Agricultural Research Division Annual Report 1990 [104th]
ARD
ANNUAL
REPORT 1990

Agricultural Research Division
Institute of Agriculture and Natural Resources
University of Nebraska
July 1, 1989 to June 30, 1990
The Nebraska Agricultural Research Division provides information and educational programs to all people without regard to race, color, national origin, sex or handicap.
ARD
ANNUAL
REPORT 1990
FOREWORD

It is a pleasure to provide the 104th Annual Report of the UNL Agricultural Research Division (ARD). This report contains lists of current faculty; active research projects; refereed journal articles, books and book chapters, and theses and dissertations published; germplasm/cultivars released; and patents awarded. Also included are brief descriptions of selected research and the financial report for the period July 1, 1989 through June 30, 1990. This report was compiled in compliance with the intent of the law of the State of Nebraska that established the Nebraska Agricultural Experiment Station on March 31, 1887.

Faculty conducting research in agriculture, home economics and natural resources in the Institute of Agriculture and Natural Resources and the College of Home Economics carry research appointments in the Agricultural Research Division. Most faculty are on joint appointments with teaching responsibilities in the College of Agriculture and Natural Resources and the College of Home Economics or serve as Extension Specialists with appointments in the Cooperative Extension Division. As of June 30, 1990, over 136 full-time equivalents in the Agricultural Research Division were distributed among 270 faculty members. These faculty are located on the East Campus of the University of Nebraska-Lincoln and at District Research and Extension Centers at Clay Center, Concord, North Platte, and Scottsbluff. The Agricultural Research and Development Center near Mead, Nebraska, serves as the primary site for field research with crops, trees, and livestock conducted by faculty located on the East Campus.

The Agricultural Research Division is charged with conducting fundamental and applied research that provides solutions to priority problems facing Nebraska’s agricultural and food industries, develops information essential for managing our natural resources and maintaining a quality environment, and enhances the quality of life for Nebraskans. All research activities are carried out as a part of one or more peer-reviewed, USDA-approved projects. There are currently more than 300 research projects supported by ARD resources. Continued investment in research is essential to the long-term profitability of agriculture and the economic well-being of Nebraska. A goal of ARD is to carry out research that will enhance our farmers’ and ranchers’ ability to produce and market quality food and other agricultural products that have consumer acceptance and that are competitive in the world marketplace. This requires continued investment in research on reducing input costs in an effort to enhance profitability. Equally important is research designed to diversify the crops and animals produced in Nebraska, to add value to agricultural commodities before transporting them from the state, and to more effectively market our products. Research focusing on environmental quality and natural resource conservation is important for the well-being of Nebraskans and the long-term sustainability of agriculture. Human development, human nutrition, and consumer behavioral research is essential for enhancing the health, economic well-being and quality of life of Nebraska citizens.

Major emphasis during the past year has been placed on implementing high priority research programs identified in the Institute of Agriculture and Natural Resources Strategic and Action Plans. Programs have been enhanced and in some cases initiated through a combination of resource redirection and addition of a limited amount of new resources. Programs in plant biotechnology, water science, sustainable agriculture, human nutrition, industrial agricultural products, and international trade have been strengthened. New programs in aquaculture and poultry pathology were initiated. Funds provided by the Nebraska Legislature through the Nebraska Research Initiative and special appropriations have been instrumental in strengthening research capability in several high priority programs. One issue of a new magazine "Research Nebraska" was published. The purpose of the magazine is to provide our clientele groups with examples of exciting research being carried out by ARD scientists and to bring the latest research results to producers, agribusiness, firms, natural resource managers, and other interested citizens.

Results derived from various projects are published in scientific journals, trade magazines, bulletins, books, UNL publications, and departmental reports. These research results then become the information base for educational programs and publications prepared by the University of Nebraska Cooperative Extension Division. Reprints of most journal articles may be obtained by writing directly to the authors.

Researchers in the Agricultural Research Division are part of a national network of Agricultural Experiment Station scientists located at Land Grant Universities across the United States. Nebraska scientists are currently involved in approximately 65 regional projects in which they collaborate with researchers at other universities to address priority problems of regional importance. High priority is given to working cooperatively with scientists having similar interests who are employed by the USDA Agricultural Research Service and Forest Service. There are currently about 28 federally-supported scientists located on the East Campus and approximately 30 scientists at the Roman L. Hruska U.S. Meat Animal Research Center at Clay Center who work jointly with ARD researchers. A number of ARD scientists are also involved in cooperative research programs with faculty on the UNL City Campus and the University of Nebraska Medical Center.

For additional information regarding the Agricultural Research Division program, contact the Office of the Dean and Director, 207 Agricultural Hall, University of Nebraska, Lincoln, Nebraska 68583-0704.

Darrell W. Nelson, Dean
Agricultural Research Division and
Director, Nebraska Agricultural Experiment Station
University of Nebraska
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UNIVERSITY OF NEBRASKA

Board of Regents

Robert M. Allen, Hastings  Nancy Hoch, Nebraska City
Don S. Blank, McCook  John Payne, Kearney
Donald D. Fricke, Lincoln  Margaret Robinson, Norfolk
Kermit Hansen, Elkhorn  Rosemary Skrupa, Omaha

UNMC  -  Mark Meyer
UNO  -  Kelli Sears
UNL  -  Phil Gosch

Administrative Officers

Ronald W. Roskens¹, President, University of Nebraska
Martin A. Massengale², Interim President, University of Nebraska
Martin A. Massengale, Chancellor, University of Nebraska-Lincoln
Irvin T. Omtvedt, Vice Chancellor, Institute of Agriculture and Natural Resources

Agricultural Research Division

Darrell W. Nelson, Dean and Director
Dale H. Vanderholm, Associate Dean and Director
Karen E. Craig, Assistant Director/Home Economics
James A. DeShazer¹, Assistant Dean/Assistant Director
Roger E. Gold¹, Assistant Dean for Water Research
Warren W. Sahs, Assistant Director for Operations
Steven S. Waller², Assistant Dean/Assistant Director
Dora Dill, Staff Assistant
Diane Mohrhoff, Clerical Assistant III
Nelvie Lienemann, Staff Secretary III
Kathy Westwood, Staff Secretary II

¹ Appointment for part of the year
² Temporary appointment
### Administrative Units Reporting to Deans and Directors

**Institute of Agriculture and Natural Resources**  
**The University of Nebraska - Lincoln**

**June 1990**

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<th>Home Economics Departments (Extension and Research)</th>
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| AGRICULTURAL COMMUNICATIONS  
Gary Vacin  
AGRICULTURAL ECONOMICS  
(Jim Kendrick\(^1\))  
Sam M. Cordes  
AGRICULTURAL ENGINEERING  
Glenn J. Hoffman  
AGRIMONY  
Robert C. Shearman  
ANIMAL SCIENCE  
Elton D. Aberle  
BIOCHEMISTRY  
Marion H. O'Leary  
BIOMETRY  
David B. Marx  
AGRICULTURAL METEOROLOGY  
Blaine L. Blad  
ENTOMOLOGY  
(Z B Mayo\(^1\))  
John E. Foster  
ENVIRONMENTAL PROGRAMS  
(Roger Gold\(^1\))  
Ed F. Vitzhum  
FOOD SCIENCE & TECHNOLOGY  
Steve L. Taylor  
FORESTRY, FISHERIES & WILDLIFE  
Gary L. Hergenrader  
HORTICULTURE  
Paul E. Read  
PLANT PATHOLOGY  
Anne K. Vidaver  
VETERINARY SCIENCE  
John A. Schmitz  
CONSUMER SCIENCE AND EDUCATION  
Gwendolyn Newkirk  
HUMAN DEVELOPMENT AND THE FAMILY  
William Meredith  
HUMAN NUTRITION AND FOOD SERVICE MGMT  
Judy Driskell  
TEXTILES, CLOTHING AND DESIGN  
Joan M. Laughlin  

---

\(^1\)Appointment for part of the year

### Off-Campus Centers (Extension and Research)

| NORTHEAST RESEARCH AND EXTENSION CENTER  
Concord  
Donald B. Hudman  
| WEST CENTRAL RESEARCH AND EXTENSION CENTER  
North Platte  
Lavon J. Sumption  
| PANHANDLE RESEARCH AND EXTENSION CENTER  
Scottsbluff  
Robert D. Fritschen  
| SOUTH CENTRAL RESEARCH AND EXTENSION CENTER  
Clay Center  
Charles L. Stonecipher  
| SOUTHEAST RESEARCH AND EXTENSION CENTER  
Lincoln  
Loyd L. Young  
| AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER  
Mead  
Warren W. Suhls  

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### Organizational Chart

**Institute of Agriculture and Natural Resources**  
**The University of Nebraska-Lincoln**

![Organizational Chart](image-url)
## Agricultural Research Division
### Faculty

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1. Ended research appointment during 1989-90
2. Began research appointment during 1989-90
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Research Highlights

Biochemistry

Temperature-Sensitive Plants

One traditional approach to studying biochemical processes is to make individuals with altered genetic make-up, called mutants. Mutants allow scientists to see how changes affect the system and, hopefully, lead to a better understanding of how the system functions normally. Professor John Markwell's laboratory is using mutants to study the reactions involved in the production of chlorophyll. The problem with this approach is that because of these genetic alterations, many mutants are unable to survive.

This problem has been solved by the use of temperature-sensitive mutations. Such plants appear to be normal at one temperature, but they soon yellow and die at a different temperature. Temperature-sensitive mutants are easy to identify, and the study of chlorophyll production in these plants provides important insight into the production of chlorophyll in normal plants.

The plant involved is Arabidopsis, a relative of the common mustard plant. The advantage of this plant is that it is small, (2 inches in diameter and 6 inches high) and grows in less than six weeks. This rapid growth permits screening of large numbers of plants relatively quickly. So far over 100 temperature-sensitive mutants have been identified. Preliminary studies indicate that some of these have specific blockages in the pathway of chlorophyll production. Eventually, these plants will help us understand how chlorophyll production is related to crop productivity and will permit plant scientists to optimize the functioning of chlorophyll in the plant.

Oxygen Inhibition of Photosynthesis

Photosynthesis is inhibited by oxygen, and this inhibition greatly reduces plant productivity. This inhibition occurs because of the effect of oxygen on an enzyme called "Rubisco." The laboratory of Professor Robert Spreitzer is interested in the effect of oxygen on Rubisco, with a view toward reducing or eliminating the oxygen effect.

Dr. Spreitzer's lab also uses mutations for this study, but this time in the green alga *Chlamydomonas reinhardtii*. This is a particularly convenient system for study because of the ease with which mutations can be produced and studied. Several mutations have now been identified that change the oxygen sensitivity of Rubisco. Study of these is continuing.

Eventually, the hope is to identify mutants in which the oxygen sensitivity is decreased. If such mutants can be found, then it is hoped that the mutation might be introduced into crop plants, with a resulting increase in overall efficiency.

Agricultural Communications

New Magazine Tells ARD Story

Sharing with Nebraskans the exciting story of the Agricultural Research Division's innovative and diverse research is the new magazine, *RESEARCH Nebraska!*

Communicating with the public about research is an exciting challenge for ARD. The new research...
Research Highlights

magazine strives to strengthen Nebraskans’ awareness and understanding of ARD accomplishments. RESEARCH Nebraska! provides a window through which the public can glimpse and understand the breadth, value and impact of ARD research. The magazine translates complex research into interesting and easy-to-read stories, photos and illustrations for its readers.

The magazine showcases significant basic and applied research in agriculture, natural resources, food science, home economics and related disciplines.

As primary beneficiaries of ARD research, Nebraskans need and deserve to know that IANR scientists are leaders in helping their state solve problems, cope with rapid change and capitalize on emerging opportunities. RESEARCH Nebraska! chronicles the importance of ARD’s contributions to Nebraska’s economic development, quality of life and global competitiveness.

An outgrowth of the IANR Action Plan, RESEARCH Nebraska! is produced by Agricultural Communications in cooperation with ARD. It will be published three times annually as an informal and informative progress report to shareholders — Nebraska taxpayers.

Presentation Graphics Tools Help Communicate Research

Visual tools are essential to effectively communicate research results.

Agricultural Communications is a leader in creating attractive, informative computer-generated visuals to help ARD scientists illustrate their research at scientific and professional meetings worldwide.

Agricultural Communications creates graphics and enhances slides prepared by researchers. The department trains researchers to generate their own computer graphics, keeps them abreast of technological developments and provides technical support for widely used computer graphics programs. As a result, IANR researchers are recognized nationally for the quality of their presentations.

Agricultural Economics

Economical Approaches for Enhancing Water Quality

Nebraska’s dual need to protect groundwater supplies while maintaining an economically robust agricultural economy presents a formidable research and public policy challenge. Analysts in the Department of Agricultural Economics are identifying the most economical methods of maintaining or enhancing groundwater quality in Nebraska. Findings show in some circumstances, production techniques such as crop rotations and chemigation may enhance environmental quality at a lower economic cost than expected. Ongoing work will help producers evaluate environmentally sensitive production techniques as they emerge from scientific laboratories and experiment farms. Project results will also help policy makers as they implement programs which strike the appropriate balance between groundwater quality and economic needs.

Packer Concentration and Livestock Prices

Concern about livestock prices and increased concentration in the meat-packing industry is nothing new in the meat business. The Sherman Antitrust Act was passed 100 years ago, partly because of concerns voiced by farmers that only a few packers dominated the livestock market. Since then, changes in concentration levels, as measured by the percentage of slaughter controlled by the largest four packers, has varied depending on species. In the steer and heifer category, for example, the four-firm concentration ratio was less than 30% during most of the 1970s, but had risen to 67% by 1987. On the other hand, concentration in pork packing increased by a smaller amount. In the 1970s, the largest four pork packers accounted for 32-35% of the kill, and accounted for close to 40% of the kill by 1987.

Is increased concentration a natural economic phenomenon that should be allowed to take its course? Is it beneficial or detrimental to the meat industry? Does it put too much market power in a few hands, and what is the tradeoff between the cost-efficiencies of larger operations and any detrimental effects associated with more concentrated market power? What do all these developments mean for the pocketbook of cattle and hog producers?

Analysts in Agricultural Economics are developing innovative methods to answer such questions. Some preliminary analysis indicates that a substantial component of the price spread cannot be accounted for by marketing costs alone. It is difficult, however, to pinpoint in the marketing channel the unaccounted portion of marketing spread occurs. In another study, the effect of increased packer concentration on cattle prices was examined in 13 cattle procurement regions within the continental United States. Results show that increased concentration in the absence of overt collusion would have a negative impact on cattle prices of 2% at most.

Impacts of Restricting Agricultural Inputs

American agriculture has dramatically increased its reliance on purchased chemical inputs over the past four decades. Two major economic forces have contributed to this trend: declining chemical inputs cost and commodity programs that have had the effect of encouraging the production of high chemical-dependent crops and the use of chemical inputs to increase yield.

Recently concern has arisen regarding the long-term impacts of a highly chemical dependent agri-
culture. Generally these concerns emphasize the effects of chemical inputs on groundwater contamination.

Researchers are using modeling techniques to estimate what will happen to agricultural output, and other inputs, if fertilizer and chemical use are reduced. This issue is important because policy proposals to limit chemical use in agriculture are receiving greater attention.

The model used assumes a moderate-to-long-term time horizon that allows for resource substitution. Results show that a 10% decrease in fertilizer and chemical use would reduce feed grain production by less than 1%, would reduce wheat production by about 2%, and would reduce soybean production by slightly more than 2%. A 20% decline in fertilizer and chemical use would double the above adjustments; however, extrapolations beyond a 25% decline in fertilizer and chemical use would not be expected to be reliable. Labor use in agriculture would significantly increase, and there would be small impacts on land and machinery use, depending upon the crop.

Agricultural Education

Evaluation of Student Teaching Centers

Research to develop measurable criteria for selecting secondary schools as student teaching centers in agricultural education revealed that 1) experience in agricultural occupations was not a predictor of success in basic college courses in agriculture, 2) there was a difference among superintendents, principals, agriculture teachers, and secondary senior agriculture students about emphasis placed on 32 agriculture/agribusiness subject matter areas taught in the Nebraska secondary school. Superintendents rated the emphasis significantly higher in 13 of the 32 subject areas. There were only two subject areas where congruent perceptions existed; agricultural mechanics and supervised agricultural experience programs, 3) joint Nebraska Department of Education and University of Nebraska-Lincoln Agricultural Education staff evaluations of schools being used as student teaching centers agree with the perceptions of student teacher's experience in these student teaching centers.

Barriers Which May Impede Change in Secondary Agricultural Education Programs

Fifty Nebraska agricultural education instructors, 49 superintendents, 48 principals, and 38 school board presidents responded to a 57-item instrument which listed possible barriers to change in local agricultural education programs. Eleven barrier categories were identified. Significant differences were found among the four groups for seven of the eleven barrier categories. Agriculture teachers believed forty-one of the items were barriers to change in local agricultural education programs, while superintendents, principals and school board presidents believed only sixteen, twenty-one, and twenty-six items, respectively, were barriers to change.

Agronomy

Soybean Varieties for Special Uses

The soybean breeding and genetics program at the University of Nebraska is combining laboratory and field information to develop new soybean varieties that will meet special needs of producers, processors, and consumers.

Researchers are testing new breeding techniques for development of high-yielding soybean varieties. A gene that prevents formation of pollen (male sterility) in the soybean flower keeps the soybeans from fertilizing themselves and allows the production of a large number of hybrid seeds. This process eliminates the labor-intensive, time-consuming method of making crosses by hand. One advantage of using male sterility is that thousands of different crosses can be made easily, compared with 200-300 per year in a conventional breeding program. The genetic diversity created by cross hybridization is the basis for a sound breeding and selection program.

Compositional quality is another objective of the soybean breeding program. Researchers are evaluating plant introductions from Asia, where soybeans originated, to identify traits like high protein content or high oil content that could be incorporated into new soybean varieties. They use biotechnology techniques to identify and locate genes that increase the protein content of the beans, and to define what types of changes in protein composition occur as the seed protein content moves from 38-40% for the average cultivar to about 50% for some of the high-

Research Highlights

Tiny soybeans, right, about half the size of normal soybeans, left, may be an alternative crop for some Nebraska farmers.
Research Highlights

Some of the main uses for high protein soybeans are in poultry meal for tofu production. Compositional quality may play an increasingly important role in world markets as well.

Other special soybean varieties that are being developed include small-seeded and large-seeded types for use in specialty markets, mainly in Japan. Small-seeded soybeans are being developed and evaluated by the soybean breeding program at UNL. These small-seeded types are used for production of a product called natto which is considered a health food in Japan. The soybeans, about half the size of normal soybeans, are inoculated with a fungus and fermented to create the natto product. This type of crop offers Nebraska farmers the opportunity to compete in alternative markets for these specialty products.

Water and Nitrogen Stress Effects on Corn

Due to economic factors and environmental concerns, Nebraska corn farmers may be faced with pressures to reduce inputs of both water and nitrogen to their crop. Since most corn hybrids have been developed to respond to high inputs of these two entities, it is not certain what will happen when these corns are subjected to even moderate nitrogen and water stresses. Studies are being conducted to evaluate what happens when these stresses occur. These studies show that genotypes differ greatly (up to 40%) in ability to withstand either stress when measured in terms of grain yield. Corns with a high degree of water use efficiency also ranked high for nitrogen use efficiency and vice versa. This is very important in the corn industry since breeding for only one type of stress should also improve corns for the other type of stress resistance or tolerance. These studies also showed that the linked relationship probably is found in the root systems. Both water and nitrogen efficiency in corn were correlated with root mass and length. By devising and using methods to select for better root systems, the resulting improved corn hybrids may better adapt to reduced water and nitrogen supplies without reducing, and perhaps even increasing, economic returns for Nebraska producers.

Efficient Nitrogen Management Systems

Nitrogen fertilizer is applied to 97% of the corn acreage in Nebraska and the efficiency with which that nitrogen fertilizer is used by the corn crop can vary between 10 and 90%. Generally, as the rate of fertilizer nitrogen increases, the efficiency with which it is used will decline. However, the fertilizer rate at which maximum profit per acre is realized is always greater than the rate at which maximum fertilizer efficiency occurs. Excess nitrate-nitrogen remaining in the soil after the corn crop is harvested may be subject to leaching and result in nitrate-nitrogen contamination of our groundwater. Nitrogen management systems that increase the efficiency of nitrogen fertilizer use must be identified. Research in fertilizer, soil and crop management effects on efficient nitrogen use have shown that annual deep soil sampling to determine residual fertilizer nitrogen is an effective way to reduce the fertilizer nitrogen requirement for corn. In a recent study over nine site-years, residual soil nitrate-nitrogen levels have been compared in continuous corn and corn/soybean rotations under different rates of fertilizer N input. Intensive soil monitoring over sites in eastern Nebraska has shown that soybeans following corn effectively reduce the amount of residual soil nitrate to levels equivalent to those following unfertilized corn with no adverse effects on the following corn crop. Over the long run, corn/soybean rotation reduces the amount of externally applied fertilizer nitrogen as it is only applied during the corn year. Although soybeans are capable of fixing their own nitrogen from the atmosphere, they will use soil nitrogen at the expense of fixation to satisfy that need. As a result, excess nitrate nitrogen following corn is recycled into a stable organic form in soybean residue. Fertilizer nitrogen additions below the optimum for maximum economic yield also incur less risk for the producer in a corn/soybean rotation since incremental yield increase per pound of fertilizer nitrogen applied are lower.
Animal Science

Clue to Heifer Puberty

Animal scientists have uncovered another clue to the molecular mystery surrounding sexual maturity in cattle. Researchers are exploring how genes influencing sexual maturation are regulated. Using biotechnology tools, researchers peer inside cells to detect the presence of genetic components that trigger sexual maturity.

The latest finding sheds light on how a primary reproductive hormone—luteinizing hormone (LH)—is produced and why little of it is available in the bloodstream until puberty nears. LH must reach the ovaries via the bloodstream to stimulate sexual maturation.

The current research was to determine what limits LH availability to the ovaries before puberty. The primary aim was to determine if the limiting factor was production or distribution into the bloodstream.

The pituitary gland was found to produce LH at least 120 days before puberty, but LH releases to the bloodstream were minimal until shortly before puberty. The limitation appears to be a hormone—luteinizing hormone releasing hormone (LHRH)—produced by the hypothalamus in the brain which regulates pituitary release of LH. Long before puberty, the hypothalamus sends enough LHRH to the pituitary for LH production but too little to spur LH releases to the blood.

This finding may be an important clue to learning how to manipulate the sexual maturation process. Estrogen has a major influence on reproductive hormones from the hypothalamus and pituitary. Before puberty, estrogen from the ovaries limits hormone production; shortly before puberty, estrogen’s inhibitive effect diminishes. Researchers can now determine whether estrogen inhibits LHRH production and/or release before puberty in heifers.

There may well be a time when puberty could be induced by estrogen immunizations, although such manipulation must be judicious because pre-puberty serves a purpose for the animal. If researchers confirm estrogen is a primary regulatory factor of sexual maturation in heifers, certain procedures may be developed to control the time when puberty occurs.

Grain Utilization in Beef Cattle Rations

The feeding of grain to beef cattle is an important part of producing beef for the consumer. No matter what type of beef production system is practiced, a short grain feeding period is required to produce highly palatable beef. Starch is the primary component of grain that provides energy to cattle. However, not all of the starch is used by cattle.

Cattle evolved to digest forage rather than grain; thus, feeding high levels of grain may create digestive problems (acidosis). Using high levels of roughage to control acidosis is not feasible because roughage reduces the energy content of the diet and is poorly used in a high grain diet. On the other hand, some grains are not as digestible as others resulting in reduced feed efficiency. The challenge is to balance rations for maximum grain utilization without causing acidosis.

Feeding a mixture of grains that are rapidly digested and slowly digested may reduce the incidence of acidosis and improve overall grain utilization.

Researchers have measured the complementary effects of feeding a combination of high moisture corn (23 to 31% moisture) with either dry rolled corn or dry rolled grain sorghum. Cattle fed a combination of 67 to 75% high moisture corn and 25 to 33% dry rolled corn or grain sorghum gained faster and more efficiently than those fed a single grain source. The greatest improvement in cattle performance was during the step-up or grain adaptation period when cattle were adjusting from a high roughage diet to a high grain diet.

Cattle fed a combination of high moisture corn and dry rolled grain sorghum digested more starch with fewer digestive problems than cattle fed either grain alone. The high moisture corn seemed to increase the digestion of the grain sorghum. Thus, grain mixtures appeared to reduce acidosis and subsequently improved grain utilization and reduced costs of feedlot gain.

Feeding combinations of grains allows producers to take advantage of lower priced grains and combined with the improvement in feed efficiency can lower cost of production.

Pigs Genetically High for Reproduction

UNL animal scientists have made a key discovery in the search to produce strains of pigs with high reproduction. Although pigs have always had a fairly high level of reproduction—8 to 10 pigs per litter and 2 litters per year—reproductive rate remains a limiting factor to efficient production. Costs of managing the sow herd have risen sharply. Confinement breeding, gestation and farrowing facilities are very expensive and labor-intensive areas on most pig farms. Thus, increasing the output per sow will substantially reduce costs of producing lean pork. Pig producers have been selecting for reproduction for many years, but little genetic change has occurred. Reasons for the lack of response and ways to overcome them needed to be identified.

In 1967, a project was begun on reproductive efficiency of pigs. It has continued to 1990 and now seven different genetic lines exist. Two lines have very high litter size and crosses among them have been even better than the pure lines.

The research demonstrated that to efficiently select for litter size it is necessary to jointly select for ovulation rate and capacity of the uterus. These two components seem to have independent systems of genetic control and are not influenced in the same way by environmental factors. However, there is heritable variation for both, and both can be selected for. In 1981, these concepts were used to develop a selection strategy for an independent population. The technique of laparotomy on pregnant females.
was used to measure ovulation rate and number of fetuses in the uterus and selection on an index of these components was initiated. After 7 years of selection, ovulation rate has increased by about 4 eggs and litter size at 50 days of gestation has increased by about 1.7 pigs, a 15% increase.

In the last 3 years, these two improved populations have been evaluated as pure lines and as crosses. Crossbred females have averaged 12.5, 12.4 and 13.7 pigs per litter for their first three litters compared to an average of 10.7, 12.1 and 12.3 for the two improved pure lines. The average for the unimproved control lines from which the lines were derived was 9.7 for first litter gilts. The total improvement from selection and crossing in these two populations has been about 2.8 pigs per litter, almost a 30% response.

This is the first experiment with pigs in which a response to selection for litter size has been realized. The research has clearly demonstrated how to select for increased litter size and has produced improved strains that may have value in commercial crossing systems.

Heat Stress in Poultry—Physiological Responses

One of the main concerns of poultry producers is heat stress and its effects on production, comfort, and mortality. As temperatures rise above 85-90 F, birds begin to pant to dissipate heat and prevent body temperature from rising. High humidity exacerbates the problem, making ventilation a matter of critical importance. Research at UNL has focused on the physiological changes that occur when birds are heat-stressed. The studies have established the timing of respiratory responses and associated acid-base disturbances in blood and brain tissue, and characterized changes in ions involved in the actual control of body temperature. Recent efforts have addressed reproductive responses to heat stress. Significant changes occur in hormones that regulate ovulation, and these changes occur well before the decrease in food intake typically observed in heat-stressed birds. In fact, both of the key hormones (progesterone from the ovary and luteinizing hormone from the brain) decrease in the blood within the first egg-formation cycle after onset of heat stress. Perhaps the most important finding is that heat stress appears to act, at least in part, directly on the ovary, causing a reduction in synthesis of progesterone. Because progesterone “drives” the ovulatory cycle, the very rapid decrease in availability of this hormone could explain, at least in part, the decrease in egg production associated with high temperatures. Data gathered in the ongoing studies have been incorporated into a temperature-humidity index for predicting expected performance of laying hens during adverse thermal conditions, and additional studies are being designed to develop a similar index for growing turkeys.

Meat Cookery for Food-Service Establishments

Large volume food-service establishments (military, health care, colleges and universities, correctional facilities, employee cafeterias, and restaurants) prepare approximately 250 million meals per day. The number of meals prepared by these establishments will continue to grow as will those prepared by delicatessen and supermarket carry-out units. Consumers expect and demand quality meat products; unfortunately, food preparation staffs often do not understand meat cookery principles. Many cookery procedures foster overcooked product which results in minimal yields and poor palatability.

Research has shown that long-time, low-temperature cookery offers improved meat yields and palatability. Low-temperature, long-time cookery is a proven concept and will improve yield and palatability for all products investigated: roasts, steaks, chops, ground beef and restructured meat products. Experience has shown that food-service professionals often hesitate to use these principles. An important component of the problem is that limited current cookery information is available to those
who need and use it daily. As a result of the UNL research, clear and simple cookery systems to maximize yield, performance and palatability of fresh and restructured meat products are being developed. The systems are being disseminated to the large volume food-service industry through appropriately formatted procedures, instructions and information.

Biometry

When designing farming systems, the new science of chaos has the potential for shedding light on poorly understood phenomena. It involves the study of nonlinear dynamics and provides a way of generating complex behavior from sets of simple mathematical equations. Chaos is being used to investigate various agricultural and biological systems—from behaviors seen in bird flocks, to model the population dynamics of insects and diseases; to examine the morphology or river networks, to model growth strategies of trees, plants and roots. When designing farming systems, it may be important to incorporate a degree of chaos to make the system capable of absorbing disturbances so that other parts of the system can remain stable.

Studies are continuing in the area of development of a method to extract inbred lines from elite maize germplasm. It is basically a single cycle of recurrent selection using the two first generation hybrids which produce an elite double cross. The $F_2$ progeny of the first generation hybrids are currently being crossed to testers to evaluate their performance. The $F_2$ progeny are also being sold to produce $S_2$ lines to be selected based on the $F_2$ progeny test-crosses.

Farmers choose among several criteria when evaluating new crop varieties, grain yield being the most important. The ability to stand up until harvested, rate of grain drydown, and many other traits are also of considerable importance. However, there is some difficulty in determining the amount of weight given to each trait when selecting among a set of potential new varieties. A mathematical optimization procedure was used to develop a model which can easily be applied in selection programs aimed at developing new crop varieties.

Multivariate statistical techniques is a second area of major importance under study where discriminant analysis is used in the exploration of differences between groups. Previously, the focus of discriminant analysis has been on forecasting, i.e., predicting group membership. This new focus on interpretation has uncovered some valuable biological insights. Further work in multivariate analysis is in the area of repeated measures designs with profile analysis and growth curve analysis. There is potential for its use in food science, soil science, and weed science research where several observations are made on the same experimental unit.

The use of a new methodology, Data Dependent Systems (DDS), to the biological systems studied in agriculture identifies an adequate mathematical model from a series of observations recorded over time. The models take the form of differential/difference equations that can be used to characterize, forecast and control. Preliminary investigations indicate this methodology is useful when little is known about the underlying dynamic behavior of a system.

Biological Systems Engineering

Focus on Pesticide Application

Proper application of pesticides has been a concern for both private and public sectors, especially with the potential surface and ground water contamination from improper handling, application and storage of pesticides. From field research of 140 farm and commercial applicators, only one out of three applicators were applying pesticides within 5% of their intended rate. Most of these errors were traced to poor or infrequent calibration practices. Twenty-six percent of the cooperators over applied pesticides during a single application. If these values were representative of the state, a savings of over $4.25 million could be expected just from the excessive applications. These costs do not reflect the potential crop or environmental damages from improper application. These results and recommendations for improving sprayer accuracy and uniformity have been discussed in 18 regional and national farm magazines and journals.

A similar field survey, focusing on golf-course applicators, was made in 1988. Fifty applicators were surveyed to determine the accuracy of chemical application, equipment used, types and amounts of chemicals applied and personal safety practices. The results showed that only one out of six applicators were applying within 5% of the intended application rate.

Correspondence with pesticide applicators indicated that calibration was not frequently used because it required the use of cumbersome equations and most procedures were a time consuming exercise. A program was initiated to distribute a calibration card (credit card size) that contained instructions for a calibration method that required no calculations and typically could be completed in one-half hour. Over 30,000 “ounce calibration cards” have been distributed.

Irrigation Management

Nebraska, with approximately eight million acres of irrigation, ranks second in the USA in irrigated area. Currently about half of the area is irrigated by furrow while sprinkling with center pivot systems is used on the other half. The four million acres of sprinkler irrigation in Nebraska is the largest sprinkled area for any state.

Faculty are developing and evaluating more efficient irrigation methods to protect the Nebraska water quality and to reduce water consumption by irrigation. In some areas the ground water level is dropping because more water is being pumped for irrigation and other uses than is recharged by rainfall.
Growers in these areas are searching for improved schemes of irrigation management to protect ground water resources.

Research has been underway to respond to this developing problem. Joint research between departmental faculty in Biological Systems Engineering and Agricultural Economics has led to new irrigation scheduling methods that consider crop water requirements for the entire growing season rather than just the next irrigation as is commonly done with conventional irrigation scheduling. These scientists also developed methods to select the most profitable crops to irrigate and to determine how many acres to irrigate when the supply of irrigation water is less than needed for maximum crop yields.

At the same time, faculty in Biological Systems Engineering and Agronomy have conducted field experiments at the West Central Research and Extension Center near North Platte to evaluate the effect of water stress on the yield of corn, soybean, and wheat when grown continuously or in a three crop rotation. Results from these projects were instrumental in the development of a series of computer programs for an irrigation management system that will assist producers, consultants and policy makers.

Research has also been underway to develop and evaluate more efficient methods of applying irrigation water. Water losses from evaporation and drift from various sprinkler irrigation devices have been studied using field experiments and computer simulation. Results show that evaporation loss may be much smaller than originally thought even for windy conditions. The use of inter-row tillage to reduce surface water runoff losses from center pivot irrigation systems was also evaluated. Three methods, implanted reservoirs, furrow basins, and subsoiling were tested. Implanted reservoirs are pits made between crop rows after the final cultivation of the season. Furrow basins are constructed between crop rows by making small dikes at about 10-foot intervals. Implanted reservoirs and furrow basins are used to store water on the soil surface until the water can infiltrate. Subsoiling involves deep chiseling after the final cultivation to increase the rate of infiltration. The implanted reservoir method was most effective on fields with steep slopes. In fields with 10% slope the implanted reservoir reduced water runoff by 68% and soil erosion was reduced by 92% compared to conventional tillage practices. These results are being used to develop guidelines and computer programs for selecting the appropriate sprinkler package for a center pivot based on soil properties and slope.

On many soils in Nebraska it is difficult to apply water efficiently with furrow irrigation because of relatively high water intake rates. A new method of applying water, surge flow, is being evaluated as a potential method of reducing infiltration rates and thus increasing water application efficiency. The average reduction in water intake in 16 experiments conducted since 1983 was 19% with the range being from 0 to 60%. Improved management criteria for the appropriate application of surge and continuous flow irrigations are being developed.

Research has also been conducted to evaluate the potential for ground water contamination when using chemigation. Chemigation is the application of fertilizers, herbicides, insecticides or other chemicals to the field using the irrigation system. The potential exists for some chemical to flow back into the irrigation well if proper precautions are not observed. Backflow prevention equipment is required by law to reduce this risk. Methods have been developed for testing backflow prevention equipment, identifying the components of the system that have the largest potential for failure, and evaluating the risk of contamination when using the required equipment. The testing procedures have been used by Natural Resource District personnel for inspecting equipment at over 8000 chemigation sites to determine if the equipment satisfies the regulatory requirements. This methodology will be used in the future to evaluate new and alternative backflow prevention systems.

ARD faculty are developing and evaluating more efficient irrigation methods to protect Nebraska water quality and reduce water consumption by irrigation.
**Electronic Stockmanship**

Sensors, controls, and mathematical models for livestock production can result in an early warning systems for the welfare of the animal and profitability to the producer. One of the most intriguing research projects is the use of swine “grunts” or vocalizations to identify management problems in swine production. Experienced producers may identify problems through swine vocalization. However, the manager or employees cannot be in the livestock facility 24 hr/day. An electronic system could identify the state of pigs, e.g. farrowing, heat and hunger. Sonographs of pig vocalizations is shown below.

The sonographs are 3-D plots showing the frequency of the sound in cycles per second or Hz, the length of the call and the loudness (amplitude) of the call. This signature or “thumb print” will tell the computer and thus the producer about the state of the pig, especially useful when the person is not on site. Initially we found that more stressful conditions tend to result in longer and higher frequency calls. The signature of farrowing is different from the other sounds and thus may allow the computer system to call the producer stating “there is a sow farrowing in Room 1 and may need your help in the next hour”.

Other behavior responses are being investigated and could be used to assess the well-being of the animal. The use of a video camera connected to a computer may help identify problems if the animal is cold, lame, or has disease problems. This information interlaced with conventional measurements of temperature, humidity and feed consumption could give an early warning if problems exist. The use of mathematical models relating to the needs of swine or poultry will determine if the environment is correctly suited for the animal and what adjustments are needed. Economic impacts can also be assessed and placed in a controlling strategy. For example a temperature humidity index (THI) for laying hens developed at the ARD presents a weighted function of air temperature and wet bulb temperature (temperature of a thermometer that is cooled down by evaporation of water). The laying hens respond to an additive effect of 60% of air temperature and 40% for wet bulb temperature. By estimating egg production declines and breakage from the THI, cooling systems and controls can be evaluated. Using livestock as its own sensor with the development of controls using predicted economic benefits can help livestock, producers and ultimately the consumer.
Research Highlights

**Agricultural Meteorology**

**Remote Sensing of Earth's Surface**

Remote sensing of the earth's surface involves measurement of reflected solar radiation and the interpretation of data in biophysical terms. Reflected radiation is a function of the surface properties and incident solar irradiance. The amount of radiation reflected from a surface is compared to the amount of solar radiation received at the surface as a way to compare information from different times of day as well as for different days of the year. It is important to get a good estimate of the amount of incoming radiation with the same instrument used to measure reflected radiation. Highly reflective reference surfaces estimate the incoming radiation. These surfaces will have reflective properties dependent on the sun's position in the sky (regardless of their construction). It is important to periodically characterize the reflective properties of reference surfaces as a function of sun angle (since dust, use and surface deterioration will change the reflective property). Reference surfaces can then be used in the field to estimate the amount of incoming radiation with the assurance of valid reflectance calculations.

We have developed field facilities to calibrate remote sensing field reference surfaces used in reflectance calculations. These surfaces are calibrated with the same instruments which measure surface reflected radiation and under the same field conditions. Reference surfaces calibrated with this technique are currently used in experiments using remote sensing techniques to quantify turf grass quality, to indirectly measure absorbed photosynthetically active radiation in alfalfa and to aid in interpreting remote sensing data acquired over water of varying turbidity levels.

**Consumer Science and Education**

**Independent Living for the Elderly**

The increasing proportion of elderly residents and decreasing resources in smaller communities has the potential of creating serious problems for the state, communities, and residents unless appropriate planning and actions occur. Nebraska has a larger proportion than the national average of its elderly residents in nursing homes. It is estimated that 20 to 40% of those in nursing homes are inappropriately housed. An alternative strongly supported both by the elderly population and by those looking for less costly living alternatives for the elderly is the concept of independent living. Elderly individuals are able to remain in their own homes rather than moving to a nursing home. However, to make independent living a viable alternative, a support system for services must be developed to provide for the gradually increasing needs of the elderly as they remain in their homes. Also, their housing may need to be modified to accommodate changes in health, mobility, and sensing abilities.

A study is currently underway to investigate the interaction between housing and service needs of the elderly and housing and service provisions within the community. Recommendations will be made that contribute to the well-being of elderly residents and the communities in which they live.

**Changes in Family Financial Well-Being**

A study is being conducted to determine how the economic situation of Nebraska families changed between 1981 and 1986. The study uses data from the Nebraska Annual Social Indicators Survey assembled after contacting over 900 households every two years to ascertain changes.

Two measures of economic well-being are used: change in household income (adjusted for inflation) and change in an income/needs ratio based on household size and composition. The study compares changes in economic well-being between rural and urban households and between households with heads over 65 years and those with heads under that age.

**Housing Design to Meet the Future Needs**

Professionals in home economics, architecture, agricultural engineering, construction management and horticulture at the University of Nebraska and at the University of Hanover, Germany, came together to share their expertise in energy efficient housing design, barrier-free design, affordability considerations, and manufactured housing possibilities. This knowledge base, combined with information acquired from a random survey of 732 Nebraska residents and from representatives of government and the housing industry, was used to develop housing prototypes designed to meet the future needs of Nebraska residents.

**Rural Households at Risk of Serious Housing Problems**

Housing researchers in six North Central states are hoping to discover the extent to which North Central households are experiencing or are at risk of experiencing serious housing problems and to discover the factors precipitating those problems. Also to be evaluated is the effectiveness of existing housing assistance programs in preventing housing problems.

**The Effects of Knowledge and Attitude on Use of Health Care Insurance**

A study is being conducted on Nebraskans 65 years of age and older to determine knowledge and attitudes toward health care insurance and health care insurance providers. This information will then be used to design an educational program to increase older Nebraskans knowledge of health care insurance.
Corn rootworm larval pruning reduces corn yield and UNL researchers are studying how rootworm populations correspond with photosynthesis and growth of corn plants.

Entomology

Effects of Corn Rootworm Larval Feeding on Corn Plant Function

The western corn rootworm is a serious pest of field corn in Nebraska. While it is well-known that the root pruning done by rootworm larvae reduces corn yield, the manner in which the plant responds physiologically to this damage has not been studied. To address this question, a research team is studying the impact of various western corn rootworm larval population levels (and corresponding root damage levels) on corn plant photosynthesis (the process which produces energy for the plant), growth, and initially reduced by larval feeding, and then followed by a high rootworm infestation levels. Plant growth is reduced by larval feeding, but, following the larval feeding period, compensation occurs which results in greatly increased root, stem, and leaf tissue production. Increased vegetative growth in response to larval rootworm injury appears to be an important factor that influences final grain yield.

Rootworm damaged plants appear to put energy into growth or regrowth of vegetative tissues at the expense of seed production. The corn rootworm/corn plant relationship is currently being studied in different soil types and under irrigated and nonirrigated conditions.

Development of Adult Corn Rootworm Management Technology

Research is being conducted to utilize and manipulate corn rootworm behavior to develop alternative corn rootworm management strategies. Adult corn rootworm attractants, feeding stimulants, and a small amount of insecticide have been successfully incorporated into corn starch matrices to create slow-release granular formulations. Results of laboratory and field experiments show that corn rootworm beetles are attracted to the starch-based formulations and that beetles are killed when they feed on granules. The level of beetle control obtained from the use of starch-based granules in small field plots was comparable to a broadcast application of a commercial insecticide while using 90% less insecticide.

The starch-based formulations were also more effective as beetle control agents when placed in the corn canopy vs. placement on or near the ground. The potential negative impact of starch-based formulations on selected non-target insects can be reduced by placing specific chemicals on the outside of the granules without reducing granule impact on corn rootworm beetles. If this concept can be successfully applied to large scale corn production, an environmentally sound alternative method of corn rootworm control would be available to growers that would also make use of a raw corn product.

Livestock Insects Research

The Midwest Livestock Insects Research Laboratory (Agricultural Research Service, USDA) is located in the Department of Entomology at the University of Nebraska-Lincoln. Members of the laboratory fill dual roles as federal employees and adjunct University faculty members in the Department of Entomology. The mission of the Laboratory is to develop integrated pest management systems for fly pests of feedlot cattle.

The two main flies in beef cattle feedlots are the stable fly and the house fly. The stable fly is estimated to cause $400 million in annual losses to the nation’s cattle industry. They feed on blood of the cattle and generally land on the animal’s legs. It is hard to put an economic value on house flies but they are known to transmit a number of disease organisms and are quite a nuisance to livestock handlers. The immature stages (maggots) of both fly species develop in the manure and organic accumulations in the feedlots.

There are four primary areas of study by members of the Laboratory:

- Studies of biology and ecology of the flies in the feedlot environment, studies of the use of natural control agents to control flies in feedlots, the development of predictive equations and computer simulations of stable fly and house populations, and the development of integrated pest management systems for the cost effective management of stable flies and house flies.

Mission Oriented Basic Research

Several programs in Entomology are partly devoted to basic research in developing modern biological technologies for application to entomological problems: use of DNA probes to identify green bug biotypes and black flies, and detailed studies of the
Research Highlights

enzymes that confer insecticide resistance upon natural populations of economically important insects. In addition to these programs, the Insect Biochemistry/Physiology Laboratory is fully committed to basic research in significant areas of insect science. The personnel in this laboratory are involved in interdisciplinary research teams, two of which are described below.

Prostaglandins, hormone-like molecules that were once thought to be important only in humans and other mammals, are crucial mediators of insect immune defenses. All animals protect themselves from bacterial infections by mounting immune defense responses. The human tragedy of AIDS underscores the devastating effects of immune deficiencies: animals do not survive without their robust immune systems. Interdisciplinary research involving biochemical, pharmacological and microbiological skills has recently shown that inhibition of prostaglandin formation leads to immune deficiency in some insect species. When immune-compromised insects were infected with pathogenic bacteria, the insects failed to clear the bacteria from their circulation systems, and they died much sooner than expected. The long-term hope is that this basic discovery can eventually lead to development of environmentally sound strategies of controlling economically important insect pests by selectively compromising their immune systems.

Chinch bugs are small insects that complete their life cycle on three separate hosts: they overwinter in bunch grasses, then move into wheat, in which they feed and lay eggs. Later in summer the chinch bugs move into sorghum fields, from which a second generation emerges and moves into native bunch grasses from overwintering. Chinch bugs express periodic population outbreaks, during which economic losses exceed 10 million dollars during a single season. Chemical, biochemical and entomological personnel are cooperating on analysis of stable carbon isotopes in chinch bugs, from which dietary histories can be reconstructed. These dietary histories reflect timing and patterns of chinch bugs movements. It is extremely difficult, if not impossible, to gain this basic information by traditional methods. However, such knowledge is essential for designing successful strategies to manage chinch bug populations. Our vision is that analysis of stable carbon isotopes will eventually become a routine tool in gaining solutions to otherwise intractable problems.

These and other projects make the point that when managed with an eye to substantial, real-world problems, basic research is a promising investment. The Insect Biochemistry/Physiology Laboratory is dedicated to generating new economically and environmentally useful knowledge.

Environmental Programs

Pesticide Impact Assessment

Potential for both field worker exposure and drift when insecticide is applied by chemigation was investigated at the Northeast Research and Extension Center, Concord. The research was to assess worker safety and environmental impacts when insecticides commonly used on corn are applied through center pivot irrigation systems.

Workers entering a field 24 hours after treatment were monitored both for dermal and respiratory exposure. Results indicated that over 80% of the exposure encountered was through workers' hands. The levels of exposure encountered were at least 80 times less than the amount that would be considered a toxic dose. Thus the risk of field workers being acutely exposed to insecticides is very low.

Data from the environmental impact component of the study showed that insecticide drift moves much further (>325 feet) when chemigated with oils.

Another project at that site focused on determining effects of tillage practices and application techniques on potential runoff and leaching of insecticides from cornfields. Results showed that insecticides remain in the top three inches of soil, regardless of tillage practices. Results also indicated that during runoff after rainfall, approximately 66% of the insecticide removed is bound to soil sediment.
Research on distribution of insecticides in soil when applied for termite control was conducted at the Nebraska Agricultural Research and Development Center, Mead. The results showed that insecticide (chlorpyrifos) moves 12 inches horizontally and vertically. In general, the soil injections 12 inches apart with less than 20 PSI provide a continuous chemical barrier against termites.

**Water Center**

**Pesticides and Nitrate in Nebraska’s Ground Water**

An atlas summarizing the magnitude and extent of agrochemical contamination in Nebraska’s ground water has been published. The atlas describes the statewide ground water occurrence of commonly used agrochemicals. Over 6,500 wells located throughout Nebraska indicated that areas as large as 200,000 continuous hectares are underlain by nitrate-N concentrations exceeding 10 mg/l. Contamination areas are increasing at rates of 0.5 to 1 ppm NO₃⁻-N/yr. The large areas where nonpoint contamination occur are predominantly irrigated and characterized by well-drained soils and depths to ground water of less than 15 meters. In these areas, 75% of the cropland is devoted to irrigated corn production, which annually receives high amounts of N-fertilizer and triazine herbicides. Throughout the vulnerable nonpoint areas the contamination has initially occurred beneath sandy loams, but gradually has become a problem beneath both silt loams and silty clay loams. Irrigated areas with fine-textured soils and greater depths to water also are vulnerable to leaching but to a lesser extent. Three hundred of some 2,200 wells throughout Nebraska contained detectable levels of the herbicide atrazine. Seventy percent of atrazine detections were in the areas most vulnerable to ground water contamination.

**Research Highlights**

**Food Science and Technology**

**Altering Composition of Food**

Consumers have become increasingly concerned about the nutritional properties of the foods available in the supermarket. Foods with a lower cholesterol and fat content are often in demand. Foods tailored to consumer needs with respect to nutritional characteristics are now in vogue. The food industry today now has new technologies which may alter the composition of the foods available in the market place.

Research is continuing the use of supercritical carbon dioxide extraction for altering lipid composition of animal products. Supercritical carbon dioxide extraction is used in the food industry today to decaffeinate coffee and extract food flavors. Results now show that lipids and cholesterol content of dried beef and chicken can be substantially reduced using supercritical fluid extraction. In fact, under certain conditions essentially all of the lipids and cholesterol can be removed from beef and chicken without substantially altering the flavor of the product. This means that new low fat, cholesterol-free shelf-stable convenience meat products such as stews, soup mixes, etc., may be available to consumers in the future. They would be easily used by adding water and reheating.

Another aspect being studied is the “surimi” process used for fish products to alter the composition and texture of poultry meat. Surimi is prepared from washing under-utilized fish to remove pigments and fat. The resulting product has greatly improved texture, binding ability and superior nutrient content (lower fat, high protein ability). Surimi has various product applications with a high profit margin: premium quality crab legs are one possible product.

At Nebraska, research has concentrated on upgrading underused poultry meat to superior quality meat items. For example, mechanically deboned poultry meat can be washed with water as done in the surimi process. The washed product has the appearance and texture of white meat. Further, the “surimi-like” product is low in fat and high in protein. Several variations of the process have been studied to achieve the best product characteristics. Studies are now concentrating on storage stability and its practical application in the food industry.

**Natural Antioxidants**

One reason consumers reject food is undesirable flavor due to lipid oxidation, i.e., rancidity. The food industry tries to prevent rancidity in foods by food additives known as antioxidants. Antioxidants prevent the beginning stage of lipid oxidation; however, over time, the antioxidant loses its ability to prevent lipid oxidation and rancidity occurs. In some foods antioxidants completely inhibit oxidation during the normal shelf-life of the product and the consumer does not experience the undesirable
flavors. In foods which undergo several processes, especially cooking or frying, controlling lipid oxidation becomes a problem. For example, a great deal of research has gone into finding a way for preventing the "T. V. dinner" flavor known as warmed over flavor (WOF) in cooked meats.

To date, preventing lipid oxidation in foods has relied on the use of synthetic antioxidant compounds such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tertiary butylated hydroxyquinone (TBHQ); however, there is some concern about the use of these synthetic compounds by the public. There is interest in the development of naturally occurring compounds which have antioxidant capabilities. The Department of Food Science and Technology has focused on developing naturally occurring antioxidant compounds. At present two sources of naturally occurring antioxidants are being investigated, i.e., soy proteins and the spice, rosemary.

One protein found in the soybean prevents the development of rancidity in cooked meats. This protein has great potential in foods which contain various ingredients including protein supplements. The second source of antioxidant compounds, the spice rosemary, has greater potential use. Six compounds have been isolated from rosemary which have equal or better antioxidant activity than the tradition synthetic compounds, BHT, BHA and TBHQ; however, they are expensive to isolate in the pure form. Research is in progress to develop rosemary as a commercial source of natural antioxidant compounds. In addition, these compounds are being investigated for possible physiological activity, since many compounds that have antioxidant activity have been shown to have some anticancer activity and may possibly help prevent the aging process.

Forxay, Fisheries and Wildlife

Interactions of Wildlife and Agricultural Systems in Nebraska

Low Input Sustainable Agriculture (LISA) seeks to maintain or increase agricultural profits while maintaining environmental quality. This often involves practicing integrated pest management and crop rotation. Crop rotation frequently involves alfalfa with row crops and thus relates to research involving plains pocket gophers. As alfalfa plantings increase (because of increased crop rotation practices), this will enlarge desirable habitat for pocket gophers. Pocket gophers decrease alfalfa yields by as much as 35%. How does one control damages caused by pocket gophers without increasing environmental risks? We are investigating the use of two alfalfa varieties. One variety is primarily tap-rooted, is widely used in Nebraska, and has a higher yield than the alternative variety that we are evaluating. The other variety has a more fibrous-root system. Although it has a lower yield, it is more cold hardy, more drought resistant, and could be more resistant to damages caused by pocket gophers. Its resistance is hypothesized because if a pocket gopher eats the tap root, the plant will die; the fibrous-rooted plant will have a higher probability of surviving. Also, when a root of the fibrous plant is broken, it vegetatively sends up a new shoot. Thus, some moderate below ground feeding by pocket gophers could result in increased yields. One year of field results have shown no difference in yields between the two varieties. Also, pocket gophers decreased the yields of each variety 15-19%. The alfalfa stand was only two years old, so we did not anticipate a large difference between the varieties. Also, 1988 and 1989 had below normal precipitation. Thus, the young age of the stand and the influence of drought could have masked yield differences. If we can minimize the impact of pocket gophers on alfalfa yield merely by planting a new variety, we will have resolved a potential problem and accomplished that in the spirit of LISA.
Wildlife Enhancement in Nebraska

Intensive farming and a shift toward row crop agriculture has simplified and fragmented many natural ecosystems in the Great Plains. Several wildlife species that once were abundant are now considered rare. The Conservation Reserve Program (CRP) provision of the 1985 Food Security Act (1985 Farm Bill) pays farmers to retire highly erodible land for 10-year periods and plant it to grass, trees, or other approved permanent vegetative cover. How CRP land affects wildlife populations remains to be seen. Various conservation practices are allowed under the current CRP rules and certain plantings will presumably be more beneficial to wildlife than others. Research is aimed at determining the effect of the CRP on wildlife on private lands in Nebraska. Selected wildlife populations are being compared in areas with high (20%) of the cropland in CRP and low (<5%) of the cropland in CRP enrollment. Additionally, bird populations are being compared on cropland, native prairies, and CRP land planted to cool-season grasses and warm-season grasses. Preliminary results show numbers of pheasants are significantly higher in areas with high CRP enrollment; no differences in bobwhite quail populations have been detected. Overall, bird populations appear similar on the cool-season and warm-season CRP land. Numbers of birds and diversity is lowest on the cropland fields. Data obtained from this project will help assess wildlife response to diverted acres in Nebraska and aid wildlife managers in recommending plantings that are beneficial to increasing bird populations.

Horticulture

Development of Concetta ROSE

A new and distinct cultivar ("variety") of rose plant of the hybrid tea rose class was originated as a sport of the rose 'Gabriella'; characterized by its bright orange red, well-formed hybrid tea type blooms with dark velvet overtones on the outer edges of the open flower; disease resistant with everblooming habit and outstanding pot forcing characteristics.

Breeding Improved Dry Edible Beans

A long time breeding program has been conducted by researchers in the Department of Horticulture, Plant Pathology, Lincoln, and the Research and Extension Centers at Scottsbluff and North Platte to develop new cultivars and enhanced germplasm of Great Northern (GN) and Pinto dry beans with disease resistance, seed quality and yield. 'Starlight', a new moderately early Great Northern dry bean cultivar has been released to fulfill a need in western Nebraska for a cultivar with a larger seed size, with a more uniform bright white seed-coat and with improved architectural avoidance mechanisms to the white mold disease. Genes controlling upright architecture and rust resistance were obtained in a black bean 'Tacaragua' (Venequala) and large seed size and uniform seed whiteness in 'Bulgarian white'. Cooperation with foreign countries has led to the identification of useful germplasm for this breeding program. Foreign buyers of Great Northern beans want a larger seed than the current predominant Great Northern cultivar. Since white mold is a serious disease in western Nebraska there is a need to develop new cultivars with improved avoidance of the disease to reduce yield losses and to reduce costs or production by eliminating the need to control the disease using chemicals. 'Starlight' has an indeterminate semi-upright plant habit with fairly open plant canopy that provides an architectural mechanism for avoidance of the white mold disease. 'Starlight' showed the lowest amount of white mold infection in trials and was higher in yield than GN 'Harris' and 'Spinet' in the white mold nurseries. 'Starlight' was comparable in yield to the highest yielding standard cultivars in the non-disease nurseries. 'Starlight' is also resistant to the strains of the rust fungus present in Nebraska.

Enhanced Dry Bean Germplasm with Multiple Disease Resistance

Great Northern and Pinto dry bean lines combining various levels of multiple resistance to the pathogens causing the disease common bacterial blight (CBB), rust, white mold and bean common mosaic virus (BCMV) have been developed using exotic germplasms from foreign countries in the breeding program. This germplasm is useful to private and public breeders in the development of improved cultivars of dry beans since the desired traits have been transferred into adapted and improved breeding lines. It is proposed to formally release Great Northern 85-55 (a line combining resistance to CBB and BCMV) and Pinto EP-1 (a line combining resistance to CBB and BCMV) in 1990.

Breeding Kentucky Bluegrass, Tall Fescue and Buffalograss for the Central Great Plains

During the past year two Kentucky bluegrasses were evaluated for seed production in the Western U.S. If adequate production is obtained these cultivars will be considered for release. Progress with buffalograss continues with increased interest due to water shortages on a national basis. Three female buffalograss clones are performing well in various parts of the U.S. One southern selection will be released and marketed by a Texas sod grower with availability in late 1990 or early 1991. Buffalograss will provide a 40 to 50% water savings over conventional turfgrasses, along with additional savings in fertilizer, mowing, and pesticides. Research has been started on the development of new, seeded turf-type buffalograsses. This project will use the synthetic plant breeding method to provide new cultivars in 1995.
Research Highlights

Human Development and the Family

The Psychosocial Effects of a Serious Motor-Vehicle Accident on Individuals and Families

More than 100 people have been involved in a pilot study of the effects of a motor-vehicle accident, and the research team hopes to have at least 300 people involved in the future. Traffic accidents are so common in our society that we often fail to realize the terrible effects they have on people. The study aims at clearly outlining these effects, and pointing out things we can do as a society to ease the burden.

Rural Nebraska Families Having a Disabled Member

Nebraska families (109) living in nonmetropolitan areas responded to questions regarding their perceptions of: (a) family strengths, (b) activities of help to them, (c) services needed, available and used, and (d) other aspects of their lives. Generally, family members indicated a strong commitment to a good quality of life for the individual with a disability. Needed services were available to these rural residents but not used.

Human Nutrition and Food Service Management

Metabolic Nutrition

Food, beverages and water may contain substances which negatively interact with nutrients. Aluminum is known to inhibit the absorption of calcium. When rats were fed ordinary chow diets plus either diet soft drinks packaged in aluminum cans or in plastic bottles as the only source of fluid, bones of animals fed the aluminum can soft drinks were weaker and broke more easily than those of animals fed plastic bottle type soft drinks. (This bone breaking strength test is conducted after animals are humanely sacrificed.) Aluminum can packaged soft drinks contained more aluminum than did plastic bottle packaged soft drinks; and the aluminum content of the aluminum canned soft drinks progressively increased with length of storage time. This suggests that aluminum canned soft drinks should not be kept for prolonged time periods before use.

Intake of specific nutrients may protect against the damaging effects of certain, presumably toxic substances found in food, beverages, and water. The primary sources of nitrosamines (most of which are potent cancer initiators) are nitrates and nitrites found in food and water. Vegetables are the major sources of nitrates in average American diets. However, fruits and vegetables are excellent sources of ascorbic acid (Vitamin C) which is known to inhibit the conversion of the relatively safe nitrates and nitrites to the far more dangerous nitrosamines. In this laboratory, adult human subjects were fed controlled diets in which the amounts of nitrate and ascorbic acid were varied by altering the kinds and amounts of fruits and vegetables. Apparent exposure to nitrosamines could be changed by these simple dietary interventions. Preservation and cooking procedures were found to affect the amounts of nitrates in beets. Those procedures which involved discarding of cooking and preservation in an acid medium appeared to offer best results.

Preliminary results indicate that eating of red meat may offer protective effects against lead toxicity. Adult human subjects were fed constant, laboratory controlled diets which contained either beef (6 ounces per day) or beef (2 ounces) and white meat (4 ounces per day). The lead content of both dietary plans was the same. Blood levels were lower and loss of lead in feces was higher when the high rather than the low beef containing diets were fed. Presumably, the apparent protective quality of beef is related to its heme iron content. Iron inhibits lead absorption and heme iron from meat is the most readily absorbable form of food iron.

Unexpected side effects of nutrient supplements may have pronounced effects on nutritional status. Because of concerns about the high incidence of osteoporosis (brittle bone disease) among American women, use of calcium supplements has become common. Because of its low cost and high calcium content per unit weight, calcium carbonate has become the most popular supplemental calcium source. Calcium carbonate is also used as an antacid since it is poorly absorbed from the intestines and acts to reduce stomach and upper intestinal tract acidity. In this laboratory, when adult human subjects were fed graded amounts of calcium carbonate in combination with a measured, constant diet, iron status of these individuals was found to decline as levels of calcium carbonate supplementation were increased. Non-meat iron absorption is most efficiently absorbed in an acid medium; hence, it is not surprising that an antacid which is also a calcium supplement would inhibit dietary iron utilization. Since iron deficiency anemia is not uncommon among women, it is unfortunate that efforts to decrease risk for one pathological condition, osteoporosis, might increase the risk in these individuals of secondarily developing another one, iron-deficiency anemia.

Depending upon specific kind, source, and processing procedures before consumption, dietary fiber is thought to have several beneficial health effects. Psyllium husk fiber has long been used as a bulk laxative. Use of psyllium husk fiber in breakfast cereals has recently occurred. Psyllium fiber supplements have been demonstrated in this laboratory modestly to lower blood cholesterol levels, increase stool bulk, and decrease fecal transit time. However, use of psyllium fiber supplements were also found to decrease utilization of several minerals including zinc. Iron supplements are also known to inhibit zinc utilization. Higher apparent zinc utilization was observed when human subjects were fed psyllium fiber plus time released iron supplements than when psyllium fiber plus regular iron supplements were employed; but the reverse was true when the iron
supplements were not given concurrently with the iron supplements. These results point up the difficulties of predicting effects of nutrient supplement use because of the multitude of possible interactions.

Effects of dietary fat on blood serum lipid levels and, presumably, upon cardiovascular disease risk continue to be a topic of intense scientific and consumer interest. Production of food products with high consumer acceptability sometimes necessitates the use of solid shortenings rather than liquid oils. To this end, highly polyunsaturated oils such as soybean and corn oils are sometimes partially hydrogenated; a process by which they become more solid at room temperature but concurrently become more saturated. Some plant oils such as palm oil tend to be relatively solid at room temperature and contain appreciable amounts of saturated fatty acids. As marketed in the industrialized world, palm oil is generally separated into a more liquid, less saturated fraction (palm olein oil) and a more solid, more saturated fraction (palm stearin oil). In the soybean oil - palm oil controversy, the relative effects of these different palm oil fractions and hydrogenated soybean oil shortening on blood serum lipids of humans has been questioned. Human adult subjects fed the test oils under controlled laboratory conditions were found to have lower blood serum total cholesterol and LDL cholesterol levels than the unFractioned palm oil, palm olein oil and palm stearin oil were fed. The hydrogenated soybean oil shortening had a higher iodine number than did any of the palm test oils. Iodine numbers show the number of double bonds which an oil contains, thus is directly proportional its degree of unsaturation. The results of this study show that even hydrogenated soybean oil is more unsaturated and produces lower blood cholesterol levels when fed to humans than do equivalent amounts of the usually marketed forms of palm oils.

Choice of dietary fat may affect human health in ways other than those usually associated with lipid nutrure. Using adult human subjects calcium absorption was found to increase as the degree of unsaturatedness of dietary oil was increased; thus, soybean oil was found to produce better calcium absorption than canola oil.

Use of omega-3 fatty acids from fish oils have been found to reduce the clotability of blood. When fed to human subjects, omega-3 fatty acid supplements from fish oil were found to increase urinary losses of sodium, increase total urine volume loss, and modestly reduce blood pressure. Similar results were not observed when omega-3 fatty acids supplied canola oil were fed. The 20 and 22 carbon length omega-3 fatty acids supplied by fish oil are more efficiently utilized than is the 18 carbon length omega-3 fatty acid supplied by canola oil.

Physicians Recommendations About Eating Beef

Concern about cholesterol has many people changing their diets. One noticeable trend is a reduction in the consumption of beef; an alarming trend in areas where beef production is a main livelihood. This trend toward lower beef consumption may be augmented by recommendations from health professionals and other sources. In previous research, Midwest physicians felt comfortable giving patients advice on reducing dietary cholesterol even though they felt that their nutrition education in medical school was inadequate. A follow-up study was conducted to determine what types of dietary recommendations physicians make patients with high blood cholesterol. Specifically, are physicians who practice in states where beef production is a large portion of the economy recommending that beef be omitted from cholesterol-lowering diets? A survey was conducted with 5,900 medical doctors in Nebraska, Iowa, Kansas, Colorado, Wyoming, and South Dakota with 1,595, or 27%, responding. Thirty three percent reported that they routinely recommend red meat be eliminated from the diet of patients trying to lower blood cholesterol, while 54.6% recommend that their patients decrease consumption of red meat. Other items recommended for elimination from the diet were “saturated fats” (45.6%), eggs (42.4%), and dairy products (42.0%). These same foods were also additional ones recommended for reduction. Foods recommended for increase were "high fiber" (61.3%), fruits and vegetables (50.6%), fish (36.4%), and poultry (22.8%). Both physicians who could identify low fat cuts of meat and those who could not identify low fat cuts of meat recommended eliminating or reducing both saturated fat and red meat. These findings suggest that more information about the use of lean red meat in cholesterol-lowering diets should be directed toward physicians.
**Research Highlights**

**Nutrition Interests of Low Literate Adults**

Reading skills of over 50% of American adults are thought to be below the tenth grade level. However, most health and nutrition information written for adults is at or above the tenth grade reading level. Obviously, a great deal of needed information is unavailable to the adult population. To make nutrition information readable for more adults, the Human Nutrition Information Service (HNIS) of USDA contracted for development of nutrition material. This material must not only be written at a level that low literate adults can read, but must also be of interest so they will want to read it. Unfortunately, the low literate population has also been neglected in terms of their interests. The purpose of the ongoing research with this population includes not only development of readable materials but development of methods for determining interests. Focus group interviews, individual in-depth interviews and critical incident interviews have been conducted in Omaha, Lincoln, and the rural areas surrounding Beatrice. The written materials were based on the HNIS Bulletin series “Dietary Guidelines and Your Diet” and were written at the fifth grade reading level. Preliminary results show that the adults with low literacy skills are interested in nutrition issues, particularly those dealing with cholesterol, weight control, and feeding young children. Items of little interest include alcoholic beverages, especially in the rural areas, and recipe modifications. The written materials are currently being revised based on comments made during the three types of interviews. The revised materials will then be tested again using the same interview methods. The outcome of the project will be suggestions to HNIS for developing interesting and readable nutrition information for adults with low literacy skills. But also, the methods used to reach low literate adults and determine their interests will surprise those who believed that these adults would not participate in such projects.

**Northeast Research and Extension Center**

**Cattle Production - Implant Research**

Previous research has shown that the response to growth promoting implants may vary depending on number of previous implants used, dose of implant used and phase of production the cattle are implanted. Recently Finaplix, a new implant containing a synthetic analog of testosterone, has been shown to improve cattle performance when used with an implant having estrogenic activity.

In a growing and finishing trial, with an average initial weight of 600 lb, 120 steers were allotted to a 2x2 factorial arrangement of implant treatments. At the start of a 92-day corn silage growing program steers were implanted with either Synovex-C (low dose) or Synovex-S (high dose). Steers within each growing period treatment group were subsequently reimplanted with either Synovex-S or Synovex-S and Finaplix at the start of the high energy (dry rolled corn) finishing program. Compared to implanting steers with Synovex-C, implanting steers with Synovex-S resulted in improved gains (2.22 vs 2.37 lb/hd/day) in the growing period. However, implanting with Synovex-C in the growing period resulted in improved gains (5.9%) and improved efficiency of feed conversions (6.5%) in the subsequent finishing period, regardless of finishing implant program used. Over the entire feeding period, gains of steers were similar, however, steers previously implanted with Synovex-C were 2.2% more efficient in feed conversion. In the finishing period, steers implanted with Synovex-S plus Finaplix had 3.2% greater gains and were 1.5% more efficient in feed conversions than steers implanted with only Synovex-S.

**Soil Erosion Control/Crop Residue Cover**

Conservation tillage, or leaving crop residue on the soil surface, is one of the best and most effective soil erosion control methods. Nationally, over 31% of the acreage complying with the conservation provisions of the 1985 Food Security Act (Farm Bill) will use crop residue to reduce soil erosion.

In Nebraska, nearly all of these plans specify that a certain percentage of residue cover, usually at least 30% and in some cases as much as 85%, must remain on the soil surface after all tillage and planting operations have been completed.

Crop producers are likely to face a major dilemma as these Conservation Plans are implemented over the next several years. In a two-year study, percent residue cover immediately after harvest was found to be only 71% for soybeans and less than 80% for corn.

Eleven common tillage and planting systems were also evaluated for their effects on residue cover. Only no-till planting consistently left more than a 40% cover in either corn or soybean residue. Currently, nearly 75% of Nebraska crop producers use either a chisel plow or a disk in a tillage system prior to planting. However, when either of these implements was included in a tillage and planting system, less than a 30% cover remained. Further when more than two residue altering operations (including planting) were conducted, residue cover was less than 20%. Even though a 20% cover will reduce erosion losses by one-half compared to a residue free field, this amount of cover is not adequate for most Conservation Plans. Thus, crop producers will need to substantially change tillage practices to remain in compliance.

**Nematode Research**

A series of cooperative studies with other entomologists, beginning in 1989, have been conducted to determine the efficacy of applying entomogenous nematodes, Steinernema feltiae, through a center-pivot irrigation system, for the control of rootworm larvae in corn. Approximately 1.5 billion nematodes per acre were applied in about 0.85 inches of water.
Application was timed with finding second and third instar rootworm larvae in the field. A center-pivot application of chlorpyrifos 4E, at planting time application of terbufos 15G, and an untreated check were used for comparison purposes. Evaluations were based on rating root damage at tasseling time.

Initial results show much promise using these naturally occurring animals for control of the rootworm complex in continuous corn. Data taken in 1989 show the nematode application results in significant control over the untreated check but not as effective as the standard chlorpyrifos application. Continued research is needed to determine the best rate structure and application timing.

Panhandle Research and Extension Center

Surge Flow Irrigation

Furrow irrigation is currently used on over half of the irrigated acres in Nebraska. Lower energy and equipment costs and the fact that many irrigated fields are already using furrow irrigation are the main reasons why furrow irrigation will continue for years to come. Surge irrigation gives furrow irrigators hope of reducing labor, improving irrigation uniformity and reducing runoff.

Surge irrigation is the process of intermittent application of water in an irrigation furrow. The intermittent application of water is accomplished by cycling irrigation water in one set of furrows with another set. Normally three to six cycles are used with the cycling of water accomplished by using an automatically controlled flow direction control valve, a surge valve.

During the cycling of water, the water is shut off in alternate furrows for short periods of time and the furrow is allowed to dry. This allows the soil particles to consolidate and form a seal in the furrow. When water is reintroduced to the furrow, the intake rate is reduced and more water is carried down the furrow rather than infiltrating the soil. This process can increase the rate water moves to the end of the field and will result in increased uniformity of water application and irrigation efficiency.

The University of Nebraska has compared the advance of water in a furrow using surge irrigation to continuous flow irrigation since 1983. Tests have been conducted on a variety of soil types from the Central Platte Valley to the Nebraska Panhandle. The average reduction found in the rate of water advance in a furrow using surge irrigation compared to continuous flow irrigation was 20%, with a range of 0% to 52%. The majority of tests were conducted during the first irrigation of the season.

Soil type plays an important role in the ability of surge to reduce irrigation advance times. Fine textured soils that currently have acceptable advance times may not benefit from surge irrigation. On the other hand, coarse textured soils with high intake rates can benefit substantially from surge irrigation. With any soil, the most benefits occur when infiltration rates are highest, and this is normally during the first irrigation.

Implant Combination for Finishing Cattle

Growth stimulating implants have been used routinely in finishing cattle to improve weight gain and cost of gain by about 10% when used alone. These implants act primarily as estrogens to influence hormonal regulation of growth. In recent years, a new implant, trenbolone acetate (TBA) which is a synthetic androgen or male hormone became available. Early results indicated that TBA was not as effective as an estrogen when either was used alone, but that combination use of the two types resulted in additive responses in cattle performance.

Two cattle finishing trials cast doubt on the effectiveness of an estrogen-androgen combination used at the start of a 110- to 125-day finishing period. In a 110-day trial, average daily gain appeared to be improved with a TBA-estrogen combination over the estrogen implant alone, but correction for lower carcass dressing percentage with the combination made the gain difference non-significant. In a similar 125-day trial, there was no difference in the carcass adjusted weight gains for the combination vs the single implant. Unless the combination is used within 80 to 100 days of slaughter, improvement in performance with the combination may not be maintained.

These trials showed slight reductions in carcass rib eye marbling and dressing percentage with the combination, but average reductions from a number of other University studies do not appear to be a serious problem. Data suggest, however, that use of the implant combination too often or too close to slaughter can reduce marbling and associated quality grade. Thus, proper timing is important for beneficial use of the implant combination.
Research Highlights

Dry Bean Varieties

The dry bean variety picture in Nebraska has been ever improving during the past decade. One hundred percent of the acres were planted with less than half a dozen varieties in 1980. By 1983, 80% of the Great Northern acreage was planted to new improved varieties developed through the Agriculture Research Division. The Plant Patenting Law of the 1970s stimulated several private companies to develop varieties, which were first sold in the 1980s, and now their materials command 80% of the sales. The foot race is on to develop new improved top yielding, disease tolerant dry bean varieties for the Nebraska producer. The producers, the private companies and the University are actively involved in demonstrating and documenting the merits of each new variety. The producers have the final say as to which varieties they are willing to accept for production on their farms under their system of management.

We are constantly developing new varieties and evaluating promising germ plasm from other breeding programs, both public and private, for performance in our environment. In addition, we evaluate all these materials in three separate nurseries for reaction to our three main diseases: white mold, rust, and common blight. It is through these trial results that producers identify consistent high yielding varieties. Producers look for stability of yield in new varieties to reduce production risks and greatly reduce, if not eliminate, inputs required to protect yield potential.

Producers are now asking for disease tolerant varieties by name, as they planted 220,000 acres in 1990. This year a producer had a smorgasbord of varieties to select from in the Great Northern and pinto market class. In addition they now plant significant acreages using varieties of the navy and light red kidney market class, which was not occurring in 1980.

Plant Pathology

Virus Interactions in Plant Cells

Potyviruses are a group of long, flexuous plant viruses that cause significant economic losses in infected crop plants. Potyviruses induce the plant host cell to synthesize relatively large, intracellular bodies called cylindrical inclusions. These inclusions are thought to aid viral spread from cell to cell across cell walls between cells. Soilborne wheat mosaic virus (SBWMV) is a virus of wheat plants spread by a fungus in root cortex cells. It causes significant losses in wheat. When plants are infected by potyviruses and SBWMV, SBWMV attaches specifically to the cylindrical inclusions of potyviruses. Research was begun to find if SBWMV attachment to cylindrical inclusions was a property of SBWMV or of cylindrical inclusions or both. It was found that with the viral combinations used, SBWMV invariably bound to cylindrical inclusions of two different potyviruses in doubly infected cells. Binding of coat proteins of co-infecting viruses was not limited to monocotyledonous crop plants, such as wheat. The same phenomenon was shown in tobacco. It was also established that although binding of protein to cylindrical inclusions is generally true, there are exceptions. Tobacco etch virus inclusions bound their own coat proteins but not those of the co-infecting pepper ringspot virus. However, the latter did bind to cylindrical inclusions of another potyvirus. Understanding why viruses bind to cylindrical inclusions of potyviruses may lead to strategies to disrupt the binding process and thus control cell to cell spread and some viral diseases of plants.

The Maize Chlorotic Mottle Virus Mystery: The Hawaiian Connection

Maize chlorotic mottle virus (MCMV) is one of a complex of viruses causing corn lethal necrosis (CLN) disease in the Republican River Valley of Nebraska and Kansas for the last 15 years. Even though the disease has fluctuated greatly in intensity it has, fortunately, remained largely confined to the valley. When it is present, it can be considered the AIDS complex of the plant world.

In January 1990 the Department of Plant Pathology was contacted by Extension Plant Pathologists, the Hawaiian Department of Agriculture and representatives of the seed trade to identify what was suspected to be MCMV on the island of Kauai, Hawaii. We confirmed that the virus was indeed very prevalent in the winter nurseries of three commercial seed producers. Their concern, of course, was whether the virus was seed transmitted and whether it would be prudent to send their crop back to the mainland.

We suggested ways that the question of seed
transmission could be tested. In early March the project was funded and by mid-May 42,000 seedlings had been tested by immuno-assay and by bioassay. Seventeen seedlings were found to have been infected through seed transmission of the virus. Even though this is a very low percentage, the threat of a single introduction into a virus free area of the corn belt could be significant. All parties in the venture have been informed of the potential risks. Additional research is underway to develop an understanding of this new virus outbreak, determine its relationship to the Nebraska strains, and determine cultural and other practices to minimize its damage.

**Milkweed Disease: A Surprise Deterrent to Growing an Alternative Crop**

Milkweed is the latest venture of some entrepreneurs and as an alternative crop. The floss is the sought-after product. In the wild, disease problems are virtually non-existent. In the cultivated crop of native plants, two fungal and one bacterial disease have served to drastically lower the health and vigor of plants and the yield of floss. The pathogens cause spots and blights of leaves, stem and pods. These pathogens have not been previously reported and seem to be specific for milkweed. Thus, nearby crops are not affected.

Current work is to determine how to manage diseases economically. Seed treatments of different chemicals and different temperatures are being tested. Likewise, potential fungicides and bactericides are being tested in commercial fields. After three independent applications, milkweeds of tested plots will be compared to non-treated plants for severity and prevalence of disease, as well as yield and quality of the floss. Physical and environmental conditions for survival of different pathogens are also being determined in hopes of interrupting a critical phase of development.

**South Central Research and Extension Center**

**Increasing Nitrogen Use Efficiency of Irrigated Corn**

The fate of nitrogen fertilizer applied to irrigated corn has been of considerable concern with the increasing awareness of the potential for nitrogen-leaching below the root zone and eventually entering ground water. One goal of using nitrogen fertilizers in crop production is to optimize the amount of fertilizer nitrogen taken up by the crop. Profitability is increased as fertilizer is more efficiently used, and less nitrogen remains in the soil, subject to leaching losses. Over a four-year period, several factors were evaluated in a study on the influence on nitrogen use efficiency of irrigated corn. Factors evaluated included fertilizer nitrogen rate, corn hybrid, and the use of a nitrification inhibitor, nitrapyrin. Nitrification inhibitors temporarily block the microbial conversion of ammonium nitrogen fertilizers to the leachable nitrate form. The study found that the application of nitrapyrin with anhydrous ammonia at late sidedress time reduced the amount of fertilizer nitrogen taken up by the crop. Nitrapyrin tended to immobilize, at least temporarily, the inorganic fertilizer nitrogen in a form which was not leachable, but was also unavailable to the crop. Although there were considerable differences among hybrids in fertilizer nitrogen uptake in any given year, there were no clear trends for one hybrid being superior or inferior over the study. Hybrid differences in nitrogen uptake appeared to be subject primarily to how the hybrids responded to climatic conditions from year to year. Results from this study show that nitrapyrin should not be applied with anhydrous ammonia as a late sidedress treatment for silt loam soils. If nitrapyrin is to be used, nitrogen should be applied earlier, preferably before planting in the spring, or as an early sidedress application.

**White Corn as an Alternative Crop**

Nebraska corn producers are concerned about diversifying crops and sources of income from their farms. An ideal alternative crop would produce high yields at a good profit, be grown with current farm equipment, require few changes in farming practices, and have readily accessible markets. White corn is one of the few alternative crops that fill most of these requirements.

A project began in 1988 to evaluate 40 to 50 white corn hybrids per year for suitability to Nebraska conditions. Two to four widely-grown yellow corn checks have been included to assess relative yields of the white hybrids. Yield, stalk and root lodging, days to flower, ear height, and grain moisture were measured. Grain mold assays and food quality data were also obtained.

White corn yields in 1988 ranged from 100 to 191 bu/a compared to 142 to 199 bu/a for the yellow corn. In 1989 white corn yields range from 124 to
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196 bu/a compared to 185 to 204 bu/a for the yellow corn. Yields of the best-yielding white hybrids were comparable to those of the best-yielding yellows in both years. Grain quality has been consistently high. Stalk quality of the white hybrids has been as good or better than that of the yellow hybrids.

White hybrids grown by Nebraska farmers 10 to 20 years ago gained a bad reputation because they were too late maturing for this area, had poor stalk quality, and yielded poorly. These problems are no longer evident in most of the higher yielding white hybrids available today. White corn is a viable alternative crop for Nebraska farmers.

Textiles, Clothing and Design

Counteracting Hard Water in Decontamination of Clothing

Use of clothing to protect applicators continues as an important safety measure. Textile scientists have addressed the problem of chemical residue in protective clothing, and effective removal of the residue in laundering. Recent work has shown that increased mineral content of water (calcium, magnesium and sometimes iron) in a range labeled “hard water”, decreased the completeness of residue removal in laundering. No work has been reported that assessed whether increasing the concentration of detergent in laundering would overcome this problem. Detergents formulated with anionic surfactants may be susceptible to variation in detergent concentration, because anionic surfactants ionize in solution where the negative charge will attract the positively charged hardness ions in water, thus reducing the effectiveness of the detergent. Nonionic surfactants are insensitive to levels of water hardness. Research was needed to see whether detergent concentration could offset the problems caused by water hardness, considering the fabric, it’s functional finishes, washing temperature, and whether or not a prewash product was used.

In general, a prewash product is important in residue removal from fabrics in laundering, and its importance increases when soil repellent fabrics are contaminated, when 30°C (cool) temperature is used, when powdered anionic phosphate detergent is used and especially when a combination of two or more of these factors is present. Residue remaining after laundering increased as temperature decreased when phosphate detergent with no prewash product is used for laundering. This illustrates the importance of prewash product use. Recommendations from these data include to use the soil repellent finish, to use a prewash product especially in areas of hard water, and to use the highest temperature possible for laundering. Temperature of washing, prewash product use and detergent selection can overcome problems caused by elevated mineral content in the wash water.

Characterization of Milkweed Floss

Critical to milkweed’s development as an alternative crop is the characterization of the fiber and identification of potential markets. Researchers focused their efforts on determining the form and structure and moisture characteristics of the two species of milkweed currently cultivated in Nebraska, Asclepias syriaca (common milkweed) and Asclepias speciosa (showy milkweed). Microscopic examination of the fiber using a scanning electron microscope (SEM) showed that the fibers have distinctive surface characteristics. Asclepias syriaca has lengthwise ridges on the fiber surface, while Asclepias speciosa has a smoother surface. These morphological differences make it possible to distinguish and identify the species to which a sample of milkweed floss belongs. These morphological differences also suggest that different species of milkweed floss may have differing yarn characteristics since the ridged fibers may exhibit more surface friction during yarn spinning processes.

Researchers also measured moisture regain, moisture uptake, and wettability of milkweed and cotton fibers. They included cotton in the study so that they could compare the moisture characteristics of milkweed fibers to cotton fibers under similar test conditions. Results showed that A. speciosa and A. syriaca possess similar moisture characteristics. Therefore, fibers from these two species of milkweed should perform similarly in absorbent materials such as disposable diapers and tissues. Generally, the milkweed fibers exhibited superior moisture regain (capacity for water vapor absorption) and moisture uptake (capacity for liquid water absorption) when compared to cotton fibers; however, neither species of milkweed fiber matched the wettability (rate of liquid water uptake) of the cotton fibers. Improving milkweed’s rate of liquid water uptake merits further study since immediate absorption of liquid is essential for textile products like disposable diapers and bandages.

Veterinary Science

Bovine Viral Diarrhea Virus

Because of the vital role of the immune system in the body’s defense against the disease, any environmental, metabolic, endocrine, or infectious factor which changes the immune system will have a significant effect on susceptibility or resistance to disease. Infectious agents may modify the immune response. Specifically there are a number of viruses, affecting both humans and animals, that can replicate and persist in lymphoid tissues. Many viruses invade and persist in lymphoid tissues of cattle. A notable consequence of this type of viral infection is the impairment or alteration of the immune response. One of the most prevalent lymphotrophic viruses (infects lymphoid cells) of cattle is Bovine Viral Diarrhea Virus (BVDV).

During the last few years our laboratory has been
developing tools for detecting genetic sequences of BVDV in bovine immune cells (lymphoid tissue), both by gene amplification techniques (Polymerase Chain Reaction or, PCR) and in situ hybridization. In addition, we have acquired experience in identifying the various subpopulations of lymphoid cells in cattle using surface markers recognized by specific monoclonal antibodies. These tools permit a detailed molecular characterization of the lymphoid cell subpopulations infected by BVDV during acute and persistent infection, and the level of expression of viral functions in each case. At the same time, this cellular characterization provides the basis to initiate studies to determine how BVDV infection affects the function of immune cells.

Data on cell tropism (affinity) and lymphoid persistence of BVDV and some other lymphotropic viruses (e.g., herpesviruses) that infect cattle may provide alternative models on mechanisms of virus-induced immunosuppression of domestic cattle. An additional aspect of this research is to develop diagnostic probes and gene amplification techniques, such as the PCR test for BVDV, that will improve the accuracy and speed of diagnosing viral diseases.

Serodiagnosis of Swine Dysentery

Swine dysentery is a highly contagious disease of growing and finishing pigs caused by a spirochete bacterium called Treponema hyodysenteriae. The acute form of the disease is characterized by severe, often fatal bloody diarrhea. Conversely, in herds where the disease has become well established, affected pigs show reduced feed efficiency and weight gain. An important aspect of swine dysentery is prolonged shedding of T. hyodysenteriae in the feces of some animals following recovery from the diarrhea. These carrier-shedder pigs are the principal way the disease is maintained on a farm and represent the major reservoir for transmission of the organism between farms. The crucial problem of swine dysentery prevention is how to keep carrier-shedder pigs from being introduced into uninfected herds. The solution lies in being able to quickly and accurately identify swine that appear normal but are carriers of T. hyodysenteriae. Several tests have been described for the diagnosis of swine dysentery; however, none of the currently available tests can identify the individual carrier-shedder pig.

Several diagnostic methods which take advantage of recombinant DNA technology are being investigated. Currently, we are developing a blood test which will be used for rapid screening and detection of individual swine exposed to T. hyodysenteriae. Purified DNA from T. hyodysenteriae was introduced into another bacterium called Escherichia coli. The resulting E. coli cells which contained gene fragments from T. hyodysenteriae, were examined for their capacity to produce proteins encoded by T. hyodysenteriae genes (recombinant proteins). To date, several such organisms have been identified and are currently being characterized. Using fermentation and protein purification technology available at the Food Processing Center Recombinant DNA Fermentation Facility, large quantities of recombinant proteins will be produced for use in the development of the blood test. The development of a blood test capable of discriminating between healthy swine and swine exposed to T. hyodysenteriae will improve the control and prevention of this costly disease by allowing better management of newly acquired stock, thereby stopping the spread of swine dysentery between farms.

West Central Research and Extension Center

Pest Resistance in Brahma Crosses

Brahma cattle have shown a degree of resistance to some external blood-feeding parasites including ticks and horn flies. The resistance is manifested by lower numbers of the pest and better weight gain performance by the infested animals. Research with Brahma and English crossbreeds in Florida showed the resistance was maintained in Brahma crosses but to a lesser degree than in purebred Brahmas. Many Brahma crossbreeds are purchased by Nebraska feeders for finish feeding in the summer months. Research is being conducted with Brahma crossbreeds to determine if they also have resistance to the blood-feeding stable fly, the major insect pest of feedlot cattle in the Midwest during the summer months.

Flies are released in fly-screened, self-contained pens to maintain a relatively constant population level on the animals. Five Brahma and five English crossbreeds are kept in each of four pens for 28 days. The research is replicated four times throughout the summer. Fly numbers and weight gains are monitored for each animal during each of the trial periods.

This data should provide cattle feeders with information which will allow them to make economically-sound decisions in the purchase of cattle for feeding during summer months in Nebraska. If the Brahma crosses are resistant to stable flies and their weight gain performance is equal to other crossbreeds, they are a good investment. If not, it is not economical for feeders to pay as much for them as for other crossbred cattle.

Improved Utilization of Little Bluestem

Little bluestem (Schizachyrium scoparium (Michx.) is one of the major native grass species in much of the Nebraska Sandhills and is an important forage resource for the beef cattle industry. However, it is often criticized by ranchers because of the apparent light grazing it receives. A study to investigate the influence of standing dead herbage on utilization of little bluestem by yearling cattle was initiated in 1989. The study was conducted within the framework of the ongoing grazing study at the Gudmundsen Sandhills Laboratory near Whitman, Nebraska. Pastures were grazed at mid-month for 4-6 days during June, July, August, and October at a stock-
Research Highlights

Irrigation Management Decisions

A field method to measure the quantity and quality of leachate under irrigated crops on a year-around basis is under development. The field research techniques developed through this project will help link ground water quality management with irrigation management. The results will guide the irrigator to management decisions based on the potential for leaching during and after the irrigation season. The results also will provide inputs to irrigation management models to develop management guidelines for irrigators to minimize leaching in their irrigated crops.

The lysimeter is a soil core 3 feet in diameter and 8 feet deep encased in a steel pipe open only at the surface. The design lysimeter goals were to: (a) completely contain an undisturbed soil core large enough to grow annual crops, (b) maintain unsaturated soil water flow through and below the crop's root zone, (c) collect all leachate at the base of the soil core, (d) analyze leachate for nitrate and pesticides, (e) provide year-around leachate sampling in a soil freezing climate, (f) provide access to vacuum drainage system for periodic maintenance, (g) install lysimeters in existing field plots.

Six lysimeters have been successfully installed into irrigated, monoculture corn plots at the West Central Research and Extension Center near North Platte, Nebraska. Eight more lysimeters will soon be completed for irrigated corn-soybean rotation plots. These plots have been established for 6 to 8 years. Since all of the leachate is intercepted by the lysimeters, we have the opportunity to conduct detailed studies of the fate of water, nitrate and pesticides.

Birdsfoot Trefoil for Hay Production.

Hay production from subirrigated meadows is essential for wintering beef cattle in the Nebraska Sandhills. Early studies showed that interseeding legumes was one of the most economic practices to increase hay yield and improve forage quality. Recent observations of 12 species and varieties of different legumes indicated that birdsfoot trefoil (*Lotus corniculatus* L.) was one of the best adapted species for subirrigated meadow environments and warranted further investigation.

A comparison of meadow plots with and without birdsfoot trefoil indicated that hay yields and crude protein content were increased by 54% and 5.1%, respectively, when birdsfoot made up 51% of the hay composition. Digestibility was similar.

Since birdsfoot trefoil is not widely grown in Nebraska, a plot evaluation of 12 varieties from different locations within the United States was conducted to determine which varieties were best adapted to subirrigated meadows. Based on yield, persistence and forage quality, the varieties of Carroll, Empire, Leo, Mackinaw and Norcen were ranked as the top five.

To determine the best methods for establishing of birdsfoot trefoil, a comparison was made of seeding methods (broadcast vs. drilling), superimposed over three methods of suppressing the existing vegetation (spraying with Roundup at 2 qts/A; spraying with Paraquat at 2 qts/A and scarification of the soil surface with a flail mower). Seedling counts and subsequent yield data indicated that drilling was better than broadcast seeding, and that suppression of the existing vegetation prior to seeding was necessary for establishment with no differences among suppression treatments.
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<td>Gilley, J. E., J. F. Power, P. J. Reznicek, and S. C. Finkner</td>
<td>Tillage and fertilizer influences on corn and legume cover.</td>
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<td>Johnson, B.</td>
<td>The probability of selecting genetically superior S2 lines from a maize population.</td>
<td>Maydica</td>
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<td>Kniep, K. R. and S. C. Mason</td>
<td>Kernel breakage and density of normal and opaque-2 maize grain as influenced by irrigation and nitrogen.</td>
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Journal Articles

Detection of bluetongue virus in bovine fetuses using the avidin-biotin complex immunoperoxidase method. Journal of Veterinary Diagnostic Investigation 1:45-49. (J. Series No. 8735)

Seminoma and parathyroid adenoma in a snow leopard (Panthera unica) ultrastructural appearance. Journal of Comparative Pathology 100:475-480. (J. Series No. 8578)

Induction of neutralizing antibodies to transmissible gastroenteritis virus by idiotypic antibodies. Viral Immunology 2:133-141. (J. Series No. 8813)

Apparent toxicosis associated with lily-of-the-valley (Convallaria majalis) ingestion in a dog. Journal of the American Veterinary Medical Association 195:485-487. (J. Series No. 8620)

Detection of bovine herpesvirus-1 specific IgM using a capture enzyme assay with isotype-specific monoclonal antibodies. Journal Veterinary Diagnostic Investigation 1:139-145. (J. Series No. 8714)

Monoclonal antibodies for coagglutination of Streptococcus suis type I. Veterinary Microbiology 20:349-356. (J. Series No. 8566)

A blocking ELISA for the detection of specific antibodies to bovine respiratory syncytial virus. Journal of Veterinary Diagnostic Investigation 1:324-328. (J. Series No. 8776)

Book Chapter


M.S. Theses

Brodersen, B. W. 1989.
Use of glutathione precursors for control of acute pulmonary edema and emphysema in cattle. (A.R. Doster, Advisor)

Resistance to host immune defense mechanisms afforded by capsular material of Pasteurella haemolytica. Serotype 1. (G.A. Anderson and M.J. Gentry, Advisors)

Molecular characterization of extrachromosomal DNA in Actinobacillus Haemophilus pleuro pneumoniae. (G.A. Anderson, Advisor)
Immune responses for serotype cross-protection from *Actinobacillus pleuropneumoniae*. (G.A. Anderson, Advisor)

**Ph.D. Dissertations**

Analysis of the immune response to the major immunogenic area of foot and mouth disease virus A12°. (S. Srikumaran, Advisor)

*Actinobacillus Haemophilus pleuropneumoniae* virulence factors: partial characterization and efficacy studies in swine. (G.A. Anderson, Advisor)

**WEST CENTRAL RESEARCH AND EXTENSION CENTER**

**Journal Articles**


Intercropping corn in perennial cool-season grass on irrigated sandy soil. Journal of Production Agriculture 2:42-46. (J. Series No. 8644)

Irrigating soybeans by growth stages in Nebraska. Applied Engineering in Agriculture 5:361-366. (J. Series No. 8659)

Intake and digestibility of low-quality meadow hay by cattle receiving various levels of whole shelled corn. Journal of Animal Science 76:2854-2862. (J. Series No. 8794)

Registration of 'Cody' wheat. Crop Science 29:490-491. (J. Series No. 8629)

Growth stage scheduling criteria for soybeans. Irrigation Science 10:99-111. (J. Series No. 8461)

Belneb rust resistant - 1 and 2 - Great Northern dry bean germplasm. HortScience 24:400-401. (J. Series No. 8693)

Survey of winter wheat *Triticum aestivum* stubble fields sprayed with herbicides after harvest in 1986. Weed Tech 3:244-254. (J. Series No. 8534)

**M.S. Theses**

Plugge, B. L. 1989.
Estrous synchronization of heifers utilizing MGA and Lutalyse compared to Syncro-Mate-B with AI or natural service. (G. H. Deutscher and J. E. Kinder, Advisors)

Parasites and predators of the face fly (*Musca autumnalis* DeGeer) in Northeast Nebraska. (J. B. Campbell, Advisor)

**Ph.D. Dissertation**

Bioavailability of calcium in alfalfa hay for gestating swine. (M. D. Danielson, Advisor)
104th
ANNUAL REPORT
Variety and Germplasm Releases and Patents
VARIETY AND GERmplASM RELEASES

Department of Agronomy

Crop: Proso Millet (*Panicum miliaceum* L.)

Variety Name: Sunup

Scientists: L. A. Nelson

Characteristics: Sunup is a white seeded proso with seed size intermediate between Dawn and Rise. It has a head type that is compact, but not as compact as Dawn. It has a height greater than Rise, but not as tall as Panhandle. It is as resistant to lodging as Dawn or Rise in spite of its taller height. Test weight and seed size are acceptable for use in the bird seed market as well as for livestock feed. Insect and disease epidemics are not a problem in western Nebraska. There is some variability in height, head type, and seed color but it does not contain red seed.

Crop: Grain Sorghum (*Sorghum bicolor* (L.) Moench)

Germplasm Release: A/B Pair N122

Scientists: D. J. Andrews

Released by: Nebraska Agricultural Research Division and the United States Department of Agriculture

Characteristics: It has a height of 85 cm and flowers in approximately 72 days. N122 has normal plant color, normal midribs, and a semi-open panicle. The seed is white and has no testa layer. The line may have value when used directly as a female parent in hybrid combination or when utilized as germplasm in a breeding program.

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Crop: Grain Sorghum (*Sorghum bicolor* (L.) Moench)

Germplasm Release: A/B Pair N125 and A/B Pair N126

Scientists: J. D. Eastin, E. Boilelen, and D. J. Andrews

Characteristics: These are short, white seeded lines with a medium to low seed number which produce medium to short height hybrids depending on the pollinator and the climate. These two sister lines come from a fairly diverse genetic background. One parent is an ICRISAT population selection developed parallel to N94A, N95A and N96A and was crossed to KHB. These A lines are earlier than either parent and generally run 4 to 6 days earlier than KS57. No breakdown in genetic sterility in any environment has been observed.

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Crop: Grain Sorghum (*Sorghum bicolor* (L.) Moench)

Germplasm Release: Thirty-six Grain Sorghum Germplasms


Released By: Nebraska Agricultural Research Division, Kansas Agricultural Experiment Station, and Georgia Agricultural Experiment Station.

Characteristics: Crosses were made between introduced tropical food quality sorghums, obtained mostly from ICRISAT, which were maintainers on the A1 milo cms system and a number of U. S. seed parents. Progeny were selected from the resulting populations a) for utilization in collaborative tropical breeding programs, and b) as potential new germplasm for U. S. grain sorghum breeding programs. Twenty-eight lines were selected which produced testcrosses of acceptable height and a good expression of male sterility in all plants. Seven lines, not testcrossed, but of a parentage likely to be maintainers were selected on per se performance. One line gave a superior fertile testcross and was also included. Some residual variability for height, maturity, head and seed size was evident in most lines.
Variety and Germplasm Releases and Patents

Crop: Grain Sorghum \((Sorghum bicolor \,(L.)\,\text{Moench})\)

Germplasm Release: 80 Sorghum Tan Plant Population Families


Released By: Nebraska Agricultural Research Division and the Kansas Agricultural Experiment Station

Characteristics: The derived population from which these families were selected is shorter and earlier than both the original TP24 population and the Georgia version. The Georgia version was especially late for Nebraska conditions. After three random matings in Nebraska, 200 fertile plants were selected from which some 700 mostly S3 families were developed generally with tan plant color and light colored seed. Fifteen heads were composited from each of 80 families for release.

Crop: Winter Triticale \((X\,\text{Triticosecale}\,\text{Wittmack})\)

Variety Name: Newcale (NE83T12)

Scientists: P. S. Baenziger

Characteristics: Newcale is an awned, white glumed winter triticale whose primary use will be as a feed grain triticale. The awns are rough, moderately long and brown to black in color. The neck of the stem is straight and moderately pubescent. Floret fertility is good. The kernels are red, elliptical, large and slightly wrinkled. Newcale has a 1000 kernel weight and kernel protein content that is higher than most wheats. Test weight generally exceeds the triticale standard of 48 lb/bu. It is earlier in flowering than most winter wheats and winter forage triticales, and is later than most winter barleys. It has good straw strength, is slightly taller than Siouxland but shorter than most forage triticales. The spike is middense to dense, moderately long, and inclined to nodding at maturity. Newcale is moderately resistant to the currently prevalent races of leaf and stem rust and contains probably Sr31. It is susceptible to Hessian fly (Great Plains Biotype) and wheat soil borne mosaic virus, and very susceptible to Cephalosporium stripe.

Crop: Winter Barley \((Hordeum vulgare \,L.)\)

Variety Name: Perkins (NE851808)

Scientists: P. S. Baenziger

Characteristics: It is a six-row, smooth-awned winter feed barley cultivar. The spike is carried erect, is moderately dense and moderately short. The kernels are colorless and intermediate in size. Perkins is generally intermediate in heading date, and it has an excellent bushel weight. It is intermediate in height and has good straw strength. It is moderately resistant to the Barley Yellow Dwarf virus, and is believed to be susceptible to currently prevalent races of stem rust.

Department of Horticulture

Crop: Chrysanthemum \((Chrysanthemum\,\text{morifolium})\)

Variety Name: 80116, 81106, 81107, 81122, 86111 and 86129

Scientists: D. T. Lindgren

Characteristics: All six selections are more compact, plantwise, compared to previous chrysanthemum selections released by the University of Nebraska. No insect injury was observed on any of these selections. A slight amount of leaf spot \((Septoria\,\text{chrysanthemi})\) was observed on two year old field plants of selections 81106 and 81107 but not on one year old field plants or greenhouse plants. No diseases were noted on the other four selections. All six selections are tolerant of light frosts \((26-28\,\text{°F})\) with only slight flower discolorations.
PATENTS

DEPARTMENT OF AGRONOMY

Patent Title: Subtiller

Patent Number: 4 817 727

Scientists: L. N. Mielke and L. L. Bashford

Description: The subtiller was developed to fracture horizontal shear planes caused by repeated sweep operations and to loosen soil several inches below such shear planes, thereby decreasing the density of the subsoil. It is a combination sweep and subtiller having a plurality of leg shanks extending downward from the sweep. Each shank is angled in the direction of travel to push soil toward the center of the sweep, and simultaneously to provide minimal draft. In addition, there is a horizontal bend midway between the upper and lower extremities of the shank so that the lower extremity is bent toward the center of the sweep in order to cause a soil fracture plane in the direction of the center of the sweep. The lower end of the shank has a diagonal bend toward the center of the sweep to agitate the soil thereby.

AGRICULTURAL ENGINEERING

Patent Title: Biodegradable Polymers.

Patent Number: 393,373.

Scientists: R. Chinnaswamy and M.A. Hanna

Description: The patent proposes a reactive extrusion process for producing a starch based foam plastic product. Starch, polystyrene and some food grade chemicals are combined via HTST extrusion to produce a foam product for use in applications such as egg cartons, fast food clam shells and fresh meat trays.
AGRICULTURAL RESEARCH SITES
REPORT OF RESEARCH EXPENDITURES
THE UNIVERSITY OF NEBRASKA
AGRICULTURAL RESEARCH DIVISION
July 1, 1989 through June 30, 1990

FEDERAL FORMULA FUNDS:

Hatch Formula .............................................. $ 1,996,279
Regional Research........................................... $  786,439
McIntire-Stennis............................................. $  139,757
Animal Health................................................ $  168,428

Total Federal Formula Funds................................. $ 3,090,903

STATE APPROPRIATED FUNDS................................................................. $18,041,840

CONTRACTS AND GRANTS:

USDA Coop Agreements................................. $ 3,783,127
USDA Special & Competitive......................... $  448,540

Federal Grants -
(NSF, NIH, HEW, AID)................................. $ 2,422,810

Industry Grants............................................... $ 3,222,013

Total Grants and Contracts................................. $ 9,876,490

Sub-Total..............................................................$31,009,233

PRODUCT SALES................................................................. $ 5,833,130

TOTAL EXPENDITURES................................................................. $36,842,363

$442,914 was added to show actual Agricultural Research Division expenditures reflecting transfers from International Programs.