sludge-Amended Coal Mine Spoil and Topsoils. J. Environ. Qual. 16:231-237.

WESTFALL, D.G. and STROHMAN, R. 1987. Fertilizer Applicator/Planter for No-till Small Grain Research. Agron. J. 79:177-180.

WESTFALL, D.G., WARD, J.M., WOOD, C.W., and PETERSON, G.A. 1987. Surface Band Application of N and P on Dryland Winter Wheat. J. Fert. Issues 4:114-121.

WESTFALL, D.G., WARD, J.M., and WOOD, C.W. 1987. Mother Nature Improves Phosphorus Placement. Solutions 31(6):24-26.

WESTFALL, D.G., WARD, J.M., and PETERSON, G.A. 1987. Placement of P for Summer Fallow Dryland Winter Wheat Production. J. Fert. Issues 4:114-121.

Department of Animal Sciences

BOURDON, R.M. and BRINKS, J.S. 1987. Simulated Efficiency of Range Beef Production. I. Growth and Milk Production. J. Ani. Sci. 65:943-955.

BOURDON, R.M. and BRINKS, J.S. 1987. Simulated Efficiency of Range Beef Production. II. Fertility Traits. J. Ani. Sci. 65:956-962.

BOURDON, R.M. and BRINKS, J.S. 1987. Simulated Efficiency of Range Beef Production. III. Culling Strategies and Nontraditional Management Systems. J. Ani. Sci. 65:963-969.

BOURDON, R.M. 1988. Bovine Nirvana - From the Perspective of a Modeler and Purebred Breeder. J. Ani. Sci. (Accept for pub.)

BOYLE, D.L., SOFOS, J.N., and MAGA, J.A. 1987. Inhibition of Spoilage and Pathogenic Microorganisms by Liquid Smoke from Various Woods. Lebensm, Wissensch, and Technol. (Accep for pub.)

CARSTENS, G.E., JOHNSON, D.E., HOLLAND, M.D., and ODDE, K.G. 1987. Effects of Prepartum Protein Nutrition and Birth Weight on Metabolism in Bovine Neonates. J. Ani. Sci. 65:745.

CLARKE, A.D., MEANS, W.J. and SCHMIDT, G.R. 1987. Effects of Storage Time, Sodium Chloride, and Sodium Tripolyphosphate on Yield and Microstructure of Comminuted Beef. J. Food Sci. 52:854-856, 860.

CLARKE, A.D., SOFOS, J.N., and SCHMIDT, G.R. 1987. Effect of Algin/Calcium, pH and Muscle Proteins on Gelation and Microstructure of Gels and Structured Beef. Lebensm, Wissensch, and Technol. (Accept for pub.)

DODSON, M.V., ALLEN, R.E., SHIMIZU, N., SHIMIZU, Y., and HOSSNER, K.L. 1987. Interaction of Obine Somatomedin and Multiplication Stimulating Activity/Rat Insulin-like Growth Factor II with Cultured Skeletal Muscle Satellite Cells. Acta Endocrinol. 116:425-432.

DODSON, M.V., MATISON, B.A., and HOSSNER, K.L. 1987. Ovine Somatomedin Binding to Ovine-Muscle-Derived Fibroblasts: Similarity to IGF-I. Acta Endocrinol. 116:186-192.

HOSSNER, K.L. and LINK, G.A. 1988. Comparison of IGF-I Serum Binding Proteins in Sheep and Cattle: Species Differences in Size and Endogenous Binding Capacities. J. Ani. Sci. In Press.

LAMM, W.D. Integrated Resource Management Program for Beef Cattle. Polled Hereford Assoc. J.

MEANS, W.J., CLARKE, A.D., SOFOS, J.N., and SCHMIDT, G.R. 1987. Binding Properties, Sensory Parameters and Storage Stabilty of Algin/Calcium Structured Beef Steaks. J. Food Sci. 52:252-256, 262.

MEANS, W.J. and SCHMIDT, G.R. 1987. Restructuring Fresh Meat Without the Use of Salt or Phosphate. In: Advances in Meat Research Vol. 3: Restructured Meat and Poultry Products. Ed. Pearson, A.M. and Dutson, T.R., AVI Pub. Co., pp. 469-488.

MILLER, R.K., CROSS, H.R., CROUSE, J.D., and TATUM, J.D. 1987. The Influence of Diet and Time on Feed on Carcass Traits and Quality. Meat Sci. 19:303.

ROMPALA, R.E., JOHNSON, D.E., RUMPLER, W.V., PHETTEPLACE, H.W., and PARKER, C.F. 1987. Level of Alimentation and Line of Breeding on Oxygen Uptake by Ovine Jejunal Mucosa. Am. J. Physiol. 252:R398.

SCHMIDT, G.R., HOLLINGSWORTH, C.A., and SLEETH, R.B. 1987. Future of Restructured Meat and Poultry Products. In: Advances in Meat Research Vol 3: Restructured Meat and Poultry Products. Ed. Pearson, A.M. and Dutson, T.R., AVI Pub. Co., pp. 489-496.

SCHMIDT, G.R. 1987. Functional Behavior of Meat Components in Processing. In: The Science of Meat and Meat Products (Third Edition). Ed. Price, J.F. and Schweigert, B.S., FNP Westport, CT. pp. 413-430.

SOFOS, J.N. and MAGA, J.A. 1987. Composition and Antimicrobial Properties of Liquid Spice Smokes. In: Frontiers of Flavor. Ed. Charalambous, G., Elsevier Science Publishers, B. V., Amsterdam. (In press)

SOFOS, J.N. 1987. Detection of Injured Sporeforming Bacteria from Foods. In: Detection of Injured Index and Pathogenic Microorganisms in Foods, Water and Feeds. Ed. Ray, B., CRC Press Inc., Boca Raton, FL. (Accept for pub.)

STANTON, T.L., BIRKELO, C.P., FACK, D.E., and BENNETT, B.W. 1987. Effect of Abortifacient on Open, Individually Fed Finishing Heifer Performance. Agric-Practice. Nov/Dec, Vol. 8, 7:27-30.

SUGIYAMA, H. and SOFOS, J.N. 1987. Clostridia. In: Developments in Microbiology - 4. Ed. Robinson, R.K., Elsevier Applied Science Publishers Ltd., Amsterdam. (Accept for pub.)

TATUM, J.D., KLEIN, B.J., WILLIAMS, J.R., and BOWLING, R.A. 1987. Influence of Diet on Growth Rate and Carcass Composition of Steers Differing in Frame Size and Muscle Thickness. J. Ani. Sci. (Accept for pub.)

TROUT, G.R. and SCHMIDT, G.R. 1987. The Effect of Cooking Temperature on the Functional Properties of Beef Proteins: The Role of Tripolyphosphate, pH and Pyrophosphate. Meat Sci. 20(2):129-147.

TROUT, G.R. and SCHMIDT, G.R. 1987. Nonprotein Additives. In: Advances in Meat Research Vol 3: Restructured Meat and Poultry Products. Ed. Pearson, A.M. and Dutson, T.R., AVI Pub. Co., pp. 307-330.

TUFFT, L. and NOCKELS, C.F. 1987. Trace Element Changes in E. coli Infected Chicks. Poultry Sci. 66:(Supplement 1)166.

Department of Entomology

BJOSTAD, L.B. 1987. Insect Electroantennogram Responses to Semiochemical Recorded with a Personal Computer. Physiol. Entomol. (In press.)

BJOSTAD, L.B., WOLF, W.W., and ROELOFS, W.L. 1987. Pheromone Biosynthesis in Lepidopterans: Desaturation and Chain-Shortening. Chapter 3 (pp. 77-120) in Pheromone Biochemistry (ed. Prestwich G. Blomquist G). Am. Chem. Soc., Boca Raton, FL.

CAPINERA, J.L. 1987. ed. Integrated Pest Management on Rangeland, a Shortgrass Prairie Perspective. Westview Press.

CAPINERA, J.L. 1987. Population Ecology of Rangeland Grasshoppers. In J. L. Capinera, ed.

CAPINERA, J.L. and THOMPSON, D.C. 1987. Dynamics and Structure of Grasshopper Assemblages in Shortgrass Prairie. Can. Entomol. 119:567-575.

CAPINERA, J.L. 1987. Observations on Natural and Experimental Parasitism of Insects by Mermis Nigresceus Dujardin (Nematoda: Mermithidae). J. Kansas Entomol. Soc. 60:159-162.

FRANKIE, G.W., BREWER, J.W., CRANSHAW, W.S. and BARTHELL, J.F. 1987. Abundance and Natural Enemies of the Spindle Gall Mide in Natural and Urban Stands of Pinyon Pine in Colorado. J. Kansas. Entomol. Soc. 69:133-44.

HIBBARD, B.E. and BJOSTAD, L.B. 1987. Behavioral Responses of Western Corn Rootworm Larvae to Volatile Semiochemicals from Corn Seedlings. J. Chem. Ecol. (Accepted. In press.)

KRASSNOFF, S.B., BJOSTAD, L.B., and ROELOFS, W.L. 1987. Quantitative and Qualitative Variation in the Male Pheromones of Phragmatobia fuliginosa and Pyrrharctia isabella. J. Chem. Ecol. 13:807-822.

MEYER, W.L., CRANSHAW, W.S. and EICHLIN, T.D. 1988. Flight Patterns of Clearwing Borers in Colorado Based on Pheromone Trap Captures. Southwestern Entomologist. (In press)

O'NEILL, K.M. and BJOSTAD, L.B. 1987. Mating Behavior and Morphological Adaptations for Mate Guarding in Males of the Bee Nomia nevadensis. Pan-Pac. Entomol. 63:207-217.

ROELOFS, W.L., DU, J.W., LINN, C.E., GLOVER, T.J., and BJOSTAD, L.B. 1987. The Potential for Genetic Manipulation of the Redbanded Leafroller Moth Sex Pheromone Blend. Evoluationary Genetics of Invertebrate Behavior (ed. Huettel, M. D.). Plenum Publishing Corp., NY. pp. 263-272.

THOMPSON, D.C. 1987. Sampling Rangeland Grasshoppers. In J. L. Capinera, 1987 (ed). Integrated Pest Management on Rangelands, pp. 219-233.

Department of Horticulture

BARTOLO, M.E. WALLNER, S.J., and KETCHUM, R. 1987. Comparison of Freezing Tolerance in Cultured Plant Cells and Their Respective Protoplasts. Cryobiology. 24:53-57.

GOLDSBERRY, K.L. and LANG, R. 1987. Response of Gerbera to Root Zone Heating in Soil and Gravel Substrates. HortScience 22:595-597.

HANAN, J.J., COKER, F.A., and GOLDSBERRY, K.L. 1987. A Climate Control System for Greenhouse Research. HortScience 22:704-708.

HOLM, D.G. and THORNTON, M.K. 1987. Colorado. National Potato Germplasm Evaluation and Enhancement Report, 1986. (ed. Webb, R.E.). USDA, Beltsville, MD. pp. 50-56.

HOLM, D.G., TWOMEY, J.A., and WORKMAN, M. 1987. Ute Russet: An Oblong Russet Potato Cultivar with Resistance to Leafroll Net Necrosis and Sclerotium Rolfsii. Am. Potato J. 64:559-562.

HOLM, D.G. 1988. Sangre Selection Studies: I. Selection and Comparative Trials. Am. Potato J. 65: (In press).

KRUSE, G.E., ELLS, J.E., and MCSAY, A.E. 1987. Comparison of Two Onion Irrigation Scheduling Programs. J. Am. Soc. Hort. Sci. 112(5):738-742.

LARSEN, H.J. 1987. Evaluation of Fungicides for Control of Powdery Mildew, 1986. (Apple). Fungicide and Nematicide Tests 41: (In press).

MOORE III, F.D. and JOLLIFFE, P.A. 1987. Mathematical Characterization of Seed Mortality in Storage. J. Am. Soc. Hort. Sci. 112(4):681-686.

MOORE III, F.D., JOLLIFFE, P.A., STANWOOD, P.C. and ROOS, E.E. 1987. Use of the Richards Function to Interpret Single Seed Conductivity Data. HortSci. (Acc. for pub.)

PANTER, K.K. and HANAN, J.J. 1987. Stomatal Resistance and Water Potential of Calceolaria Grown Under Two Different Heating System. J. Am. Soc. Hort. Science. 112:637-641.

RENQUIST, A.R. 1987. Evapotranspiration Calculations for Young Peach Trees and Growth Responses to Irrigation Amount and Frequency. HortSci. 22:221-223.

RENQUIST, A.R., HUGHES, H.G., and ROGOYSKI, M.K. 1987. Solar Injury of Raspberry Fruit. HortSci. 22:396-397.

RENQUIST, A.R. and HUGHES, H.G. 1987. Fruit Yield and Solar Injury Comparison of Two Primocane Fruiting Red Raspberries. Fruit Var. J. 41:133-135.

RENQUIST, A.R. and HUGHES, H.G. 1987. Fruit Yield and Solar Injury Comparison of Two Primocane Fruiting Red Raspberries. Fruit Var. J. 41:133-135.

ROKOYSKI, M.K. RENQUIST, A.R., and YU, K.S. 1987. Peach Industry in Intermountain Areas of Colorado and Utah (ed. Childers, N.F.). The Peach. (Acc. for pub.)

WADDELL, J.W. and WALLNER, S.J. Cell Wall Changes During Cold Acclimation of Pea Seedlings. Plant, Cell, and Environment. (In press.)

WEISER, R.L. and WALLNER, S.J. Freezing Woody Plant Stems Produces Acoustic Emissions. J. Amer. Soc. Hort Sci. (In press.)

YU, K.S. and NC-140 REGIONAL COMMITTEE. 1987. Growth and Production of 'Starkspur Supreme Delicious' on 9 Rootstocks in the NC-140 Cooperative Planting. Fruit Varieties J. 41(1):31-39.

Department of Plant Pathology and Weed Sciences

DONALD, W.W. and ZIMDAHL, R.L. 1987. Persistance, Germinability and Distribution of Jointed Goatgrass (Aegilops cylindrica) Seed in Soil. Weed Sci. 35:149-154.

HARRISON, M.D., FRANC, G.D., MADDOX, D.A., MICHAUD, J.E., and MCCARTER-ZORNER, N.J. 1987. Presence of Erwinia Carotovora in Surface Water in North America. J. App. Bacteriology 62:565-570.

HILL, J.P., ARMITAGE, C.R., KAUTZMAN-EADES, D., and HANCHEY, P. 1987. Surface Disinfestation of Wheat Seed and Inoculation of Seedling Roots with Single Macroconidia of Fusarium acuminatum. Plant Disease 71:130-131.

MERRILL, L.A., HAWKSWORTH, F.G., and JACOBI, W.R. 1987. Frequency and Severity of Ponderosa Pine Dwarf Mistletoe in Relation to Habitat Type and Topography in Colorado. Plant Disease 71:342-344.

STOCKWELL, V. and HANCHEY, P. 1987. Signification of Lesion Borders in Rhizoctonia-Infected Bean Hypocotyls. Phytopathology 77:589-593.

College of Applied Human Sciences

Department of Food Science and Human Nutrition

JANSEN, G.R., GRAYSON, C., and HUNSAKER, H. 1987. Wheat Gluten Fed During Pregnancy and Lactation: Effects of Mammary Gland Development and Pup Viability. Am. J. Clin. Nutr. 46:250-257.

KIM, C.H. and MAGA, J.A. 1987. The Extrusion of Potato Flour and Starch with Various Dried Distiller Grains. J. Food Sci.

KURACINA, T.A., LORENZ, K., and KULP, L. 1987. Starch Functionality as Affected by Amylases from Different Sources. Cereal Chem. 64:182-186.

LORENZ, K. and HWANG, Y.S. 1986. Lipids in Proso Millet (Panicum milliaceum) Flours and Brans. Cereal Chemistry 63:387-390.

LORENZ, K. 1986. Ball-milling of Flour: Effects of Quality of Bread Made by the Mechanical Dough Development Process. New Zealand J. of Tech. 2:183-186.

LORENZ, K. and BARUCH, D. 1986. Interrelationships Between Flour Yield, Particle Size Distribution, and Flour Baking Performance in the Mechanical Dough Development Process. New Zealand J. of Tech. 2:33-36.

College of Arts, Humanities and Social Sciences

Department of Sociology

KNOP, E. 1987. Alternative Perspectives on Community Impacting: Toward Complementary Theory and Application. Soc. Inquiry. 57:(3):273-291.

KNOP, E. 1988. Holistic Anthropology in Interdisciplinary Rural Development: Insights from a Domestic Farming Systems Case. In Lawrence Van Horn, ed., Holistic Anthropology in Application (a Nat'l Assoc. of Practicing Anthropologists monograph). 48 p.

College of Engineering

Department of Agricultural and Chemical Engineering

ALVAREZ-MARTINEZ, L., KONDURY, K.P., and HARPER, J.M. 1987. A General Model for Expansion of Extruded Products. J. Food Sci. (In press.)

CHRESAND, T.J., DALE, B.E., HANSON, S.L., and GILLIES, R.J. 1987. A Stirred Bath Technique for Diffusivity Measurement in Cell Matrices. Biotech. Bioeng. (In Press.)

CHRESAND, T.J., GILLIES, R.J., and DALE, B.E. 1987. Optimum Fiber Spacing in a Hollow Fiber Bioreactor. Biotech. Bioeng. (In Press.)

DALE, B.E. 1987. Lignocellulose Conversion and the Future of Fermentation Biotechnology. Trends in Biotech. 5:287-291.

DUKE, H.R., CROOKSTON, M.C., HANBURG, G.R., HESS, M.E., ISRAELI, I., LOUDON, T.L., and SCOTT, J.A. 1987. Scheduling Irrigation: A Guide for Improved Irrigation Water Management Through Proper Timing and Amount of Water Application. USDA Soil Cons. Serv. Tech. Publ. (In Press.)

EL-HAKIM, O., CLYMA, W., and RICHARDSON, E.V. 1987. Quality Performance Functions for Border Irrigation. J. of Irrig. and Drainage of ASCE. (In Press.)

EL-HAKIM, O., SRITHARAN, S., CLYMA, W., and RICHARDSON, E.V. 1987. Performance Parameter Functions and Optimal Design of Border Irrigation Systems. J. of Water Resources Planning and Management of ASCE. (In Press.)

HARCUM, J.B. and LOFTIS, J.C. 1987. Design and Evaluation of Regional Weather Monitoring Networks. Trans. ASAE. (In Press.)

HARPER, J.M. 1986. Processing Characteristics of Food Extruders. In Food Engineering and Processing Applications. Vol. 2. Unit Operations. M. LeMaguer and P. Jelen, eds. Elsevier Appl. Sci. Pub. Co., New York, NY. pp. 101-114.

HARPER, J.M. 1987. Effects of Extrusion Processing on Nutrients. In Nutritional Evaluation of Food Processing, 3rd Edition. E. Karmas and R. S. Harris, eds. AVI Publ. Co., Westport, CT. pp. 365-391.

HARPER, J.M. 1987. High-Temperature Short-Time Extrusion Cooking. In Food Technology International-Europe 1987. A. Turner, ed. Sterling Publ., Ltd., London, UK. pp. 51-55.

HARRIS, J., LOFTIS, J.C., and MONTGOMERY, R.H. 1987. Statistical Methods for Characterizing Ground Water Quality. Ground Water. 25(2):176-184.

HOUGHTALEN, R.J. and LOTFIS, J.C. 1987. Irrigation Water Delivery System Operation via Aggregate State Dynamic Programming. Water Res. Bul. (In Press.)

KUEPER, B.H. and MCWHORTER, D.B. 1987. Mechanics and Mathematics of Immiscible Fluids in Porous Media. Chpt. 2 in Dense Organic Solvents in Ground Water, J.A. Cherry and J. Pankow, eds. Univ. of Waterloo Press, Ontario, Canada. (In review.)

LINDEN, J.C., HENK, L.L., MURPHY, V.G. SMITH, D.H. GABRIELSEN, B.C., TENGERDY, R.P., and CZAKO, L. 1987. Preservation of Potential Fermentables in Sweet Sorghum by Ensiling. Biotechnol. Bioeng. 30:860-867.

LOFTIS, J.C. and HOUGHTALEN, R.J. 1987. Optimizing Temporal Water Allocation by Irrigation Ditch Companies. Trans. ASAE. 30(4):1075-1082.

MCCORNICK, P.G., DUKE, H.R., and PODMORE, T.H. 1987. Field Evaluation Procedure for Surge Irrigation. Trans. ASAE. (In press.)

MELICK, M.R., KARIM, M.N., LINDEN, J.C., DALE, B.E., and MIHALTZ, P. 1987. Mathematical Modeling of Ethanol Production by Immobilized Zymomonas Mobilis. Biotech. Bioeng. 29:370-382.

MONTGOMERY, R.H. and LOFTIS, J.C. 1987. The Applicability of the Student's "t" Test for Detecting Trends in Water Quality. Water Res. Bul. 23(4):653-662.

MONTGOMERY, R.H., LOFTIS, J.C., and HARRIS, J. 1987. Statistical Characteristics of Ground Water Quality Variables. Ground Water. 25(2):185-193.

SRITHARAN, S., CLYMA, W., and RICHARDSON, E.V. 1987. On the Sizing of Terminal Units in Surface Irrigation Projects - I. J. of Water Res. Planning and Manag. of ASCE. (In Press.)

SRITHARAN, S., CLYMA, W., and RICHARDSON, E.V. 1987. On-Farm Application System Design and Project Scale Water Management. J. of Irrig. and Drainage of ASCE. (In Press.)

Department of Atmospheric Science

DOESKEN, N.J., RENQUIST, A.R., and MCKEE, T.B. 1987. A Climatological Assessment of the Utility of Wind Machines for Freee Protection in Mountain Valleys. J. Clim. Appl. Meteor. (In Review.)

Department of Civil Engineering

OBEYSEKERA, J.T.B., TABIOS, G.Q., and SALAS, J.D. 1987. On Parameter Estimation of Temporal Rainfall Models. Water Resource Res. 23(10):1837-1850.

SHAIKH, A., RUFF, J.R., and ABT, S.R. 1987. Erosion Rate of Compacted NA-Montmorsillonite Soils. ASCE J. of Geotech. Div. (Acc. for pub.)

SHAIKH, A., RUFF, J.R., and ABT, S.R. 1987. Erosion Rate of Dispersive and non-Dispersive Clays. ASCE J. of Geotech. Div. (Acc. for pub.)

SMITH, G.J., ABT, S.R., and NELSON, J.D. 1987. Profile Prediction of Hydraulically Deposited Tailings. Soc. of Mining Eng. of AIME. Trans. 280:2024-2047.

WITTLER, R.J., ABT, S.R., and SANDERS, T.G. 1987. Channel Discharge Measurement by Thermodilution". Water Res. Bul. (In Press.)

College of Forestry and Natural Resources

Department of Earth Resources

ALLEN, K.G.D. and AUTHOR, J.A. 1987. Inhibition by 5-sulphosalicylic Acid of the Glutathione Reductase Recycling Assay for Glutathione Analysis. Clin. Chim. Acta. 162:237-239.

ARTHUR, J.A., NICOL, F., BOYNE, R., ALLEN, K.G.D., HAYES, J.D., and BECKETT, G.J. 1988. Old and New Roles for Selenium. Trace Substances in Environmental Health-XXI, Hemphill, D.D., ed., Univ. of Missouri, Columbia. (In press.)

Department of Fishery and Wildlife Biology

TENGERDY, R.P. and NAGY, J.G. 1987. Increasing the Feed Value of Forestry Waste by Ammonia Freeze Explosion Treatment. Biol. Waste. (Subm.)

Department of Forest and Wood Science

APLET, G.H., LAVEN, R.D., and SMITH, F.W. Patterns of Community Dynamics in Colorado Engelmann Spruce - Subalpine Fir Forests. Ecology. (In Press.)

BETTERS, D.R. 1987. Planning Economic Strategies for Agroforestry Systems. J. of Agroforestry Sys. (In Press.)

DONNELLY, D.M. and BETTERS, D.R. 1987. Optimal Control for Scheduling Final Harvest: An Example for Lodgepole Pine. Can. J. of For. Res. (In Press.)

GRAHAM, J.C. and BETTERS, D.R. 1985. A Simulation Model of Timber-Forage Production Alternatives in Rocky Mountain Aspen Stands. For. Ecol. and Manag. 10(4):313-321.

GUERTIN, D.S. and RIDEOUT, D.B. 1987. The 1986 Tax Reform Act and Forest Investments. J. For. 85(9):29-31.

HOF, J.G., ROBINSON, K.S., and BETTERS, D.R. Expected Values in Optimal Solutions with Random Technical Coefficients in Renewable Resource Linear Programs. Forest Sci. (Acc. for pub.)

LONG, J.N. and SMITH, F.W. Leaf Area - Sapwood Area Relations of Lodgepole Pine as Influenced by Stand Density and Site Index. Can. J. of For. Res. (In Press.)

POTTER, L.R. and BETTERS, D.R. A Net Energy Simulation Model for Wood Energy Systems. Forest Prod. J. (In Press.)

RIDEOUT, D.B and WAGNER, J.E. 1988. Testing Cost Sharing Techniques on a Multiple Use Timber Sale. For. Ecol. and Manag. (In Press.)

RIDEOUT, D.B. 1987. Below-Cost Sales: A Rocky Mountain Perspective. J. For. 85(8):33-36.

RIDEOUT, D.B. and HOF, J. 1987. Allocating Joint Costs in Applied Forestry. West. J. Appl. For. 2(2):45-48.

RIDEOUT, D.B. and HOF, J. 1987. Cost Sharing in Multiple Use Forestry: A Game Theoretic Approach. For. Sci. 33(1):81-88.

SCHULER, T.M. and SMITH, F.W. The Effect of Species Mix on Size-Density and Leaf Area Relations in Southwest Pinyon-Juniper Woodlands. Forest Ecol. and Manag. (In Press.)

SMITH, F.W. and SCHULER, T. 1987. Yields of Southwestern Pinyon-Juniper Woodlands. West. J. of Appl. Forestry. (In Press.)

TURNER, M. and BETTERS, D.R. Singularity Conditions in Renewable Resource Optimization. J. of Appl. Math. and Optim. (In Press.)

Department of Range Science

ABDEL-MAGID, A.H., TRLICA, M.J., and HART, R.H. 1987. Soil and Vegetation Responses to Simulated Trampling. J. Range Manag. 40:303-306.

AHMED, C.J. and BONHAM, C.D. 1987. Application of Geometric Programming to Optimum Allocation Problems in Multivariate Double Sampling. Appl. Math. and Comput. 21:157-169.

BAILEY, D.W., RITTENHOUSE, L.R., and HART, R.H. 1987. Effect of Forage Availability on Foraging Velocity and Biting Rate in Heifers. J. Ani. Sci. 65:(suppl.1):216. (Abst.)

BARTLETT, E.T. and RITTENHOUSE, L.R. 1987. Implications of Technological Advances in Range Livestock Production. Rangelands 9(2):58.

BARTLETT, E.T. and TROCK. W.L. 1987. The Conservation Reserve Program: Economic Perspectives. Rangelands 9(4):147-148.

BIONDINI, M.E. and REDENTE, E.F. 1986. Interactive Effect of Stimulus and Stress on Plant Community Diversity in Reclaimed Lands. Recl. and Reveg. Res. 4:211-222.

BONHAM, C.D. and MACK, S.E. 1987. Biomass Responses of Two Agropyron spp. in Presence of Winter Fat on Disturbed Soils. Recl. and Reveg. Res. 6:13-24.

BRUMMER, J. and ROATH, L.R. 1988. Community Dynamics of a Mountain Park Following Herbicide Control of Orange Sneezeweed. J. Range Manag. (Subm.)

BURLESON, W.H. and LEININGER, W.C. 1988. Intensive Grazing - Precautions. Rangelands. 10: (In press.)

COFFIN, D.P. and LAUENROTH, W.K. 1987. The Effects of Disturbance Size and Frequency of a Shortgrass Plant Community. Ecol. (In Press.)

JAMESON, D.A. and BARTLETT, E.T. 1987. Selection of Optimal Management Strategies Based on Stochastic Dynamic Ecological Models. Ecol. Model. 36(1):5-13.

KEHMEIER, P.N., QUIGLEY, T.M., TAYLOR, R.G., and BARTLETT, E.T. 1987. Demand for Forest Service Grazing in Colorado. J. Range Manag. 40(6):560-564.

LAUENROTH, W.K. SALA, O.E., MILCHUNAS, D.G., and LATHROP, R.W. Root Dynamics of Bouteloua gracilis During Short Term Recovery from Drought. Func. Ecol. (In Press.)

LEININGER, W.C. and SHARROW, S.H. 1987. Seasonal Diets of Herded Sheep Grazing Douglas-fir Plantations. J. Range Manag. 40:551-555.

MILCHUNAS, D.G., SALA, O.E., and LAUENROTH, W.K. A Generalized Model of the Effects of Grazing by Large Herbivores on Grassland Community Structure. Am. Naturalist. (In Press.)

SALA, O.E., PARTON, W.J., JOYCE, L.A., and LAUENROTH, W.K. Primary Production of the Central Grassland Region of the United States: Spatial Pattern and Major Controls. Ecol. (In Press.)

SENFT, R.L., COUGHENOUR, M.B., BAILEY, D.W., RITTENHOUSE, L.R., SALA, O.E., and SWIFT, D.M. Large Herbivore Foraging and Ecological Hierarchies. Biosci. (In Press.)

STARK, J.M. and REDENTE, E.F. 1987. Production Potential of Stockpiled Topsoil. Soil Sci. 144:72-76.

STEDNICK, J.D. and LEININGER, W.C. 1987. Chapter 13. Watershed and Rangeland Management. Introduction to Forest Sci., ed. R. Young. John Wiley Publ. 2nd Edition. (In Press.)

STEDNICK, J.D. 1987. The Potential of Subalpine Forest Management Practices on Sediment Production. Management of Subalpine Forests: Building on 50 Years of Research. USDA For. Serv., Rocky Mtn. Forest & Range Exp. Sta., Gen. Tech. Rpt. RM-149. pp. 95-100.

College of Natural Sciences

Department of Biochemistry

HIMMEL, M.E. and SQUIRE, P.G. Size Exclusion Parameters. Ed., Dubin, P.L., Aqueous Size-Exclusion Chromatography. Elsevier. (In Press.)

Department of Biology

CARPITA, N.C., HOUSELY, T.L., HENDRIX, J.E., and SILLERUD, L.O. 1987. Structure of Plant Fructans by Methylation and Carbon-13 NRM Spectroscopy. Purdue AES.

COLBERT, J.T., COSTIGAN, S.A., AVISSAR, P., CHRISTENSEN, A.H., PETERS, N.K., and QUAIL, P.H. 1987. Transcriptional and Post-Transcriptional Regulation of Phytochrome mRNA Abundance in Oat Seedlings. J. Cellular Biochem. 118:51.

COLBERT, J.T. 1988. Molecular Biology of Phytochrome. Plant, Cell and Env. (Invited Review, In Press.)

COSTIGAN, S.A., ZHAEO, Z., and COLBERT, J.T. 1988. Light Induced Decrease in Beta-tubulin mRNA Abundance. J. Cellular Biochem. (In Press.)

EDWARDS, C.L. and COLBERT, J.T. 1988. Regulation of Phytochrome mRNA Abundance in Green Oat Leaves. J. Cellular Biochem. (In Press.)

HENDRIX, J.E., LINDEN, J.C., SMITH, D.H., ROSS, C.W., and PARK, I.E., 1986. Relationship of Preanthesis Fructan Mebaolism to Grain Numbers in Winter Wheat (Triticum aestivum T.). Aust. J. Plant Physiol. 13:391-398.

HENDRIX, J.E., LINDEN, J.C., SMITH, D.H., and ROSS, C.W. 1986. Influence of Assimilate Partitioning During Inflorescence Development on Grain Numbers in Winter Wheat. Eds., Cronshaw, J. and Lucas, W.J., Plant Biology, Vol. 1. Phleom Trans. Alan R. Less, Inc., NY. pp. 557-559.

HENDRIX, J.E., LINDEN, J.C., SMITH, D.H., and ROSS, C.W. 1986. Influence Pre-Anthesis Fructan Metabolism on Grain Number in Winter Wheat. Eds., Randall, D.D., Miles, C.D., Nelson, C.J.,Belvins, D.G., and Murnyk, J.A., Current Topics in Plant Biochem. & Phys., Vol. 5. Univ. of Missouri, Columbia.

HOGAN, M.E. and HENDRIX, J.E. 1986. Labeling of Fructans in Winter Wheat Stems. Plant Physiol. 80:1048-1050.

RADER, R.B. and WARD, J.V. 1987. Resource Utilization, Overlap and Temporal Dynamics in a Guild of Mountain Stream Insects. Freshwater Bio. (In Press.)

Department of Chemistry

HATFIELD, G.R., SARDASHTI, M. and MACIEL, G.E. 1987. Analysis of the Orientation of Lignin and Cellulose in Whole Wood by Solid State Nuclear Magnetic Resonance. Anal. Chem. 59:1649-1664.

SPOERKE, D.G., HALL, A.H., DODSON, C.D., STERMITZ, F.R., and RUMACK, B.H. 1987. Two Cases of Probable Henbane (Hyocyamus niger) Poisoning. J. Emer. Med. 5:385-388.

STERMITZ, F.R. and HARRIS, G.H. 1987. Transfer of Pyrrolizidine and Quinolizidine Alkaloids to Castilleja (Scrophulariaceae) Hemiparasites from Composite and Legume Host Plants. J. Chem. Ecol. 13:1917.

College of Veterinary Medicine and Biomedical Sciences

Department of Microbiology

DUNN, D.C., BLAIR, C.D., WARD, D.C., and BEATY, B.J. 1986. Detection of Bovine Herpesvirus-Specific Nucleic Acids by in situ Hybridization with Biotinylated DNA Probes. Am. J. Vet. Res. 47:740-746.

Department of Physiology

BRADEN, T.D., MANNS, J.G., CERMAK, D.L., NETT, T.M. and NISWENDER, G.D. 1986. Follicular Development Following Parturition and During the Estrous Cycle in Beef Cows. Theriogenology. 25:833-843.

BRADEN, T.D., KING, M.E., ODDE, K.G., and NISWENDER, G.D. 1988. Development of Preovulatory Follicles Destined to Form Short-Lived Corpora lutea in Beef Cows. Biol. Reprod. (Acc. for pub.)

CLARK, K.E., SQUIRES, E.L., MCKINNON, A.O. and SEIDEL, G.E., JR. 1987. Viability of Stored Equine Embryos. J. Ani. Sci. 65:534-542.

FARIN, C.E., MOELLER, C.L., SAWYER, H.R., GAMBONI, F., and NISWENDER, G.D. 1986. Morphometric Analysis of Cell Types in the Ovine Corpus Luteum Throughout the Estrous Cycle. Biol. Reprod. 35:1299-1308.

GLASS, J.D., AMANN, R.P., and NETT, T.M. 1984. Effects of Season and Sex on the Distribution of Cytosolic Estrogen Receptors within the Brain and the Anterior Pituitary Gland of Sheep. Biol. Reprod. 30:894-902.

INSKEEP, E.K., BRADEN, T.D., LEWIS, P.E., GARCIA-WINDER, M., and NISWENDER, G.D. 1988. Receptors for LH and FSH in the Largest Follicle of Postpartum Beef Cows. Biol. Reprod. (In Press.)

KUZAN, F.B. and SEIDEL, G.E., JR. 1986. Embryo Transfer in Animals. Manipulation of Mammalian Devel. pp. 247-276.

NETT, T.M. and NISWENDER, G.D. 1982. Influence of Exogenous Melatonin on Seasonality of Reproduction in Sheep. Theriogenology. 17:645-653.

SEIDEL, G.E., JR. 1986. Characteristics of Future Farm Animals. Genet. Eng. of Ani.: An Agric. Persp. pp. 299-310.

WARFIELD, S.J., ELSDEN, R.P., and SEIDEL, G.E., JR. 1987. Transfer of Bovine Demi-Embryos with and Without the Zona pellucida. J. Ani. Sci. 65:756-761.

WHEELER, M.B. and SEIDEL, G.E., JR. 1987. Zona pellucida Penetration Assay for Capacitation of Bovine Sperm. Gamete Res. 18:237-250.

Professional Papers

College of Agricultural Sciences

Department of Agricultural and Resource Economics

ECKERT, J.B. 1987. Differences and Commonalities: Farmer Stratifications in the South-Western San Luis Valley. Agric. & Res. Econ. Research Report AR:87-8. Colo. State Univ., Fort Collins. 42 p.

GARLAND, F. AND TINNERMEIER, R.L. 1987. Farm Loan Delinquency Estimates Based on Colorado Credit Survey Data. Agric. & Res. Econ. Research Report AR:87-4. Colo. State Univ., Fort Collins. 84 p.

HARPMAN, D.A., WALSH, R.G., and KASAL, J.M. 1987. Watershed Economic Evaluations: Review of Six Watershed Improvement Projects of the BLM. Dept. of Agric. and Res. Econ., Colo. State Univ., Fort Collins. 40 p.

HUSZAR, P.C. 1987. Economics of On-site Conservation Practices in Terms of Off-site Benefits. Dept. of Agric. & Res. Econ., Colo. State Univ., Fort Collins. (November)

JOHNSON, D.M. and WALSH, R.G. 1987. Economic Benefits and Costs of the Fish Stocking Program at Blue Mesa Reservoir, Colorado. Tech. Rpt. No. 49, Colo. Water Res. Res. Inst., Colo. State Univ., Fort Collins. 25 p.

RABIEE, K.M. 1987. International Comparison of Agricultural Production Costs: The U.S. Versus the U.S.S.R. Ph.D. Thesis. Colo. State Univ., Fort Collins. 237 p.

SHINN, M.C. 1987. Price Discovery in the U.S. Pinto Bean Market and Planning Models to Reduce Risk. M.S. Thesis. Colo. State Univ., Fort Collins. 119 p.

SKOLD, M.D. and DALSTED, N.L. 1987. The Economics of Controlling Wind Erosion. Soil Conservation Society of America, Symposium on Soil Erosion by Wind. Proceedings. Denver. pp. 47-54.

SKOLD, M.D. 1987. U.S. Competitiveness in the World Wheat Market--A Comment. Proceedings of a Research Conference. International Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. pp. 119-120.

TINNERMEIER, R.L. AND GARLAND, F. 1987. Financial Characteristics of Colorado Agriculture 1970-1985. Agric. & Res. Econ. Report AR 87-6. Colo. State Univ., Fort Collins. 40 p.

YOUNG, R.A. 1987. The Role of the State in Water Management: Some Unresolved Issues. Colorado Water Management and Engineering Conference, Proceedings. N. Grigg (Editor). pp. 387-398.

Department of Agronomy

BARBARICK, K.A., LERCH, R., UTSCHIG, J.M., WESTFALL, D.G., FOLLETT, R.H., MCBRIDE, T.M., and OWEN, W.F. 1987. Application of Municipal Sewage Sludge to Dryland Winter Wheat. Waste Management Conference - Focus on the West.

CASCIANO, D.H. 1987. Sclerotinia sclerotiorum (Lib.) de Bary Inoculum and Disease Development. M.S. Thesis. Colo. State Univ., Fort Collins. 75 p.

ECHOLS, J.W. and QUICK, J.S. 1987. Variety Trials Study Russian Wheat Aphid Impact. Colorado Wheat Farmer. 29(3):6-7.

FOLLETT, R.H., WESTFALL, D.G., ECHOLS, J., CROISSANT, R., and QUICK, J. 1987. Integration of Soil Fertility Trials into On-going Cultivar Testing Programs. Agron. Abst., p. 20.

GARRETT, K.A. and SCHWARTZ, H.F. 1987. Research on Pseudomonad Bacterial Epiphytes in Colorado. Annual Rept. Bean Improv. Coop. 30:15-16.

GARRETT, K.A. and SCHWARTZ, H.F. 1987. Pseudomonad Epiphyte Response to Copper-based Bactericides on Dry Beans. Phytopathology 77: Abstract.

JOHNSON, D.L. 1987. Release of (CO 407) Quinoa Germplasm. National Seed Storage Laboratory, Fort Collins, Colorado. Unpub.

KIM, B.Y. 1987. Cytological and Protein Banding Pattern Variations in Callus Induced from Embryo Culture of Hordeum Vulgare (L.). Ph.D. Thesis. Colo. State Univ., Fort Collins. 111 p.

KIM, B.Y. and JOHNSON, D.L. 1987. Karyotypical Variations in Embryogenic and Nonembryogenic Calli of H. Vulgare. Abst. Western Society of Crop Science. p. 15.

KIM, B.Y. and JOHNSON, D.L. 1987. Application of Microtechnique for Accurate Separation of Callus Types in Barley. Abst. Western Society of Crop Science. p. 23.

LAI, T.M., EBERL, D.D., and BARBARICK, K.A. 1986. A System to Release Nutrients Through Ion Exchange: NH4-zeolite/phosphate rock. Agron. Abst. p. 205.

LERCH, R.N. 1987. Performance of Sewage Sludge Verus Nitrogen Fertilizer Applied to Dryland Winter Wheat. M.S. Thesis. Colo. State Univ., Fort Collins. 153 p.

PETERSON, G.A. and WESTFALL, D.G. 1987. Integrated Research in Soil and Crop Management. pp.3-5. In: Proc. Western Phosphate Conf., Corvallis, OR, March, 1987.

PETERSON, G.A. and WESTFALL, D.G. 1987. Integrated Research: A Necessity for the Future of Soil and Crop Management. Agron. Abst., p. 213. Am. Soc. of Agron., Madison, WI.

QUICK, J.S. 1987. (ed.) Annual Wheat Newsletter, Vol. 33.

REUSS, J.O. 1987. Base Cation Release in Response to Acid Deposition Inputs to Selected Representative Soils. In Aquatic Effects Task Group IV. Peer Review Summaries Vol 1:335-342. National Acid Precipitation Assessment Program. Washington, DC.

RODRIGUEZ, J.B., PETERSON, G.A. and WESTFALL, D.G. 1987. Calibration of Soil Tests for N and P on Proso Millet (Panicum milaceum). Agron. Abst., p. 215. Am. Soc. of Agron., Madison, WI.

SCHWARTZ, H. F. 1987. Pest Problems of Field Beans in the United States. In Grain Legumes as Alternative Crops. Symposium Proc. Center for Alternative Crops and Products. Univ. of Minn., St. Paul, July 23-24. pp. 125-131.

SIEMER, E.G., GERY, G.H., and CADWELL, C.K. 1987. Effects of Soil Fertilization upon Weedy Plant Species. Abstract. Proceedings of the Annual Meeting of the Western Society of Crop Science, Laramie, WY., June 22-24.

SIMEONI, L.A. 1987. Critical Iron Level Associated with Biological Control of Fusarium Wilt. Ph.D. Thesis. Colo. State Univ., Fort Collins. 89 pp.

TSUCHIYA, T. and FUJIGAKI, J. 1987. Comparison of Homoeologous Chromosomes Between Barley and Rye Based on Primary Trisomic Analysis. Agron. Abst. p. 83. Am. Soc. of Agron., Madison, WI.

VAUGHAN, B., WESTFALL, D.G., and BARBARICK, K.A. 1987. Spring N Recommendation Model for Dryland Winter Wheat. Agron. Abst. p. 218.

WALTHALL, P.M., REUSS, J.O., LINDSAY, W.L., ROSWALL, E.C., and HOPPER, R.W.E. 1987. Effects of Acid Weathering and Exchange Reactions and Solution Composition of Eight Acidic Soils. Agron. Abstracts. p. 268. Am. Soc. Agron., Madison, WI.

WANG, S. 1987. Evaluation of Alfalfa Germplasm for Productivity and Response to Selection for Two Root Characteristics. Ph.D. Thesis. Colo. State Univ., Fort Collins. 57 p.

WESTFALL, D.G. 1987. Surface Band Application for Fertilizer on Dryland Winter Wheat. In Proc. Western Phosphate Conf., Corvallis, OR, March, 1987.

WESTFALL, D.G. 1987. Fertilization of Dryland Winter Wheat - A Paying Proposition. Better Crops 71:3-5.

Department of Animal Sciences

ANDERSON, K.J. 1987. Reproductive Tract Scores, Condition Scores, and Performance Traits in Beef Cattle. M.S. Thesis. Colo. State Univ., Fort Collins.

BAILEY, D.W., BRINKS, J.S., and BOURDON, R.M. 1987. Genetic Parameters for Reproductive Traits in Beef Cows. Amer. Soc. Ani. Sci. West. Sec. Proc. 38:29-32.

BRINKS, J.S. 1987. Genetic Aspects of Calving Ease. Proc. The Range Beef Cow Symposium X, Cheyenne, WY, December 8-10, 1987.

CARSTENS, G.E., JOHNSON, D.E., SZYMANSKI, T.M., BOURDON, R.M., RICHARDSON, C.V., and JOHNSON, K.A. 1987. Metabolic Rate Comparisons in Monozygous Beef Calves. Proc. West Sect. ASAS 38:.

CARSTENS, G.E., JOHNSON, D.E., HOLLAND, M.D., and ODDE, K.G. 1987. Effects of Prepartum Protein Nutrition and Birth Weight on Basal Metablism in Bovine Neonates. Fed. Proc. 46:358. Abst.

CLARKE, A.D. 1987. Physical, Sensory and Microstructural Characteristics of Beef Structured with Algin/Calcium Binders. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 142 p.

CLARKE, A.D., SOFOS, J.N., and SCHMIDT, G.R. 1987. Interaction of Hydrogen Ion Concentration and Algin/Calcium Binder levels on Selected Physical and Sensory Parameters of Structured Beef. 47th Annual Meeting of the Institute of Food Technologists, June 16-19, Las Vegas, NV. Abst. 286.

DODSON, M.V., MATHISON, B.A., and HOSSNER, K.L. 1987. Interaction of Ovine Somatomedin and IGF-I with Specific Receptors on Cultured Ovine Muscle Fibroblasts. J. Ani. Sci. 65(Suppl. 1) Abstr. 185.

ELLENBERGER, M.A. 1987. Endocrine and Metabolic Changes During Altered Tissue Accretion Rates in Beef Cattle. M.S. Thesis. Colo. State Univ., Fort Collins. 92 p.

FIELD, L.B. 1987. Simulation of Beef-Heifer Production on Rangeland. M.S. Thesis. Colo. State Univ., Fort Collins.

GOLDEN, B.L., GRAVES, B.E., BOURDON, R.M., and BRINKS, J.S. 1987. Comparison of Iteration Strategies for Mixed Model Equations. Am. Soc. Ani. Sci. West. Sec. Proc. 38:37-40.

HOLLAND, M.D., HOSSNER, K.L., NISWENDER, G.D., and ODDE, K.G. 1987. Validation of a Heterologous Radioimmunoassay for Bovine Insulin-like Growth Factor-I. J. Ani. Sci. 65(Suppl.1) Abst. 176.

HOLLAND, M.D. 1987. Insulin-like Growth Factor I in Pregnant Beef Heifers. M.S. Thesis. Colo. State Univ., Fort Collins. 84 p.

LEFEVER, D.G. and ODDE, K.G. 1987. A Method of Selecting Replacement Heifers. The Salers Stockman.

LIKIMANI, T.A., MAGA, J.A., and SOFOS, J.N. 1987. Extrusion Cooking of a Weaning Food Using a Thermostable -Amylase. 47th Annual Meeting of the Institute of Food Technologists, June 16-19, Las Vegas, NV. Abst. 20.

LINK, G.A. and HOSSNER, K.L. 1987. Comparison of IGF-I Serum Binding Proteins in Sheep and Cattle: Species Differences in Size and Endogenous Binding Capacities. J. Ani. Sci. 65:(Suppl. 1) Abst. 177.

LINK, G.A. 1987. Comparison of IGF-I Serum Binding Proteins in Sheep and Cattle: Species Differences in Size and Endogneous Binding Capacities. Seniors Honors Thesis. Colo. State Univ., Fort Collins. 29 p.

MILLER, W.C. and SNELLING, W.M. 1987. Modeling of Colorado's IRM Herds. Proceedings: Range Beef Cow Symposium X. 96 p.

MILLER, W.C. and BRINKS, J.S. Most Important Ranch Tools - Ever. Colorado Rancher and Farmer.
NOCKELS, C.F., TUFFT, L., and FETTMANN, M. 1987. Trace Element Changes in E. coli Infected Chicks Fed Varying Levels of Dietary Zinc. Fed. Proc. 46:596.

ODDE, K.G. 1987. Cow Body Condition - A Key to Your Bottom Line. Colorado Rancher and Farmer.

ODDE, K.G. Cow Size, Body Condition Scores Boost Conception Rates. Colorado Rancher and Farmer.

ODDE, K.G., LEFEVER, D.G., MAUCK, H.S., and TAYLOR, R.E. 1987. Calving Distribution of Estrous Synchronized Beef Cows. CSU Beef Program Report, Fort Collins. p. 89.

SCHAFER, D.W. 1987. Estimation of Genetic Parameters and Time Trends in a Herd of Angus Cattle. M.S. Thesis. Colo. State Univ., Fort Collins.

SCHMIDT, G.R., MEANS, W.J., and SOFOS, J.N. 1987. Restructuring Beef with the Algin/Calcium Gelation Mechanism. Proceedings of New Protein Technology Conference, March 30-31, Brigham Young Univ., Provo, UT., pp. 167-173.

SCHMIDT, G.R. and SOFOS, J.N. 1987. Restructured Steaks. Proceedings of the Range Beef Cow Symposium X, Dec. 8-9, Cheyenne, WY. (In press)

SCHMIDT, G.R. and ERNST, E.A. 1987. Product Development Research for Export Markets: United States and Pacific Rim Countries. Sponsored by W-177 Western Regional Beef Res. Project and Farm Foundation, Chicago, IL., Nov. 19-20, Univ. of Ariz, Tucson, pp. 107-113.

SCHMIDT, G.R., MEANS, W.J. and SOFOS, J.N. 1987. Restructuring Beef with the Algin/Calcium Gelation Mechanism. Proceedings of the Great Plains Cattle Feeders Conference at the SW Kansas Experiment Station Feeders Day, May 13-14, Garden City, pp. 7-13.

SCHMIDT, G.R. and SOFOS, J.N. 1987. Restructured Meats: The SMR Alginate Process. Proceedings of the International Symposium: Trends in Modern Meat Technology - II, November 24-26, Pudoc, Wageningen, The Netherlands. (In press)

SOFOS, J.N., BOYLE, D.L., CLARKE, A.D., and SCHMIDT, G.R. 1987. Growth of Various Microorganisms in Algin/Calcium Structured Beef Stored in Vacuum Packages. 47th Annual Meeting of the Institute of Food Technologists, June 16-19, Las Vegas, NV. Abst. 141.

SOFOS, J.N., BOYLE, D.L., CLARKE, A.D., and SCHMIDT, G.R. 1987. Growth of Various Microorganisms in Algin/Calcium Structured Beef Stored Under Aerobic (tray-pack) Condition. 47th Annual Meeting of the Institute of Food Technologists, June 16-19, Las Vegas, NV. Abst. 140.

SOFOS, J.N., MAGA, J.A., and BOYLE, D.L. 1987. Inhibition of Aeromonas hydrophila and Staphylococcus aureus by Liquid Smoke from Various Woods. 47th Annual Meeting of the Institute of Food Technologists, June 16-19, Las Vegas, NV. Abst. 128.

SOFOS, J.N., and MAGA, J.A. 1987. Composition and Antimicrobial Properties of Liquid Condensates from Spice Smoke. 5th Int. Flavor Conf. Am. Chem. Soc., Div. of Ag. & Food Chemistry, July 1-3, Porto Carras, Greece.

TULL, M.L. and HOSSNER, K.L. 1987. Optimization of a Multiplication-Stimulating Activity Binding system for Ovine Hepatic Membranes. J. Ani. Sci. 65(Suppl.1) Abst. 196.

WINDER, J.A. 1987. Characterization of Direct and Maternal Influences on Growth of Red Angus Cattle. Ph.D. Dissertation. Colo. State Univ., Fort Collins.

Department of Entomology

BJOSTAD, L.B. 1987. Semiochemical Applications in Insect Pest Control. Proc. Nat. Alliance of Independent Crop Consultants. (Acc. In press.)

CRANSHAW, W.S. 1988. Biological and Integrated Control of Turfgrass Pests. Lawn Servicing Magazine. (In press)

CRANSHAW, W.S. and HART, E. 1988. Honeylocust Insect Management. American Nurseryman. (In press)

CRANSHAW, W.S. 1987. Management of Thrips in Vegetables. Proc., Colorado Crop Protection Institute. 5 p.

CRANSHAW, W.S. 1987. Biological and Integrated Control of Turfgrass Pests. 1987. Proc., Rocky Mountain Turfgrass Institute. 7 p.

PEAIRS, F.B. 1987. Russian Wheat Aphid in Colorado. Proc. 17th Annual Colo. Crop Prot Conf. (In press)

PEAIRS, F.B. and PILCHER, S.D. 1987. Control of Russian Wheat Aphid with Hand-applied Insecticides, Springfield, CO, 1986. Insecticide and Acaricide Tests 12:313.

PEAIRS, F.B. and PILCHER, S.D. 1987. Chemigated Insecticides for Control of First Generation European Corn Borer, Wray, CO, 1986. Insecticide and Acaricide Tests 12:215.

PEAIRS, F.B. and PILCHER, S.D. 1987. Western Bean Cutworm Hand-Applied Treatments. Eckley, CO, 1986. Insecticide and Acaricide Tests 12:216.

PEAIRS, F.B. and PILCHER, S.D. 1987. Control of Pale Western Cutworm in Winter Barley. Springfield, CO, 1986. Insecticide and Acaricide Tests 12:180.

PILCHER, S.D. and PEAIRS, F.B. 1987. Western Corn Rootworm Planting-Time Treatments. Akron, CO, 1986. Insecticide and Acaricide Tests 12:216-7.

PILCHER, S.D. and PEAIRS, F.B. 1987. Western Corn Rootworm Cultivation Treatments. Akron, CO, 1986. Insecticide and Acaricide Tests 12:218.

Department of Horticulture

BARTOLO, M.E. 1987. Cell Wall Changes and Freezing Stress Resistance. M.S. Thesis. Colo. State Univ., Fort Collins. 137 p.

BULLA, A.D. 1987. Insecticide Trials and Pyrethroid Testing. Proc. West. Colo. Hort. Soc. 44:28-31.

BURR, K.E. 1987. Cold Hardiness, Root Growth Capacity, and Bud Dormancy Testing of Conifer Seedlings. Ph.D. Thesis. Colo. State Univ., Fort Collins. 242 p.

BUTLER, J.D. and FRY, J.D. 1987. Short Season, Cold Weather Turfgrass Maintenance. Proc. Western Canada Turfgrass Conf. 24(1):4-9.

BUTLER, J.D. and FRY, J.D. 1987. Application of Turfgrass Water Research--1987. Proc. West. Canada Turfgrass Conf. 24(1):33-46.

CAHN, H., MOORE III, F.D., and HUGHES, H.G. 1987. CO2 Enrichment of Strawberry. Proc. Pacific Div. AAAS. 6(1):21 (Abst.)

CLEVENSTINE, M., HUGHES, H.G., RENQUIST, A.R., and WALLNER, S.J. 1987. Raspberry Grower's Guide. Colo. State Univ. Coop. Exten. Bul. 538A.

COKER, F.A. 1987. Effect of Shading and Greenhouse Cover on the Growth and Gas Exchange of 'Samantha' Roses. M.S. Thesis, Colo. State Univ., Fort Collins. 80 p.

CRANSHAW, W.S., LARSEN, H.J., and RENQUIST, A.R. (eds.) 1987. Colorado Small Fruits: 1987 Pest Management Guide. Colo. State Univ. Coop. Ext. Bul. XCM-49. 41 p.

DAVIDSON, R. and HOLM, D.G. 1987. Control of Blackleg with Streptomycin and Oxytetracycline as a Seedpiece Treatment. Proc. of the 1987 San Luis Valley Potato/Grain Conf. 2:10.

ELENES-FONSECA, C. and HANAN, J.J. 1987. Handling Renewal Canes on 'Sonia' Roses. Colo. Greenhouse Growers Assoc. Res. Bul. 450:1-5.

ELENES-FONSECA, C. and HANAN, J.J. 1987. The Effect of Greenhouse Cover and Shading on 'Royalty' Rose Yield. Colo. Greenhouse Growers Assoc. Res. Bul. 449:1-6.

ELLS, J.E., KRUSE, E.G., and MCSAY, A.E. 1987. Scheduling Irrigations for Cucumbers. HortSci. 22(5):1051 (Abst.).

FRY, J.D. 1987. Evapotranspiration and Water Management of Turf Canopies in a Semi-arid Environment. Ph.D. Thesis. Colo. State Univ., Fort Collins. 166 p.

FRY, J.D. 1987. Update on Turfgrass Water Research at Colo. State Univ. Rocky Mtn. Reg. Turf Conf. Proc. 33:55-58.

FRY, J.D. and BUTLER, J.D. 1987. Water Management Requirements for Turfgrass Establishment. HortSci. 22(5):1052. Abst.

GOLDSBERRY, K.L. 1987. Dwarf Carnations, A Future Pot Crop. Colo. Greenhouse Growers Assoc. Res Bul. 440:1-2.

GOLDSBERRY, K.L. 1987. Another Look at Dutch Greenhouse Production. Colo. Greenhouse Growers Assoc. Res. Bul. 447:1-3.

HANAN, J.J. 1987. The Third International Carnation Symposium. A Pictorial Tour. Colo. Greenhouse Growers Assoc. Res. Bul. 446:1-5.

HANAN, J.J. 1987. So Speaks the Rose. Colo. Greenhouse Growers Assoc. Res. Bul. 442:1-4.

HANAN, J.J. 1987. Substrate and Volume--A Brief Review. Colo. Greenhouse Growers Assoc. Res. Bul. 448:2-3.

HOLM, D.G. 1987. 1986 Annual Research Progress Report to the Area II Potato Administrative Committee, San Luis Valley. 21 p. (Unpub.)

HOLM, D.G. and THORNTON, M.K. 1987. 1986 Post Harvest Evaluations Research Progress Report to the Area II Potato Administrative Committee, San Luis Valley. 4 p. (Unpub.)

HOLM, D.G. 1987. Sangre Selection Studies. Am. Potato J. 64:443 (Abst.)

HOLM, D.G. 1987. Sangre Selection Studies and Grower Evaluations of New Potato Selections. Proc. of the 1987 San Luis Valley Potato/Grain Conf. 2:1-5.

JACOBSON, J.F. 1987. Herbicide Evaluations on Containerized Herbaceous Perennials. M.S. Thesis. Colo. State Univ., Fort Collins. 197 p.

JEONG, B.R. and LEE, C.W. 1987. Bedding Plant Production in Rockwool Mixtures. HortScience 22:1130. Abst.

JEONG, B.R., et al. 1987. Production of Lilium Longiflorum in Rockwool. HortScience 22:1142. Abst.

KEIL, L. 1987. The 'Ideal' Temperatures for Alstroemeria Production in Colorado. Colo. Greenhouse Growers Assoc. Res. Bul. 445:1-4.

KEIL, L. 1987. Air and Medium Temperatures for Alstroemeria 'Atlas' and 'Monika'. M.S. Thesis. Colo. State Univ., Fort Collins. 69 p.

KLETT, J.E. and WILSON, C. 1987. Water Requirements of Herbaceous Perennials. HortSci. 22(5):1052. (Abstr.).

KLETT, J.E. 1987. CSU Research Update - What's New at CSU. Colorado Green 2(4):32.

KLETT, J.E. 1987. CSU Research Update - Research Round-up - A Summary of On-Going CSU Plant Projects. Colorado Green 3(1):12-14.

KLETT, J.E. 1987. CSU Research Update - A Review of the Viburnum Project and Other On-Going CSU Research Work. Colorado Green 3(2):18-19.

KLETT, J.E. 1987. CSU Research Update - Perennial Favorites - A Review of Outstanding, Hardy Perennial Varieties Selected from CSU's On-going Plant Research Program. Colorado Green 3(4):42-44.

LARSEN, H.J. 1987. Orchard Diseases and Their Control. Proc. West. Colo. Hort. Soc. 44:76-80.

LARSEN, H.J., CRANSHAW, W.S., and YU, K.S. (eds.) 1987. Colorado Tree Fruits: 1987 Pest and Crop Management Guide. Colo. State Univ. Coop. Ext. Bul. XCM-41. 80 p.

LEE, C.W., GOLDSBERRY, K.L. and HANAN, J.J. 1987. Evaluations of Loose Rockwool as a Growing Medium for Poinsettia: Comparison with Peatlite and Soil Mixes. Colo. Greenhouse Growers Assoc. Res. Bul. 441:1-3.

LEE, C.W., GOLDSBERRY, K.L. and HANAN, J.J. 1987. Evaluation of Loose Rockwool as a Growing Medium for Pot Chrysanthemums: Comparison with Peatlite and Soil Mixes. Colo. Greenhouse Growers Assoc. Res. Bul. 439:2-3.

MOORE III, F.D., JOLLIFFE, P.A., STANWOOD, P.C., and ROOS, E.E. 1987. Using the Richards Function to Interpret Single Seed Conductivity Data. Proc. Pacific Div. AAAS. 6(1):35 Abst.

PANTER, K.K. and HANAN, J.J. 1987. Heating System Alone Does not Effect Carnation Yield. Colo. Greenhouse Growers Assoc. Res. Bul. 444:1-3.

PANTER, K.K. and HANAN, J.J. 1987. The Effect of Heating System on Stomate Resistance and Water Stress in Calceolaria. Colo. Greenhouse Growers Assoc. Res. Bul. 443:1-4.

PASCHAL, M., HUGHES, H.G., and RENQUIST, A.R. 1987 Strawberry Grower's Guide. Colo. State Univ. Coop Exten. Bul. 539A.

RENQUIST, A.R., DOESKEN, N.J. and MCKEE, T.B. 1987. Orchard Freeze Protection in Relation to Overlying Weather, Surface Air Flow, and Temperature Inversions. HortSci. 22(5):1059. Abst.

RENQUIST, A. R., HUGHES, H.G., and ROGOYSKI, M.K. 1987. Ultraviolet Light and High Temperature Influences on Simulated Solar Injury of Red Raspberry Fruit. HortSci. 22(5):1084. Abst.

ROGOYSKI, M.K. 1987. Computer-Aided Orchard Management. Proc. of the 44th Ann. Conv. of West. Colo. Hort. Soc. 44:20-24.

ROGOYSKI, M.K. 1987. A Prototype of Expert System for Apple Crop Load Management in Colorado for Computers Using MS-DOS. HortSci. 22(5):1061. Abst.

ROGOYSKI, M.K. 1987. An Inexpensive Interface for Measuring Orchard Temperatures Using an MS-DOS Compatible Computer. HortSci. 22(5):1061. Abst.

SCHUETT, J. and KLETT, J.E. 1987. Preemergent Weed Control in Container-Grown Perennials. Proc. Pacific Div. AAAS 6(1):38. Abst.

SCHWEISSING, F.C. and ELLS, J.E. 1987. Potassium Fertility Study on Onions, Rocky Ford, CO. Colo. State Univ. Veg. Growers Update.

TINUS, R.W. BURR, K.E., WALLNER, S.J., and KING, R.M. 1987. Relation Between Cold Hardiness, Root Growth Capacity, and Bud Dormancy in Three Western Conifers. Plant Physiol. 83:71. Abst.

Department of Plant Pathology and Weed Sciences

BAKER, R.R. PAULITZ, T., WINDHAM, M.H., and ELAD, Y. 1986. Enhancement of Growth of Ornamentals by a Biological Control Agent. Colo. Greenhouse Growers Assoc. Bul. 431:1-7.

BECK, K.G. 1987. Canada Thistle Control in a Non-Grazed Colorado Pasture. Res. Prog. Rep. Western Soc. Weed Sci. pp. 24-25.

BECK, K.G. 1987. Great Plains Yucca Control in Colorado Rangeland. Res. Prog. Rep. Western Soc. Weed Sci. pp. 77-78.

BECK, K.G. 1987. Barnyard-grass Control in Seedling Kentucky Bluegrass Turf with New Herbicides. Res. Prog. Rep. Western Soc. Weed Sci. pp. 137-138.

FRANC, G.D., HARRISON, M.D., and LAHMAN, L.K. 1987. Day-Degree Model for Timing Early Blight Control in Colorado. Am. Potato J. 64:438-439. Abst.

FRANC, G.D. and HARRISON, M.D. 1987. Infectivity Titration of Corynebacterium Sepedonicum on Russet Burbank and Centennial Russet Potatoes in Colorado. Am. Potato J. 64:438. Abst.

FRANC, G.D. 1987. Bacterial Transport--A New Theory. Proc. Fifth Ann. North Amer. Seed Potato Seminar, Vol. 4:19-30.

FRANC, G.D. and HARRISON, M.D. 1987. The Role of Contaminated Irrigation Water in the Recontamination of Erwinia-free Seed Potatoes. Am. Potato J. 64:438. Abst.

HARRISON, M.D. 1987. Potato Early Dying and Storage Diseases. Proc. San Luis Valley Potato and Grain Conference 1987. pp. 48-51.

HARRISON, M.D. 1987. Blackleg Update: Recent Research Developments. Proc. Fifth Annual North Amer. Seed Potato Seminar, Vol. 4:4-18.

JACOBI, W.R., BOYD, J.E., and ZENTZ, W.R. 1986. Comandra Rust Damage and Risk Rating Research. Proceedings of the 34th West. Int. Forest Disease Work Conf., Juneau, AK. pp. 29-30.

MAFFEI, H. and JACOBI, W.R. 1986. The Effect of Dwarf Mistletoe Infection and Growth and Mortality Rates of Ponderosa Pine Growing in Unevenaged-Irregular Stands in Colorado. Proceedings of the 34th West. Int. Forest Disease Work Conf., Juneau, AK. p. 47.

PAULITZ, T. and BAKER, R. R. 1986. Effects of Peat-Vermiculite Mixes on Increased Growth Response with Trichoderma. Colo. Greenhouse Growers Assoc. Bul. 432:1-3.

PEAIRS, F., SCHWARTZ, H., BROWN, W., WESTRA, P., and BECK, G. 1987. Colorado Pesticide Guide - Field Crops. Colo. State Univ. Bul. XCM-43.

RAMALEY, A.W., MCINTYRE, G.A., and JACOBI, W.R. 1987. Factors Affecting Infection of Aspen by Cytospora chrysosperma. Phytopathology. Abst.

REYES, C. C. 1987. Trifluralin Degradation in Four Soils. M.S. Thesis. Colo. State Univ., Fort Collins. 123 p.

WESTRA, P., SCHWARTZ, H.F., BECK, K.G., and PEAIRS, F. 1988. 1988 Colorado Pesticide Guide-Field Crops. SCM-45. Colo. State Univ. AES. 82 p.

WESTRA, P., SCHWARTZ, H.F., and CRANSHAW, W.S. 1988. 1988 Colorado Pesticide Guide-Commercial Vegetable Crops. Colo. State Univ. AES. 119 p.

ZENTZ, W.R. 1987. Comandra Blister Rust Incidence: Effects of Host and Alternate Host Location and Site Characteristics. M.S. Thesis. Colo. State Univ., Fort Collins. 164 p.

ZIMDAHL, R.L. 1987. Herbicide Degradation in Soil. Invited Paper at International Sulphonylurea-Soil Interaction Workshop. E.I. duPont de Nemours and Co. Inc., Wilmington, DE.

College of Arts, Humanities, and Social Sciences

Department of Sociology

KNOP, E. 1987. Managing Rural Sociologist Roles in Mixed Discipline Development Projects. Rural Sociology Soc. Annual Meet. Paper. 15 p.

KNOP, E. and KNOP, S. 1988. Approaching Full-Family Dynamics in Rural Development: Insights from Egyptian and Domestic Farming System Cases. In H.S. Feldstein and J. Jiggins, eds., Intrahousehold Dynamics in Farming Systems Research and Extension: A Methodologies Handbook. Univ of FL, Farming Sys. Supp. Proj. 27 p. (In press.)

College of Engineering

Department of Agricultural and Chemical Engineering

ADISASMITO, S. 1987. Starter Culture Production of Trichoderma reesei RUT C-30 in Fluidized Bed Reactors. M.S. Thesis. Colo. State Univ., Fort Collins. 101 p.

ALOUINI, A. 1987. Modeling Between Furrow Spatial Variability Effects in Furrow Irrigation. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 225 p.

ALVAREZ-MARTINEZ, L. 1987. Modeling Fungal Growth on Extruded Corn by Solid Substrate Fermentation. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 220 p.

BROWN, G.O. 1987. Solute Transport by a Volatile Solent. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 191 p.

CHOUDHARY, M.R. 1987. Optimal Conjunctive Use of Surface and Groundwater in a Watercourse Command Area of the Indus Basin. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 201 p.

CHRESAND, T.J. 1987. Diffusion and Reaction in a Hollow Fiber Mammalian Cell Reactor. M.S. Thesis. Colo. State Univ., Fort Collins.

DURNFORD, D.S., GUTWEIN, B.J., and PODMORE, T.H. 1987. Computerized Drainage Design for Arid, Irrigated Areas. In Drainage Design and Management, W. R. Johnson, ed. Proc. of ASAE Fifth Natl. Drainage Symp. ASAE, St. Joseph, MI. (In Press.)

DURNFORD, D.S., PODMORE, T.H., and GUTWEIN, B.J. 1987. Drainage Model Selection and Use in Irrigated Areas. In Proc. of the Third International Workshop on Land Drainage, B.H. Nolte, ed. Ohio State Univ., Columbus. (In Press.)

HARCUM, J.B. and LOFTIS, J.C. 1987. Design and Evaluation of Weather Monitoring Networks: A Kalman Filtering Approach. ASAE Paper No. 87-4045. ASAE Summer Meeting, Baltimore, MD.

HOUGHTALEN, R.J., LOFTIS, J.C., and FONTANE, D. 1987. Delivery System Management via Dynamic Programming. In Irrigation Systems for the 21st Century, L.G. James and M.J. English, eds. Proc. of ASCE Irrig. and Drainage Spec. Conf. ASCE, New York, NY. (In Press.)

KARIM, M.N. and TRAUGH, G. 1987. Data Acquisition and Control of a Continuous Fermentation Unit. J. of Indus. Micro. 2:305-317. KHAN, C.M.A. 1987. Modeling Basin-Furrow Irrigation. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 209 p.

KHAN, C.M.A., PODMORE, T.H., and KRUSE, E.G. 1987. Evaluation of Basin-Furrow Irrigation Systems. In Irrigation Systems for the 21st Century, L.G. James and M.J. English, eds. Proc. of ASCE Irrig. and Drainage Spec. Conf. ASCE, New York, NY. (In press.)

KHAN, C.M.A., PODMORE, T.H., and KRUSE, E.G. 1987. Evaluation of Basin-Furrow Irrigation Systems. In Irrigation Systems for the 21st Century, L.G. James and M.J. English, eds. Proc. of ASCE Irrig. & Drain. Spec. Conf. ASCE, New York, NY. (In Press.)

KRUSE, E.G. and ISRAELI, I. 1987. Evaluation of a Subsurface Drip Irrigation System. Paper No. 87-2034. ASAE Summer Mtg., Baltimore, MD.

KUHN, R.L. 1987. Factors Affecting Butanol Tolerance of Clostridium Acetobutylicum. M.S. Thesis. Colo. State Univ., Fort Collins. 150 p.

MCWHORTER, D.B. 1987. Retardation of Flow in Oil Shale Residues Affected by in situ Hydration. Proc. of East. Oil Shale Symp., Lexington, KY.

MCWHORTER, D.B., FOX, P., HOLTZ, W., and HIESTAND, R. 1987. Synthesis for Disposal of Oil Shale Solid Wastes. Final Rept. to U.S. Env. Prot. Agency.

MCWHORTER, D.B. 1986. Transport and Geotechnical Properties of Porous Media with Applications to Retorted Oil Shale. Final Rept. to U.S. Dept. of Energy on Agreement No. DE-AC02-83ER-60122.

MOHAMMED, R.A. 1987. A Theory for Monitoring an Irrigation Conveyance System for Management. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 182 p.

NOAH, K.S. 1987. Extraction and Fermentation of Ensiled Sweet Sorghums. M.S. Thesis. Colo. State Univ., Fort Collins. 187 p.

PAIGE, M.R. 1987. Fed-Batch Acetone-Butanol Fermentations. M.S. Thesis. Colo. State Univ., Fort Collins. 141 p.

PETERSON, T.C. 1987. Transport of Copiotrophic Bacteria in Oligotrophic Coarse Soils--A Monte Carlo Analysis. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 187 p.

SRI RANJAN, R. and MCWHORTER, D.B. 1987. Fundamental Relationships Between Anisotrophy and Degree of Saturation. Paper No. 87-2001. ASAE Summer Meeting, Baltimore, MD.

WARD, R.C. and LOFTIS, J.C. 1987. Making Effective Use of a Monitoring Program at a Landfill Site. Proc. of 1987 Waste Manag. Conf., Colo. State Univ., Fort Collins. (In Press.)

WESTENDORP, J.A. 1987. Trailwater Management with Surge Irrigation. M.S. Thesis. Colo. State Univ., Fort Collins. 171 p.

WESTENDORP, J.A. and PODMORE, T.H. 1987. Tailwater Management with Surge Irrigation. In Irrigation Systems for the 21st Century, L.G. James and M.J. English, eds. Proc. of ASCE Irrig. and Drainage Spec. Conf. ASCE, New York, NY. (In Press.)

WESTENDORP, J.A. and PODMORE, T.H. 1987. Tailwater Management with Surge Irrigation. In Irrigation Systems for the 21st Century, L.G. James and M.J. English, eds. Proc. of ASCE Irrig. and Drainage Spec. Conf. ASCE, New York, NY. (In Press.)

Department of Atmospheric Science

CHANGNON, D. and MCKEE, T.B. 1987. The Costs Related to Implementation of Probable Maximum Precipitation Estimates for Reservoirs in Eastern Colorado. Preprints, 5th Conf. on App. Climatol., March 9-13, Baltimore, MD.

DOESKEN, N.J. and SCHAEFER, G.L. 1987. The Contribution of SNOTEL Precipitation Measurements to Climate Analysis, Monitoring, and Research in Colorado. West. Snow Conf., April 14-16, Vancouver, BC, Canada. pp. 20-30.

DOESKEN, N.J. and MCKEE, T.B. 1987. Colorado Hydrometeorological Committee Index of Precipitation Measurement Sites in Colorado. Climatology Rpt. 87-1. Dept. of Atmos. Sci., Colo. State Univ., Fort Collins. 92 p.

DOESKEN, N.J. and ECKRICH, W.B. 1987. How Often Does it Rain Where You Live? Weatherwise. 40(4):200-203.

DOESKEN, N.J. and KLEIST, J. 1987. Observed Variations in Cloudiness, Precipitation and Temperature in Colorado During the Past Century. CIRA Workshop on Monitoring Climate for the Effects of Increasing Greenhouse Gas Concentrations. August 26-28, Colo. State Univ., Fort Collins.

DOESKEN, N.J. and MCKEE, T.B. 1987. Colorado Climate Summary Water Year Series (October 1985-September 1986). Climatology Rpt. 87-3, Dept. of Atmos. Sci., Colo. State Univ., Fort Collins. 116 p.

MCKEE, T.B. 1987. Colorado Climate Issues. Proc., Colo. Water Eng. and Manag. Conf., February 17-18., Colo. State Univ. pp. 34-39.

Department of Civil Engineering

CLOSE, B., WARNER, J.W., SUNADA, G., and SUNADA, D.K. 1986. Pre- and Post-Processing of Data for Groundwater Model. 4th Natl. Conf. on Microcomputers in Civil Eng., Orlando, FL. November.

DAWOD, A.M. 1986. Modeling Soil Erosion from Rainfall Volume. Ph.D. Thesis. Colo. State Univ., Fort Collins. 131 p.

DOEHRING, F.K. 1987. Influence of Drop Height on Outlet Scour. M.S. Thesis. Colo. State Univ., Fort Collins.

HORSEY, H.R., RICHARDSON, E.V., RUFF, J.F., and ZIMBELMAN, D.D. 1985. Reservoir Operation Simulation on Micro-Computer. Proc. Spec. Conf., Hydr. Div., ASCE. Lake Buena Vista, FL.

MOLDEN, D.J. 1987. Water Control as a Basis for Evaluation of Irrigation Water Delivery Systems. Ph.D. Thesis. Colo. State Univ., Fort Collins. 172 p.

MOREL-SEYTOUX, H.J. and RESTREP, J.I. 1987. Users Manual. SAMSON. Colorado Water Resources Res. Inst., Colo. State Univ., Fort Collins. Vol. 1. 387 p.

MOREL-SEYTOUX, H.J. and RESTREPO, J.I. 1987. Calibration to the South Platte River Basin. SAMSON. Colorado Resources Res. Inst., Colo. State Univ., Fort Collins. Vol. II. 54 p.

MOREL-SEYTOUX, H.J. and RESTREPO, J.I. 1987. Introduction to CYBER 205. SAMSON. Colorado Water Resources Res. Inst., Colo. State Univ., Fort Collins. 13 p.

NIELSEN, K.F. 1987. Potential Groundwater Impacts from Chemigation. M.S. Thesis. Colo. State Univ., Fort Collins. 71 p.

OBEYSEKERA, J.T.B., TABIOS, G.Q., and SALAS, J.D. 1987. On Parameter Estimation of Temporal Rainfall Models. Pres. at AGU Spring Mtg., Baltimore, MD. May.

PAULSON, C.L. and SANDERS, T.G. 1987. Evaluation of Design Flow Criteria for Effluent Discharge Permits in Colorado. Prepared for the Low Flow Task Force Comm., October. 304 p.

SALAS, J.D. TABIOS, G.Q., and OBEYSEKERA, J.T.B. 1987. Estimation and Application of Temporal Rainfall Models over the Northeastern Plains of Colorado. Proc. of Colo. Water Eng. and Manag. Conf., Feb. 17-18. Colo. State Univ., Fort Collins.

SHAIKH, A. 1986. Erosion of Compacted Clays. Ph.D. Thesis. Colo. State Univ., Fort Collins. 131 p.

SRITHARAN, S.I., CLYMA, W., and RICHARDSON, E.V. 1985. Scheduling in Manually Controlled Canal Irrigation Delivery Systems. Proc. Spec. Conf., Irrig. and Drainage. ASCE, San Antonio, TX.

WARNER, J.W., SUNADA, D.K., and HARTWELL, A. 1986. Recharge as Augmentation in the South Platte River Basin. Groundwater Tech. Rept. #13, Colo. State Univ., November. 116 p.

WARNER, J.W., SUNADA, D.K., and ODOR, J.L. 1987. Stream Augmentation by Artificial Recharge in the Platte River Basin. South Platte River Basin, Colorado Water Eng. and Manag. Conf., February. 31 p.

College of Forestry and Natural Resources

Department of Earth Resources

LEININGER, W.C., STEDNICK, J.D., and TANNER, D.Q. 1987. Copper Deficiency in Cattle on the Colorado Western Slope. Soc. of Range Management., Boise, ID. Abst.

STEDNICK, J.D. 1987. The Effects of Hydrochemistry Variability on Water Quality Sampling Frequencies in an Alpine-Subalpine Forested Basin. Forest Hydrology and Watershed Manag. Vancouver, BC. (Proc. of Vancouver Symp. IAHSAISH). Publ. No. 167:401-407.

TANNER, D.Q. 1987. Soil Copper and Molybdenum Availability to Forage Plants in the Gunnison Area, Colorado. M.S. Thesis. Colo. State Univ., Fort Collins. 66 p.

Department of Fishery and Natural Resources

BENSON. 1987. Holistic Range Management and the Ecosystem Approach to Wildlife Conservation. Proc. of the Privatization of Wildlife and Public Lands Access Symp. Casper, WY.

Department of Forest and Wood Sciences

BETTERS, D.R. 1986. Gamble Oak in Colorado's Front Range. Potential of Non-Commercial Forest Biomass for Energy. Univ. of Ariz., Tucson. Tech. Bul. 256. pp. 25-30.

BETTERS, D.R. 1987. Economic Analysis of Agro-Forestry Systems. Proc. Short Course in Agroforestry, Eitemiller and Lynch. Colo. State Univ., Fort Collins. pp. 130-152.

COHEN, W.B., OMI, P.N., and KAUFMANN, M.R. 1987. Water Uptake of Subalpine Conifer Branches During Heating. Proc. Tech. Conf., Manag. of Subalpine Forests: Building on 50 Years of Research, Silver Creek, CO, July 6-9, 1987. (In Press.)

DAY, J.T. 1987. Forest Harvest Scheduling Simulation. M.S. Thesis. Colo. State Univ., Fort Collins. 68 p.

DONNELLY, D.M. 1987. Stand Harvest Schedules Using Optimal Control Methods. Ph.D. Dissertation. Colo. State Univ., Fort Collins. 190 p.

DONNELLY, D.M. and BETTERS, D.R. 1985. Optimal Control in Timber Harvest Scheduling. Proc. Systems Analysis Symp., Soc. of Am. Foresters, Athens, GA.

SMITH, F.W. and SCHULER, T. 1987. Assessment of Site Quality in Pinyon-Juniper Woodlands. Proc. Pinyon-Juniper Conf. (ed. R. Everett). Reno, NV, Jan. 13-16, 1986. USDA Forest Serv. Gen. Tech. Rept. INT-215:260-265.

SMITH, F.W. Silviculture of Subalpine Conifers in the Central Rocky Mountains. Proc. Management of Subalpine Forests of the Rocky Mtns., ed. C. Troendel. Fraser, CO., July 6-9, 1987. USDA Forest Serv. Gen. Tech. Rept.

TURNER, M. 1988. Convex vs. Concave Singular Paths in Optimal Harvest Schedules for Even-Aged Stand. M.S. Thesis. Colo. State Univ., Fort Collins. 102 p.

Department of Range Science

BAILEY, D.W., RITTENHOUSE, L.R., HART, R.H., and RICHARDS, R.W. 1987. Spatial Memory of Heifers in Radial- and Parallel-Arm Mazes. Proc. West. Sec. Amer. Soc. Ani. Sci. 38:7-10.

BAILEY, D.W., RITTENHOUSE, L.R., HART, R.H., and RICHARDS, R.W. 1988. Memory and Response Patterns of Beef Cattle in Radial- and Parallel-Arm Mazes. Soc. Range Manag. Abst. 41st Ann. Mtg., Corpus Christi, TX. Feb. 14-19.

BARTLETT, E.T., 1987. Livestock Grazing on Public Lands: Procedures and Issues. In Proc. of the Public Lands During the Remainder of the 20th Century, Planning, Law, and Policy in the Federal Land Agencies. Nat. Res. Law Center., Univ. of Colo. School of Law, Boulder. 16 pp.

BARTLING, S.W. 1987. Effect of Dust Deposition on Blue Grama. M.S. Thesis. Colo. State Univ., Fort Collins. 67 p.

BERN, C.M. and SHAW, R.B. 1986. Sex Ratios of Buchloe dactyloides Along Catenas in the Shortgrass Steppe. Poster pres. at the Ecol. Soc. Mtg., Syracuse, NY. August.

COTTRELL, T.R. 1987. Life History Strategies in Artemisia tridentata Subspecies. M.S. Thesis. Colo. State Univ., Fort Collins. 71 p.

FORERO, L.C. and RITTENHOUSE, L.R. 1987. The Determination of a Yearling/Cow-Calf Substitution Ratio in Southeastern Colorado. Soc. Range Manag. Ann. Mtg., Boise, ID. (Abst.)

FORERO, L.C. 1987. The Determination of a Steer:Cow-Calf Substitution Ratio at the Southeastern Colorado Research Center. M.S. Thesis. Colo. State Univ., Fort Collins. 31 p.

LEININGER, W.C. 1988. Successional Changes in a Montane Riparian Zone in Northern Colorado in Response to Livestock Grazing. Abst. of the 41st Ann. Mtg. of the Soc. for Range Manag., Corpus Christi, TX. (In Press.)

ORODHO, A.B. 1987. Previous Heavy Grazing Effects on Growth Characteristics and Seed Production of Indian Ricegrass. Ph.D. Dissertation. Colo. State Univ., Fort Collins.

RITTENHOUSE, L.R., BAILEY, D.W., HART, R.H., and RICHARDS, R.W. 1988. Temporal Parameters of Spatial Memory in Beef Cattle. Soc. Range Manag. Abst. 41st Ann. Mtg., Corpus Christi, TX. Feb. 14-19.

ROATH, L.R. Grass for Livestock - Good Economics. Steamboat Springs Pilot.

SHAW, R.B. and BERN, C.M. 1986. The Bur of Buchloe dactyloides in Grass Systematics. Poster presented at the 1st Intl. Grass Symp. Smithsonian Inst., Washington, DC. August.

TUCKER, T.L. and LEININGER, W.C. 1987. Livestock Grazing Affects Fish Habitat and Nongame Wildlife Populations in a Mountainous Riparian Area. Abst. of the 40th Ann. Mtg. of the Soc. for Range Manag., Boise, ID.

TUCKER, T.L. 1987. Cattle Grazing Effects Nongame Wildlife Populations and Fish Habitate in a Montane Riparian Area. M.S. Thesis. Colo. State Univ., Fort Collins. 84 p.

TURNER, S.J. 1987. Competition and Coexistence Between Two C4 Grasses of the Shortgrass Steppe. Ph.D. Dissertation. Colo. State Univ., Fort Collins.

College of Natural Sciences

Department of Biochemistry

MOSTAFA, A-M. M. 1988. Some Studies on Bovine Pneumonia with Special Reference to Pasteurellosis and its Control. Dept. of Biochem., Colo. State Univ., Fort Collins.

MUIR, S.J., MCCANN, D., BRUSS, M.L., OSBURN, B.I., and SQUIRE, P.G. 1987. Enzyme Linked Immunosorbent Assay for Anti-Lipopolysaccharide Immunoglobulins in Calves Following Pasteurella haemolytica Infection or Endotoxin Infusion. Abst. of 8th Ann. West. Food Ani. Disease Res. Conf., Boise, ID.

SCHENCK, C., ROBERTS, R., BRASHER, B., and GAUL, D. 1988. Construction of a RC Deletion Mutant in R. Sphaeroides. Biophys. J. Abst. (In Press.)

Department of Biology

HENDRIX, J.E. 1985. Partitioning of Sucrose into Fructans in Winter Wheat Stems. Eds. Heath, R.L. and Preiss, J., Regulation of Carbon Partitioning in Photosynthetic Tissue. Proc. 8th Ann. Symp. Plant Physiol. Am. Soc. Plant Physiol. pp. 272-288.

Department of Chemistry

BELOFSKY, G.N. 1987. Phytochemistry of Some Euphydryas Hostplants: Castilleja, Pedicularis, and Aureolaria. M.S. Thesis. Colo. State Univ., Fort Collins. 76 p.

DODSON, C.D. 1987. Neognans of Ocotea veraguensis and Toxic Secondary Metabolites in the Plant Diet. Ph.D. Thesis. Colo. State Univ., Fort Collins. 88 p.

College of Veterinary Medicine and Biomedical Sciences

Department of Microbiology

AKKINA, R. 1987. Biochemical Differences Among Strains of Bovine Viral Diarrhea Virus that Differ in Pathogenicity and Host Specificity. Abst. ICN-VCI Symp. on Molecular Biology of Viral Pathogenesis. p. 63.

Department of Physiology

INLOES, E. Lynch Rotational Grazing Study. Video Tape.

KIMBERLING, C.V. Trichomoniasis. Cattle Guard, Colorado Rancher and Farmer.

MAUCK, H.S., KING, M.E., HOLLAND, M.D., LEFEVER, D.G., and ODDE, K.G. 1987. Comparison of Two MGA-Lutalyse Combinations for Estrous Synchronization in Beef Heifers". CSU Beef Program Report, Fort Collins. p. 85.

TEEGARDEN, R.M. Promoting Health in Beef Cattle. Cattle Guard.

TEEGARDEN, R.M. No Surprises Please - Plan Now to Stop Trich. Colorado Rancher and Farmer.

1988 FIELD DAY SCHEDULE
AGRICULTURAL RESEARCH CENTERS

May 17	Eastern Colorado Research Center, Akron, 10:00 a.m. View cattle and facilities; noon lunch and afternoon programs.
June 21	Central Great Plains USDA Field Station, Akron, 8:00 a.m. Agronomy research programs.
June 21	San Juan Basin Research Center, Hesperus, 10:00 a.m. Review irrigated pasture, brush control and cow-calf breeding projects.
June 23	Southeast Research Center, Springfield, 9:30 a.m. Review of center research.
July 22	San Luis Valley research Center, Center, 8:30 a.m. Irrigated crops research.
July 28	Rogers Mesa Research Center, Hotchkiss, 10:00 a.m. Orchard management and fruit research.
Aug 18	Southwest Research Center, Yellow Jacket, 4:00 p.m. Review of current crops research.
Sept 8	Southeastern Colorado Research Center with Plainsman Agri-Search Foundation, Walsh, 10:00 a.m. Open house and review of ongoing research.
Sept 17	Arkansas Valley Research Center, Rocky Ford, 3:00 p.m. Review current field crop research. Center's 100th anniversary.