The Kentucky
Agricultural Experiment Station

109th

Annual Report

1996

College of Agriculture
University of Kentucky • Lexington, Kentucky 40546

To His Excellency,
The Honorable Paul Patton
Governor of Kentucky

I herewith submit the one hundred and ninth annual report of the Kentucky Agricultural Experiment Station for the period ending December 31, 1996. This is done in accordance with an act of Congress, approved March 2, 1887, entitled, "An act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and also the act of Kentucky State Legislature, approved February 20, 1888, accepting the provisions of the act of Congress.

Very respectfully,

C. Oran Little, Director
Lexington, Kentucky
June 30, 1997

Contents

Purpose

As a Land Grant institution, the University of Kentucky is responsible for serving the people of the Commonwealth of Kentucky. The College of Agriculture, with its research, teaching, and extension activities, has developed a structure and organization to provide the mandated Land Grant services in agriculture and related areas.

The Kentucky Agricultural Experiment Station has been providing research results to farmers for more than 100 years. The continued growth of Kentucky agriculture attests to the benefits of applying new knowledge and technology to the agricultural production process. Much of the research leading to increased quantity and improved quality of Kentucky's agricultural output was performed by the Experiment Station. Also, College researchers address problems of agribusiness, consumers, international trade, food processing, nutrition, community development, soil and water resources, and the environment.

Although much Experiment Station research has immediate application to agricultural problems, scientists are also involved in basic research, generating new information to help solve present and potential problems. The ability of Kentucky producers to be competitive in domestic and world markets requires an expanded base of knowledge in emerging areas of research applicable to agriculture.

This Annual Report summarizes Experiment Station research highlights for 1996. Lists of the faculty, research projects, and publications completed during the year are also provided.

The research programs of the Kentucky Agricultural Experiment Station have benefited Kentucky's agriculture over the past century, and the results of present and future research will continue to serve Kentucky's primary industry.

Agricultural Economics

Research in Agricultural Economics involves diverse subjects including improving profitability, through management and marketing, environment and natural resources and assisting in the revitalization of rural communities.

Risk Management Research

The 1995/96 Farm Bill changed the way government will support farm prices and incomes for the next seven years, and quite possibly forever. Thus, when market prices go down, farmers cannot count on government payments to make up the difference. This will increase risk. Many argue that the changes will also increase price volatility. Recent crop failures also remind farmers that significant yield risk continues to be part of cash crop farming.

Crop insurance products are evolving to handle both price and yield risk. Work at the University of Kentucky in the past five years has been focused on new products for the crop insurance program. The Group Risk Plan (GRP) was developed at the University of Kentucky. The GRP is the only USDA program that attempts to adjust for technological advance by using trend county yields as the index to make payments to farmers. By insuring the combination of price and yield shortfalls, new products will provide more effective risk management for cash crop farmers. Economists at the University of Kentucky are involved in reviewing these products.

Rural Economic Development Research—Telecommunications

Our TVA Rural Economic Development Studies Center is organized to support the development and dissemination of useful research for use by decision makers engaged in rural economic development. We have defined three main areas for our work. The Center's most visible project has been *The Farmer's Guide to the Internet.* The first edition of the book was printed in March 1996, and by the end of December more than 10,000 copies were sold. *The Farmer's Guide* has been purchased by individuals and small businesses in rural areas who seek a source of information on how to gain access to the Internet, and by large corporations and universities to use in Internet training. In addition, the Center produces a research report with the National Rural Electric Cooperative Association on telecommunications opportunities for electric cooperatives. This study, "The New Telecommunications Environment," has been used in a series of regional workshops to help managers of rural electric cooperatives and municipal power systems assess opportunities for augmenting their electricity operations with telephone, cable or Internet subsidiaries.

Rural Economic Development Research—Environment

Experts around the world are currently debating how environmental conditions and regulations affect economic growth. Research recently completed at the University of Kentucky shows that states within the U.S. which had better environmental conditions also experienced more per capita income growth, all else being equal. This suggests that relationships between growth and the environment can be complementary, and that it is not necessarily always competitive as is commonly believed. This research has an impact on how researchers conceptualize and model the relationship between growth and the environment over time. The research also suggests that communities which strive to improve their natural environments will experience faster income growth than those which do not.

Tobacco Research

Agricultural Economics research into the cost-saving benefits of lower plant populations for burley tobacco is saving Kentucky tobacco farmers thousands of dollars in reduced labor costs. The collaborative extension educational efforts of agricultural economics, agronomy, agricultural engineering, and plant pathology specialists have resulted in some major shifts toward wider-spaced tobacco plants. Economic/agronomic research suggests that reducing per acre plant population by 25% can lower costs of production by eight cents per pound. Labor savings account for most of the cost advantage with per acre labor reductions in the 20- to 40-hour per acre range.

If half of Kentucky's 220,000-acre 1997 burley crop is grown at 6,500 plants per acre instead of 8,500 plants per acre, the labor savings alone could account for the equivalent of 1,320 full-time jobs. Or, from another perspective, an eight cents per pound cost reduction is worth $22,000,000 in extra net farm income if even half of the 1997 crop is produced at wider spacings.

Enhancing Farm Profitability

Analysis of more than 280 farms participating in the Kentucky Farm Business Analysis program revealed that 1995 was a mixed year, financially. Returns varied around the state and by enterprise.

All Purchase area farms, Ohio Valley area livestock farms, Pennyroyal area grain and livestock farms, and Central Kentucky hog and crop farms improved upon returns in 1995, whereas Ohio Valley area grain farms, Pennyroyal area dairy farms, and Central Kentucky dairy and beef farms had lower returns than in 1995. The Pennyroyal livestock and dairy farms and the Central Kentucky dairy, hog, and beef farms experienced negative net returns. The operator's share of net farm income (showing the financial rewards for the operator, their equity capital, and their management input) was positive for all six groups in the state.

Livestock Marketing Research

A model of the livestock industry was developed that could track the reaction of beef cow numbers to changes in pastureland as well as dairy cow numbers, beef prices, and other variables internal to the industry. A quarterly version of this model helped to explain what response beef cattle prices would have to the dairy cow buyout of the mid-1980s. There were some pretty dire forecasts at that time, but our analysis suggested that the effect would be minimal. And so it proved.

The model was used to anticipate the effects of biotechnological innovations that are under development. Joint work with economists at the University of Georgia indicated that, with current feeder steer/heifer price spreads, cow-calf producers would find it profitable to adopt sexed technology to determine the offspring gender under a wide range of cost estimates and treatment effectiveness rates.

Price effects would not wipe out profitability of adopting the technology at moderate adoption rates, up to 50%, and given our estimates of application costs. Steer prices do not decline as application rates rise, however. The analysis to date indicates that major price effects and changes in the structure of the beef cattle industry might result from widespread adoption of sexed-semen technology.

Research Projects

Analyzing the Future International Competitiveness of the U.S. Food Industry — *M.R. Reed, M.A. Marchant, and L.L. Mather*

An Analysis of Finance Efficiency and Socioeconomic Influences in Urban and Rural Public Schools — *S.J. Goetz and D.L. Debertin*

An Evaluation of International Markets for Southern Commodities — *M.A. Marchant and M.R. Reed*

Changing Patterns of Food Demand and Consumption Behavior — *B.W. Bobst*

Development of Multiobjective Decision Criteria Models for Agricultural Investment Appraisal — *A. Pagoulatos and D.L. Debertin*

Economic Analysis of Biotechnological Innovations in the U.S. Beef Cattle Industry — *B.W. Bobst*

Economic and Environmental Impacts of Water-Quality Protection Policies on Kentucky Agriculture — *H.H. Hall and J.R. Skees*

Evaluation of Public Policy Alternatives Designed to Help U.S. Cash Crop Farmers Manage Risk — *J.R. Skees and H.H. Hall*

Regulatory, Efficiency and Management Issues Affecting Rural Financial Markets — *D. Freshwater*

Rural Economic Development Alternatives in the New Competitive Environment — *S.J. Goetz and D. Freshwater*

Agronomy

The Department of Agronomy conducts research on soils, crop ecology/management, crop genetics, and plant biology. Our objectives include the improvement of plant quality and productivity for food, feed, and fiber applications. We strive to develop innovative plant production systems which are profitable, sustainable, and environmentally sound. To address these objectives, we require a diverse, interdisciplinary faculty with expertise ranging from cutting-edge molecular biology to applied production technology. The recent successes— and the tremendous future potential— of both crop biotechnology and precision agriculture systems make this a fast-moving and exciting time for agronomic science. Furthermore, the broad-based, popular concern for the quality of Kentucky's soil and water resources provides even greater urgency for research on sustainable land-management practices. Examples of significant research accomplishments during 1996 are described here.

- We are conducting several studies to exploit and evaluate the potential of the new precision agriculture/GPS technology. In one experiment, when corn population was varied according to depth of topsoil, returns per acre were increased relative to constant corn populations. This appears to be the first U.S. report of successfully controlling corn populations with a specific soil variable.
- We have introduced the animal gene for metallothionein, a compound which binds the heavy metal cadmium, into transgenic plants. We can target the gene to specific tissues in the plant. Expression of the gene was found to be most effective in the cytoplasm and perhaps in the vascular tissue of the plant.
- Our new wheat variety Foster will be available for production this year. Foster is a high yielding, high test weight variety with excellent disease resistance and superior milling and baking quality.
- A major research and education initiative on agronomic potential in eastern Kentucky is under way. Much of this work is sponsored by the Robinson Trust. A large beef cattle study on previously mined land will assess the impact of grazing on the plant community and soil fertility. A 27-acre site on the Laurel Fork of the Robinson Forest is being developed to demonstrate state-of-the-art reclamation technology.
- Weather-related losses during dry hay production and storage cost Kentucky livestock producers millions of dollars each year. We ensiled high-moisture forage in round bales using stretch-wrap plastic to achieve anaerobic conditions. In three years of studies, this increased nutritive value and reduced dry matter loss by 80% compared with hay stored outside.
- We continue to learn more about the mechanisms by which contaminants move through soil to springs and groundwater. We recently observed that soil colloids (very small particles of soil or organic matter) may be responsible for accelerating and increasing the leaching of heavy metals through the soil. In another study, we found that the supposedly inert surfactants applied with herbicides may have a strong influence on mobility and degradation of the herbicides.
- Soybean varieties with altered oils have been developed by private industry and are being grown in states to our north. Our work has shown that varieties with low linolenic acid level can be induced to produce even lower linolenic concentrations under our warmer Kentucky conditions. This suggests an opportunity for value-added soybean production in the near future.
- We have developed an efficient new regeneration system for soybean called somatic embryo cycling. It results in shorter cycling times for recovering plants and reduces detrimental effects from tissue culture. We believe this will be a major improvement for soybean transformation.
- Some of the first studies in the nation on the ability of forage grasses and alfalfa to withstand continuous, close grazing are in progress. These researchers are also cooperating with Plant Pathology and the Eden Shale Farm to study the effects of varietal resistance of alfalfa to aphanomyces root rot on alfalfa establishment.
- Two major advances in understanding plant-pathogen interactions were accomplished. The structure and function of a key phytoalexin enzyme has been analyzed in detail. This will advance rational design and genetic engineering of the genes coding for these enzymes. Further refinement in identifying the regulatory DNA sequences controlling expression of plant defense genes was also completed. Both of these studies could lead to major advances in engineering disease resistance for plants.
- Growing three soybean varieties, one from each maturity group II, IV, and V, provides greater yield stability than growing one superior variety or growing three varieties of the same maturity. Techniques were developed for selecting varieties that provide high yield and stability without changing varieties every year.
- We found that in late plantings, resistance to soybean mosaic virus provided a 12% yield advantage compared to SMV-susceptible soybean. For double-cropped soybeans grown after winter wheat in Kentucky, soybean producers should benefit by selecting high yielding varieties with SMV resistance.
- We have generated a large number of transgenic tobacco lines with different pathogen-derived resistance genes.

Tobacco lines resistant to tobacco vein mottling, tobacco etch, potato virus Y, alfalfa mosaic, and tomato spotted wilt viruses have been produced. These germplasms are being greenhouse and field evaluated for virus resistance and agronomic traits prior to deployment in future cultivars.

- In collaboration with the Kentucky Tobacco and Health Research Institute, several Agronomy faculty are pursuing possibilities for extended uses of tobacco. It has been demonstrated that genetically engineered tobacco can produce a variety of valuable biochemicals including antibodies, vaccines, enzymes, and industrial feedstocks. Further research in molecular biology, product engineering, and economic analysis will be required to bring these opportunities to the farm.
- Our turfgrass project on fungal disease control via Integrated Pest Management has been investigating the effects of dewfall on golf course greens and fairways. We measured leaf surface moisture to determine the amount of accumulation and re-accumulation after removal on creeping bentgrass. This knowledge of how and when moisture accumulates on turfgrasses will help managers reduce the duration of leaf wetness, thus reducing disease pressure without the use of fungicides.

Research Projects

A Silica/Fly Ash Based Technology for Controlling Pyrite Oxidation — *V.P. Evangelou*

Agri Industry Development Program — *C.W. Absher and M. Rasnake*

Alkaloid Accumulation in Acremonium Coenophialum Infected Tall Fescue — *L.P. Bush and H.R. Burton*

Altered Fatty Acid Varieties: Does Our Climate Give Us an Angle? — *L.J. Grabau*

Altering Ergot Alkaloid Biosynthesis by the Acremonium Endophyte of Tall Fescue — *C.L. Schardl, M.R. Siegel, and L.P. Bush*

Ameliorative Designs to Improve the Efficiency of Constructed Wetlands Treating High Metal Load Acid Mine Drainage in the Rock Creek Watershed — *A.D. Karathanasis*

Analysis of MRNA Polyadenylation and Metabolism in Plants — *A.G. Hunt*

Backup of Clover (CLO) Accessions in the NSSL — *N.L. Taylor*

Backup of Clover (CLO) Accessions in NSSL - Phase 2 — *N.L. Taylor*

Bacterial Dissimilation of Nitrate to Ammonium in Batch and Chemostat Culture — *M.S. Coyne*

Behavior, Fate, and Bioactivity of Acetolactate (ALS)-Inhibiting Herbicides — *M. Barrett and W.W. Witt*

Biochemistry and Molecular Biology of Sesquiterpene Cyclase and Squalene Synthetase from Tobacco — *J. Chappell*

Breeding Burley Tobacco for Improved Pest Resistance and Productivity — *M.T. Nielsen, B.S. Kennedy, and P.D. Legg*

Breeding Improved Varieties of Wheat, Oats, and Barley for Kentucky — *D.A. Van Sanford*

Cellular and Molecular Biology Initiative in Dark Tobacco — *G.B. Collins*

Characterization and Classification of Kentucky Soils — *A.D. Karathanasis and R.I. Barnhisel*

Characterization and Modification of Heavy Metal Accumulation in Plants, with Emphasis on Tobacco — *G.J. Wagner*

Characterization of Phytoalexin and Sterol Biosynthetic Genes in Tobacco — *J. Chappell*

Characterization of a Plant Polya Polymerase — *A.G. Hunt*

Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position — *E. Perfect*

Cloning Epoxy Fatty Acid Genes — *D. Hildebrand*

Cloning and Heterologous Expression of Pesticide Metabolizing Cytochrome P450 Genes — *M. Barrett*

Cloning Genes Encoding Enzymes for Epoxy Fatty Acid Accumulation in Oilseeds — *D. Hildebrand*

Corn Breeding and Genetics: White Endosperm Breeding, Food Quality Inheritance, and Hybrid Performance Tests — *C.G. Poneleit*

Correlation and Calibration of Crop Yields with Soil Test Levels of Major Nutrients — *W.O. Thom*

Cropping and Planting Systems to Allow Economic Canola Production — *J.H. Herbek and L.W. Murdock, Jr.*

Damage Thresholds Risk Assessment and Environmentally Compatible Management Tactics for White Grub Pests of Turfgrass — *D.A. Potter, K.F. Haynes and A.J. Powell, Jr.*

Dark Tobacco Breeding Genetics and Management — *P.D. Legg*

Determining Optimum Rates for Several Crop Nutrients — *W.O. Thom*

Development of a Basic Soil Morphology Training Course for Onsite Sewage Disposal Treatment System Personnel — *A.D. Karathanasis*

Development of Efficient Tissue Culture and Genetic Engineering of Soybean — *G.B. Collins and R. Dinkins*

Direct Vegetation of Fly Ash — *R.I. Barnhisel*

Distribution of Constituents within Tobacco Leaf — *H.R. Burton and L.P. Bush*

Does Kentucky Need an Early Maturing Soybean Variety Trial? — *L.J. Grabau*

Early Maturing Soybean Cropping System: Identifying Appropriate Cultivars — *L.J. Grabau*

Effect of Row Width on Corn Yields — *M.J. Bitzer and J.H. Herbek*

Effects of Riparian Vegetation on Water Quality: Modeling and Experimental Studies — *B.J. Barfield, R.L. Blevins, V.P. Evangelou , and D.T. Carey*

Effects of Suckering Practices on Growth Characteristics — *J. Calvert*

Environmental and Genotypic Control of Assimilate Allocation in Grain Crops — *D.B. Egli*

Environmental and Morphological Determinants of Field Curing Rates of Legume Hay — *M. Collins and N.L. Taylor*

EPA/EPSCOR: Assessing Transport of Colloid Bound Herbicides and Heavy Metals to Groundwater — *A.D. Karathanasis, R.E. Phillips*

Establishing an Advanced Techniques Course in Biotechnology — *J. Chappell*

Evaluation of Burley Tobacco Varieties — *M.T. Nielsen, J. Calvert, and B. Kennedy*

Evaluation of Soybean Varieties and Breeding Lines for Use in Kentucky — *T.W. Pfeiffer, J.M. Wood, and C.R. Tutt*

Field Application of Pyrite Microencapsulation Technologies for Controlling Pyrite Oxidation and Acid Mine Drainage Production — *V.P. Evangelou and R.E. Phillips*

Forage Crop Breeding to Improve Yield and Quality — *N.L. Taylor*

Foreign Gene Introduction into Soybean — *G.B. Collins and R. Dinkins*

Fungal Pathogen Resistance in Dark Tobacco — *M.T. Nielsen*

Genetic Control of a Putative Multiple Pesticide Metabolizing Cytochrome P-450 — *M. Barrett*

Genetic Engineering of Dark Tobaccos: A Sub-project of Cellular and Molecular Biology Initiative in Dark Tobacco — *J. Chappell*

Genetic Engineering of Soybeans for Increased Oil Content and Epoxy Fatty Acid Accumulation — *D. Hildebrand*

Genetic Engineering of Soybeans for Increased Value — *D. Hildebrand*

Genetic Improvement of Soybean for Kentucky — *T. Pfeiffer*

Grain Quality Laboratory — *C.G. Poneleit*

HHMI Initiative Teacher Research — *T.D. Phillips*

Identification Characterization Seed Increase of Clovers — *N.L. Taylor*

Improved Fertilizer Use Efficiency and Environmental Soundness in Burley Tobacco Production — *J.L. Sims*

Improved Management of Legume Cover Crops for Sustainable Grain Crop Production — *W.W. Frye, R.L. Blevins, and J.H. Herbek*

Improving Switchgrass Productivity as a Biofuel Crop — *M. Rasnake*

Increased Desaturation of Soybean Triacylglycerolo — *D. Hildebrand*

Influence of Soil Structural Heterogeneity on Transport of Fecal Pathogens and Solutes with the Vadose Zone — *E. Perfect*

Isolation of Sclareol/Labdenediol Synthase — *G.J. Wagner*

Kinetics and Thermodynamics of Adsorption-Desorption in Binary and Ternary Soil Colloid Systems — *V.P. Evangelou*

Maintenance of Seed of Trifolium Species — *N.L. Taylor*
Mechanisms for Vacuolar Storage/Sequestration of Cd, Zn, Mn, Ni — *G.J. Wagner*
MOA #13814 with Natural Resources and Environmental Protection Cabinet Division of Water — *A.D. Karathanasis*
Modifying Recombination Rates in Soybean and Assessing the Effect on Breeding Progress — *T.W. Pfeiffer*
Multiplicative (Linear-Bilinear) Models for Genotype X Environment Interaction in Crop Cultivar — *P.L. Cornelius*
Multiplicative Models for Genotype X Environment Interaction — *P.L. Cornelius*
Nicotine Synthase and Nicotine Demethylase — *L.P. Bush*
On-Farm No-Till Studies: Making It Work — *L.J. Grabau and J.H. Grove*
Pest Control Strategies for Grazing Livestock using Grass Endophyte Associations — *C.T. Dougherty, F.W. Knapp and L.P. Bush*
Phenology, Population Dynamics, and Interference: A Basis for Understanding Weed Biology and Ecology — *W.W. Witt*
Plant, Animal, and Environmental Factors Limiting Intake of Grazing Beef Cattle — *C.T. Dougherty*
Plant Genetic Resource Conservation and Utilization — *N.L. Taylor*
Polishing Peers: Improving Plant and Soil Science Education through Peer Review — *L.J. Grabau, M.S. Smith, L.K. Worley, and W. Burke*
Population Improvement and Line Development of White Endosperm Maize — *C.G. Poneleit*
Potyvirus Replication and Pathogenicity — *A.G. Hunt*
Predicting Changes in Corn Seed Quality during Storage — *D.M. TeKrony*
Predicting Nitrogen Needs of Wheat by Measuring Chlorophyll — *L.W. Murdock, Jr.*
Refining Components of an Early-planted, Early-maturing Soybean Cropping System — *L.J. Grabau*
Relationship between Photosynthesis, Assimilate Supply, and the Size of the Reproductive Sink — *D.B. Egli*
Restoration of Altered Lands — *R.I. Barnhisel*
Screening Soft Red Winter Wheat Varieties and Breeding Lines for Resistance to Head Scab — *D.A. Van Sanford*
Seed Biology and Technology Investigations — *D.M. TeKrony and D.B. Egli*
Soft Red Winter Wheat Breeding and Variety Development for Kentucky — *D.A. Van Sanford*
Soil and Crop Nitrogen Testing to Improve Nitrogen Management for Burley Tobacco — *R.C. Pearce, J.G. Grove, and D.C. Ditsch*
Soil Nitrate Testing to Improve N Use Efficiency and Reduce Residual Nitrate under Corn and Wheat — *J.H. Grove, D.A. Van Sanford, and C.G. Poneleit*
Soil Survey Characterization and Environmental Impact Assessment of Daniel Boone National Forest Ecosystems — *A.D. Karathanasis*
Somatic Cell Genetics of Crop Plants — *G.B. Collins*
Soybean Tissue Culture and Genetic Engineering Center — *G.B. Collins*
Studies of a Novel Pathway for the Biosynthesis of Straight and Branched, Odd and Even Length, Medium-chain Fatty Acids in Plants — *G.J. Wagner*
Studies to Reduce Cadmium Accumulation in Tobacco and Research toward Extending the Uses of Tobacco — *G.J. Wagner*
Targeting of the Cd-Chelator Metallothinein to the Plant Cell Wall and Root Tissue Using Recombinant DNA Methodology — *G.J. Wagner*
Terpene Cyclases: Functional Domains and Structures — *J. Chappell*
319 Program Assessment of Constructed Wetlands for Animal Waste Phase II — *W.O. Thom, Y. Wang, and J. Dinger*
319 Program Implementation and Demonstration of BMPs for the Utilization of Poultry Litter in the Lower Green River Water Shed — *C.W. Absher, G. Henson, and W.O. Thom*
319 Program Site-specific Nutrient and Biosolids Management on Agricultural Lands — *R.I. Barnhisel and S.A. Shearer*
Understanding and Manipulation of Lipid Biosynthesis in Plants — *D.F. Hildebrand*
Understanding Recombination and Modifying its Frequency in Soybean and Corn — *T.W. Pfeiffer and C.G. Poneleit*
Using Early-maturing Soybean Varieties to Help Manage Soybean Cyst Nematode — *L.J. Grabau*
Using Farm Family Case Studies to Teach Sustainable Agriculture — *M. Rasnake*
Utilization of Coal Combustion By-products in Agriculture and Reclamation — *W.O. Thom*
Utilizing Seed Vigor as a Component of Seed Quality — *D.M. TeKrony*
Variable Rate Seeding: A Cooperative Study with Kentucky Corn Producers — *R.I. Barnhisel, S.A. Shearer, and M.J. Bitzer*
Yield Evaluation of Alfalfa Varieties — *L. Lauriault and J.C. Henning*
Yield Potential and Long-term Effects of No Tillage on Wheat Production — *L.W. Murdock, Jr., J.H. Herbek, and J.R. Martin*

Animal Sciences

The Department of Animal Sciences conducts research on poultry, swine, sheep, dairy cattle, beef cattle, horses, and foods. The research enhances our teaching program by providing new, up-to-date information for instructors and educational experiences for students. We conduct research from the molecular level to livestock production systems. The discovery research is designed to elucidate chemical and physiological functions that will eventually improve efficiency of livestock performance and enhance the quality and safety of our food supply.

The Cooperative Extension Service disseminates research results that can be applied to livestock production, food handling, and food processing. We are fortunate to have a system that allows teaching, research, and extension personnel to work together to provide new knowledge to keep us self-sufficient in our food supply. Many countries with dense population, such as China, will never be self-sufficient in food production since an extremely low percentage of their land is tillable and much of that is close to highly urbanized areas.

Food production will become more globalized. Technological advances will be needed to feed the population. Research is the key to maintaining an adequate supply of safe, high-quality food, and livestock production is a necessity. The Department of Animal Sciences conducts research in several disciplines to help achieve the goal of providing an adequate supply of food. We strive to provide the technology for livestock producers and food processors in the Commonwealth of Kentucky to produce and process that food in a sustainable manner.

Food Science

Weakening of gels made from salt-extracted muscle proteins was not diminished by protease inhibitors, suggesting that proteases were not involved in binding of meat particles during processing and cooking. Beef heart surimi prepared in the presence of the antioxidant propyl gallate and then blended with cryoprotectants had excellent long-term frozen storage stability and functionality. Antioxidant treatments retarded lipid oxidation during storage of both restructured and intact steaks, and a beefy flavoring masked the grassy off-flavor characteristics of grass-fed beef.

Studies were conducted to determine the effects of natural volatile compounds on bacteria *in vitro* and on the microflora of strawberry and blackberry fruits during storage. Percent reductions in populations of the eight test species varied with compound and exposure and ranged from 0% to 100% after 2, 4, and 6 h exposure. Microbial populations of strawberry and blackberry fruits decreased during storage at 2°C and increased after transfer to 22°C. Natural volatile compounds showed antimicrobial properties which may be useful in controlling microbial growth during storage of some foods.

Research was conducted on flavor problems associated with soy protein products (the single greatest impediment to their use in human foods). As part of this research, we discovered a major contributor to the undesirable flavor of soy protein. The mean content of 2-pentyl pyridine was found to be 0.65 ppm which is 54,000 times above its flavor threshold (0.000012 ppm). This strong flavor impact combined with its extremely repulsive flavor profile makes 2-pentyl pyridine a major contributor to the undesirable flavor of SPI.

Rumen Microbiology

Experimental models have been developed which explain the beneficial effects of several microbial supplements and competitive exclusion products on microbial populations in the gastrointestinal tract of domestic livestock. These models are based on the stimulation of critical physiology groups of bacteria and the elimination of specific pathogenic bacteria in the digestive tract. One of these models suggests that stimulatory effects of some of the yeast strains used in dietary supplements can be explained by the presence of several low molecular weight compounds which serve as growth modulators for anaerobic bacteria. Similar stimulatory compounds have not been previously reported.

Most ruminal microorganisms derive energy via the fermentation of carbohydrates. Our studies with the important ruminal bacteria *Ruminococcus albus* and *Prevotella ruminicola* indicated that both phosphorylytic and hydrolytic enzymes are used to metabolize the products of starch and cellulose degradation. In addition, we demonstrated that *P. Ruminicola* converts up to 40% of maltose into intracellular glycogen using a unique enzymatic pathway. This large deposition of glycogen was not previously recognized, and since *P. Ruminicola* is a predominant rumen organism this observation has potential implications for our understanding of ruminant nutrition.

Physiology and Breeding

The impact of heat stress or parturition on the antioxidant capacity of plasma from dairy cattle was evaluated. Heat stress depressed the antioxidant activity of plasma, and recovery of activity occurred when temperatures returned to thermoneutral levels. Antioxidant activity was also depressed

at calving, coincident with decreased vitamin E levels in plasma. Decreased antioxidant activity may be related to compromised resistance and increased incidence of mastitis during periods of heat stress in the periparturient period.

Although problems are associated with utilization of Brahman bulls, our regional results indicated no distinct overall advantage for alternative subtropically adapted sire breeds over the Brahman. Most of the alternative subtropically adapted sire breeds are expected to create less calving difficulty due to their siring calves with lighter birth weights; however, these calves are also expected to weigh less at weaning.

Swine Nutrition

Nitrogen excretion was reduced and ammonia concentration in anaerobic pits was suppressed when pigs were fed low-protein diets supplemented with amino acids. The immunoglobulin fraction of spray-dried porcine or bovine plasma increased growth performance of pigs weaned at 2 or 3 weeks of age, and pigs given exogenous somatotropin required higher dietary levels of a near-ideal blend of amino acids to maximize protein deposition in the carcass.

New information has been generated on the bioavailability of phosphorus in feedstuffs commonly fed to pigs. This new information allows nutritionists to more precisely formulate diets to meet pigs' available phosphorus requirements. Feeding low-phosphorus diets with added phytase improved bone mineralization and significantly reduced the excretion of phosphorus in the manure. Deletion of inorganic phosphorus from the diet of finishing pigs had little negative effect on performance or bone breaking strength, but it markedly reduced phosphorus excretion.

Ruminant Nutrition

Daily feed intake of lactating ewes was reduced for 7 days prior to weaning, and 96 mg of methscopolamine (MB) was injected at weaning. Both procedures effectively reduced milk production. Even greater reduction was achieved when MB administration was combined with feed restriction.

Data were collected on 276 cow-calf pairs grazing endophyte-infected tall fescue and supplemented with a molasses-based supplement continuously throughout each year. Supplemented cows produced heavier calves at weaning while maintaining heavier weights and higher body conditions.

Polypay wethers were allowed ad libitum access or were limit-fed soybean meal or molasses-supplemented diets. Based on gain, feed intake, and carcass data, molasses-based rumen bypass supplement can replace equivalent soybean meal in growing-finishing diets without decreasing lamb performance or carcass characteristics.

Steers were used to determine the effect of small intestinal adaptation to a partial beta-amylase starch hydrolysate on activity and location of small intestinal glucose transport. Sodium-glucose cotransport activity was not affected by treatment, but did change along the small intestine. Maltase activity was maintained throughout the small intestine, whereas sodium-glucose cotransport activity may limit small intestinal starch assimilation in the distal small intestine. It does not appear glucose arising from carbohydrate hydrolysis regulates activity of sodium-dependent glucose transport in cattle.

Research Projects

Acid-base Balance and Mineral Requirements of Dairy Cattle — *R.W. Hemken*
Amino Acids Sources and Concentrations for Swine — *G.L. Cromwell*
Beef Cattle Grazing: Endophyte-infected Tall Fescue with Alfalfa and Water Quality in Stream Pastures — *B.T. Larson*
Bioenergetics of Nutrient Transport and Growth of Gram-negative Ruminal Microorganisms — *H.J. Strobel*
Comparison of Forage Finishing Systems, Carcass Traits, and Processing Technologies — *W.G. Moody*
Effect of Additives and Processing Methods on Culture Agglutination and Cheese Yield — *C.L. Hicks*
Endocrine Mechanisms Contributing to Establishment of Pregnancy in Ruminants — *W.J. Silvia*
Enhancing Food Safety through Control of Foodborne Disease Agents — *B.E. Langlois*
Evaluation of Tall Fescue in Dairy Cattle — *J.A. Jackson*
Functional Properties of Food Proteins — *Y.L. Xiong*
Genetic and Phenotypic Aspects of Cow Productivity Using Field Records Collected on Angus Cattle — *D.K. Aaron*
Hydrolyzed Feather Meal as a Supplement for Lambs Consuming High Concentrate on High Roughage Diets — *D.G. Ely*
Impact of Level of Preweaning Performance on Subsequent Cow Herd Reproduction — *F.A. Thrift*
Increased Efficiency in Sheep Production — *D.G. Ely*
Induction of Puberty Onset in Beef Cattle — *K.K. Schillo*
Lipid-derived Flavors/Odors and Their Association with Food Proteins — *W.L. Boatright*
Metabolic Relationships in Supply of Nutrients for Lactating Cows — *D.L. Harmon*
Microbial Strategies for Improving the Efficiency of Ruminant Production by Enhancing Proprionate Metabolism in the Ruminant — *K.A. Dawson*
Nutrition and Exercise on Development of Horse Skeletal and Muscular Tissue and Subsequent Performance — *L. Lawrence*
Nutritional Systems for Swine to Increase Reproductive Performance — *M.D. Lindemann*
Optimizing Digestion and Absorption in the Ruminant Small Intestine — *D.L. Harmon*
Requirements and Bioavailability of Phosphorus for Swine — *G.L. Cromwell*
Resistance to Mastitis in Dairy Cattle — *R.J. Harmon*
Skeletal Problems in Poultry — *A.H. Cantor*

Biosystems and Agricultural Engineering

Biosystems and Agricultural Engineering research is directed toward solving existing and emerging engineering-related problems found on Kentucky's farms and forests, as well as developing methods of protecting foods and other farm products which are consumed or used sby the public. Five broad areas of interest are pursued.

Machine Systems design involves development and evaluation of basic machine systems through the application of theoretical and applied mechanics. A fully-automated burley tobacco harvesting and curing system has been developed and is being tested on the Experiment Station. A mechanical burley tobacco spearing machine has been developed and demonstrated to farmers. A commercial version of the wire-strung portable frame system was used on a limited number of farms throughout the burley producing area. A two-row mechanical tobacco topper was shown to significantly reduce labor. An electric power tobacco stripping wheel has been developed that saves labor at the rate of three to five cents per pound.

Techniques for targeted herbicide application using GIS/GPS and reflectance sensors are being researched. A significant effort is in the area of robotics and machine vision as a support technology for machine systems for harvesting, grading, and automated control of field machinery. The effects of soil compaction created by heavy machinery on water infiltration, ground water movement, and plant growth are being studied.

Bioenvironmental Engineering is the application of principles of mathematics, chemistry, biology, and physics to sustain and improve the quality of our natural resources. The broad goal of current research efforts is to develop technology that improves the compatibility between water/soil resources and activities such as agriculture and mining. Research to minimize erosion and stream quality impacts from mined lands continues to be a productive, highly visible program involving improved detention basin design and continued development of computer-based design aids. Recently initiated research is devoted to assessing and reducing the effects of cattle grazing and tobacco production on runoff and subsurface quality. Increasing concerns regarding the environmental impacts of lawn care have prompted a study to relate runoff of commonly used herbicides to factors such as application rate, post-application irrigation, and storm severity.

Bioprocess Engineering involves optimization of equipment, sensors, and control algorithms for processes which use living cells or subcomponents of cells as bioreactors or biocatalysts. The cells typically employed include microbes, plant tissue cells, or mammalian cells and may be modified through biotechnology. Current research in this area includes optimizing the fermentation of *Aspergillus* to produce extracellular enzymes for use as additives in animal feeds. The enzymes produced include a cellulase and hemicellulase to aid in cellulose digestion, and phytase to increase the efficiency of inorganic phosphorus use and reduce the phosphorus excreted by the animal. Another current research project is investigating the use of whole cells in organic solvents to catalyze reactions.

Structures and Environment involves the design of farm structures and environmental control systems for plant and animal production, feed storage and processing centers, residences, and utility buildings. Research efforts are directed toward reducing infiltration into residences, better management of animal waste, improved design of grain storage systems and structures, improved environmental control within poultry and swine growing facilities, computer-aided design methods for dairy facility design, and the development of alternative structures for curing burley and dark tobacco. Evaluation of a portable frame and field curing system for burley tobacco showed significant labor savings and excellent potential for adoption.

Crop Processing research involves basic engineering sciences, particularly heat and moisture transfer processes, to the processing, storage, and handling of farm products. Management protocol has been developed for curing burley tobacco in the field under plastic in various types of frameworks.

Food Engineering involves applying principles to achieve efficient production and high standards of quality during processing, packaging, storage, and distribution of food products. A milk coagulation sensor has been developed using fiber optics and light reflectance that improves the control of cheese making. The sensor is being evaluated in this country and several foreign countries. Experiments have been conducted that show the applicability of using light reflectance as an aid in making cottage cheese.

Other ongoing research which has basic implications in more than one of the areas mentioned above includes developing a profitable beef-forage production system through computer modeling and modeling growing swine. Meteorological research will improve the understanding and use of weather-related agricultural management models in the southern region. The Agricultural Weather Center provides: 1) weekly Kentucky weather summary for the National Weather Service for the Weekly Divisional Averages (WDA) for the Palmer Drought Index Model and dissemination on the National Weather Wire System and 2) Kentucky rainfall, temperature, and deviation-from-normal maps created daily for various time periods using the Geographical Information System (GIS) and made available on the World Wide Web. Research is under way to identify ways of reducing the health and accident risk for farm workers and youth.

Research Projects

A System for Reconstruction or Rehabilitation of Rooting Media for Growing High-value Trees — *L.G. Wells*

A Systematic Approach to Enzyme Recovery from Solid-state Fermentation — *S.E. Nokes*

Agricultural Pesticide Handling and Application Technology Demonstrations — *S.G. McNeill*

Analysis and Management of Misting Systems for Tunnel-ventilated Broiler Housing — *R.S. Gates*

Assessment of the Hydrologic Response of Reclaimed Surface-mined Lands in the Appalachian Coal Region — *R.C. Warner*

BMP Equine Waste Demonstration Project — *R.C. Warner*

Comparison of Integrated Electronic Controllers to Conventional Staged Thermostatic Control in Large Broiler Houses — *R.S. Gates*

Design and Demonstration of a Low-pressure Low-flow Irrigation System for Nurseries' Containerized and Ball and Burlap Areas — *R.C. Warner*

Determination of Design Weather Parameters International Locations — *D.G. Colliver*

Determination of Infiltration Characteristics of Mine Spoil Planted with Hardwoods — *R.C. Warner*

Determination of Straw Properties and Air Flow Through an Upflow Biomass Gasifier — *W.E. Murphy*

Determination of the Hydrologic and Sedimentation Response of Loose and Compacted Mine Spoil Planted with Hardwoods — *R.C. Warner*

Development and Evaluation of a Model for an Active Gas Collection System at Municipal Landfills — *R.C. Warner*

Development of a 3-axis Manipulator for Harvesting Fruit and Vegetable Crops — *S.A. Shearer*

Development of Analytical Methods to Predict Stream/Aquifer Interactions in Alluvial Valleys — *S.R. Workman*

Development of a Trickle Irrigation Design and Specification Program — *R.C. Warner*

Development of Geographical Information Systems (GIS) in the UK College of Agriculture — *K.T. Priddy*

Development of Near-real Time Weather Station at Woodford County Research Farm — *K.T. Priddy*

Development of Profitable Beef-forage Systems for the Southern Region — *L.W. Turner*

Development of Weather-related Insect Forecast Model Output in Geographical Information System (GIS) Format — *K.T. Priddy*

Dietary Manipulation to Reduce Aerial and Effluent Nitrogen Concentrations in Broilers — *R.S. Gates*

Dynamic Mist Control Strategies for Poinsettia Propagation — *R.S. Gates*

Dynamic, Probabilistic Modeling of Respiratory Disease in Livestock — *L.W. Turner*

Economic and Environmental Impacts of Water Quality Protection Policies on Kentucky Agriculture — *J.L. Taraba*

Electric 4-H Project Manuals — *G.A. Duncan*

Energy Savings from Combined Natural/Forced Ventilation Systems for Greenhouse Retrofits — *R.S. Gates*

Enhanced Design of Burley Spearing Machine — *G.A. Duncan*

Eroded Particle Size Distribution for Forest Soils, Mine Spoils, and Weathered Mine Spoils — *R.C. Warner*

Estimating the Impact of Commercial Building Occupancy and Hot Water Needs in Sizing Ground Source Heat Exchanger Fields — *W.E. Murphy*

Evaluation of a Bag-type Geothermal Ground Heat Exchanger — *W.E. Murphy*

Facility Design and Testing for Closed System Plant Micropropagation — *R.S. Gates*

Field Test of Low-cost Greenhouse Microprocessor Controls for Bedding Plant and Tobacco Plug Production — *R.S. Gates*

GPS Tracking of Animal Position for Improved Pasture Systems Design/Layout — *L.W. Turner*

Improved Information Delivery by Developing Internet Gopher/Web Server in the UK College of Agriculture — *K.T. Priddy*

Improved Quality and Efficiency of Burley Tobacco Market Preparation — *L.G. Wells*

Influence of Construction Quality Control on the Permeability of Soil Liner Waste Lagoons — *R.C. Warner*

Interior Environment and Energy Use in Poultry and Livestock Facilities — *R.S. Gates*

Inventory of Constructed Wetlands for Residential Treatment Systems — *R.C. Warner*

Knowledge-based System for Single-stem Greenhouse Rose Production — *R.S. Gates*

Landfill as a Bioreactor — *R.C. Warner*

Measurement of Factors that Influence Soil Development, Water Transport, and Tree Growth in Reclaimed Surface Mines in Eastern Kentucky — *S.R. Workman*

Mechanics of Granular Solids — *I.J. Ross*

Milk Coagulation Sensor Development — *F.A. Payne*

Model Development and Calibration for Predicting the Persistence and Efficacy of Chlorothalonil on Tomatoes — *S.E. Nokes*

Model Development and Verification of a Tubular Trickle Irrigation System to Increase Water Application Efficiency — *R.C. Warner*

Modeling of Heat Transfer from U-tube Heat Exchangers for Ground-source Heat Pumps — *W.E. Murphy*

Modeling Responses of Growing Pigs — *L.W. Turner*

Monitoring Impacts of Animal Research Center on Surface and Groundwater Quality — *J.L. Taraba*

Nighttime Ventilation Strategies for Summer Heat Stress Relief in Broilers — *R.S. Gates*

Optimization of Process Variables for Solid-state Fermentation Production of Xylanase — *S.E. Nokes*

Physical and Bioremediation of Hazardous Waste Contained Soils through Incorporation of Coal Fines and In Situ Environmental Management — *R.C. Warner*

Potential Utilization of Clay Deposits Extracted During Mining for Fly Ash Monofills — *R.C. Warner*

Reducing Heat Stress in Dairy Cows through Forced Evaporative Cooling — *L.W. Turner*

Reducing Nitrogen, Phosphorus, and Ammonia Erosion in Swine Waste through Diet Manipulation — *L.W. Turner*

Reflectance Profile in Milk as a Function of Fat Content — *F.A. Payne*

Residential Air Infiltration and Air Quality — *D.G. Colliver*

Response of Hardwoods Planted in Mine Spoil and Receiving Trickle Irrigation — *R.C. Warner*

Sensor Development for Cottage Cheese and Yogurt Culture — *F.A. Payne*

Sequences of Extreme Temperature and Humidity for Design Conditions — *D.G. Colliver*

Simulation of Infiltration and Lateral Subsurface Transport of Water in Hillslopes on Small Watersheds in Kentucky — *S.R. Workman*

Site-specific Management of Herbicides on Crop Lands — *S.A. Shearer*

Site-specific Crop Management: Nutrient Management — *S.A. Shearer*

Stabilization of Embankments on AML Slopes Using Soil Bioengineering Techniques: A Field Evaluation of Cost-effectiveness — *R.C. Warner*

Sterilizable Fiber Optic Probe for a Septic Food Processing Application — *F.A. Payne*

Stress-strain Modeling of Wheel Compaction Incurred during Restoration of Prime Farmland — *L.G. Wells*

Subsurface Leaching Potential of Animal Waste Holding Ponds as a Function of Soil Moisture and Compaction — *R.C. Warner*

Testing of Time-integrated Variable Control in Tunnel-ventilated Broiler Housing — *D.G. Overhults*

The Impact of Agricultural Systems on Surface and Ground Water Quality — *D.R. Edwards*

Time-integrated Variable Control Strategies for Animal and Plant Environments — *R.S. Gates*

Utilization of Commercially Composted Waste to Reduce the Transport of Herbicides to Surface and Ground Water — *R.C. Warner*

Vapor Pressure Deficit Control as an Alternative Environment Control Technique for Plant Production — *R.S. Gates*

Variable-rate Seeding: A Cooperative Study with Kentucky Corn Producers — *S.A. Shearer*

Entomology

Research in Entomology has two major goals: 1) understanding biology of insects and related arthropods and their interactions with plants and animals and 2) development and implementation of safe and effective management tactics and strategies for pest species. Three broad areas of research are pursued, ranging from fundamental studies to practical field trials. Highlights of accomplishments for 1996 are reported here.

Behavior, Biosystematics, Ecology, and Evolution

- A previously unknown form of *Pandora* sp., an entomopathogenic fungus, was discovered. This finding suggests an entirely new (soil-borne) aspect of the ecology of this pathogen.
- More than 40 compounds induced by Japanese beetle feeding were identified from preferred host plants. Complexity of a plant's volatile blend seems to be an important cue used by this pest for host location. Constituents of leaf surface waxes play a role in resistance of some woody plants.
- Abundant pollen during sweet corn pollination led to higher densities of the predator *Coleomegilla maculata*, which feeds on pollen as well as insect pests.
- Populations of the predator *Coleomegilla maculata* were higher in sweet corn than in field corn; the predators developed faster feeding on sweet corn pollen than on field corn pollen.
- There is heritable variation in the pheromone blend of the black cutworm moth in populations from Kentucky, Egypt, and France. This finding indicates that the pheromone communication system could evolve in response to selection.
- Pheromones and sex attractants have now been identified for all of the prey species of a bolas spider, *Mastophora hutchinsoni*. This spider mimics the pheromones produced by female moths, and thus it attracts and captures male prey.
- The parasitoid complex of the introduced pine sawfly, *Diprion similis*, was characterized.
- In *Harmonia axyridis*, an introduced ladybird beetle, the extent to which diet affects development, size, and color depends on the genetic makeup of individuals. Successful colonizing and continued population growth of *H. axyridis* in Kentucky may therefore be facilitated by genetic variation underlying traits related to feeding, growth, survival, and reproduction.
- In *Nauphoeta cinerea*, male-male social interactions depend on the quantity of different pheromone components that have conflicting roles. Increasing one component can eliminate the effects of increasing the other two components.
- Keys, descriptions, host records, and distribution records for 41 parasitic wasps of the braconid subfamily *Agathidinae* of Japan were published, including fifteen species new to science. The publication will allow biocontrol investigators to tap the reserve of Japanese species that are of potential use against introduced pests. To date, five species of *Agathidinae* have been introduced to the United States in classical biological control programs.
- Spider predation lowers densities of one group of forest-floor detritivores, but does not affect several other insects. Information on prey palatability and spider foraging behavior aids in predicting the actual impact of spider predation.

Pest Management and Applied Ecology

- Early-season release of *Pandora* sp. (generated from its overwintering form) was as effective at controlling tobacco aphids as conventional chemical controls.
- An improved method of incorporating biological control agents into economic decision tools was developed that can be easily implemented into traditional pest management programs.
- Field studies of white grubs and black cutworms in turfgrass revealed ways that cultural practices, including mowing, clipping removal, pH modification, top dressing, and resistant grasses, can be used to manage these pests with reduced reliance on insecticides.
- Studies of the horned oak gall, a severe pest of pin oak trees on horse farms, revealed periods when the wasps can be controlled with horticultural oils or other nontoxic means, thus safeguarding horses in adjacent pastures.
- A system was developed by which thrips and aphids on greenhouse crops can be controlled by overnight exposure to modified atmospheric conditions, without use of pesticides.
- The spider *Clubiona abbotii* consumed 20 to 25 corn earworm eggs per day on intact soybean plants when egg densities were high (32 to 64 eggs per plant).
- The predator *Nabis roseipennis* survived better and produced heavier adults when fed corn earworm eggs than when fed corn earworm larvae throughout its development.
- A newly identified third pheromone component of the black cutworm moth, (Z)-11-hexadecenyl acetate, improves trap efficiency by several fold. This finding should allow for more effective detection and monitoring of this pest.

- Evaluation of an expert system for management of potato leafhopper on alfalfa showed that this pest must be controlled at early regrowth of alfalfa after harvest to prevent stunting.
- Synthetic pyrethroid insecticides at rates as low as 0.0125 lb ai/acre gave excellent control of alfalfa weevil larvae and potato leafhopper on alfalfa.
- Autodissemination of the SeMNPV baculovirus for suppression of beet armyworm populations was investigated.
- Field studies support the efficacy of a new termite bait being marketed to homeowners in Kentucky. Of 22 chronically-infested houses baited in 1995, 18 (82%) exhibited no further signs of termite activity the following year.
- 350 nurseries were inspected and licensed in 1996, and 664 nursery dealers were licensed to sell nursery stock in the state.
- A third generation of permethrin analog was found to be effective against cattle horn flies as well as face flies. Organophosphate insecticides formulated into ear tags are still effective against horn flies but are ineffective against face flies.
- Preliminary field experiments demonstrated that predation by spiders and ground beetles may lower densities of Colorado potato beetles on potatoes and spotted cucumber beetles on cucumbers and squash.

Physiology, Genetics, and Molecular Biology

- A teratocyte (extraembryonic cell of a parasitic insect) gene that inhibits protein synthesis at the level of translation was isolated and expressed.
- A new type of hydrolase that acts on oxygen-nitrogen bonds was characterized from the midgut of the tobacco budworm.
- Regulation of dietary glucose for trehalose and glycogen synthesis in the tobacco hornworm was shown to be altered by parasitism.
- Quantitative genetic studies reveal that genetic variation among individuals influences the growth, reproduction, color, and development of the introduced ladybird beetle, *Harmonia axyridis*.
- Differences in the chemical composition of the pheromone of *Nauphoeta cinerea* are due primarily to genetic differences among individuals.
- Polydnavirus genomes appear to be segmented to regulate viral gene copy number and the level of viral gene expression; this finding provides insights into the evolutionary processes that produced segmented viral genomes.
- A teratocyte gene that inhibits protein synthesis at the level of translation was isolated and expressed. This activity is linked to the inhibition of growth in parasitized insects.

Research Projects

Biological Control of Selected Arthropod Pests and Weeds — *K.V. Yeargan*
Biology and Management of Insects Attacking Urban Landscape Plants — *D.A. Potter*
Control Processes in a Terrestrial Food Web: Trophic Interactions of a Generalist Predator — *D.H. Wise*
Cooperative Agricultural Pest Survey: Gypsy Moth — *B.C. Pass, P.M. Dillon*
Damage Thresholds, Risk Assessment and Environmentally Compatible Management Tactics for White Grub Pests of Turfgrass — *D.A. Potter, K.F. Haynes, A.J. Powell*
Determination of Resistance of Woody Landscape Plants to the Japanese Beetle — *D.A. Potter, T.R. Kemp, P.A. Weston, R.E. McNiel*
Development and Integration of Entomopathogens into Pest Management Systems — *G.C. Brown*
Development of Sustainable IPM Strategies for Soybean Arthropod Pests — *K.V. Yeargan*
Ecology and Management of European Corn Borer and Other Stalk Boring Lepidoptera — *G.C. Brown*
Evaluation of Controlled Atmosphere Anoxia Treatments as a Potential Disinfestation Technique for Thrips and Spider Mites in Greenhouses — *D.A. Potter, R.G. Anderson*
Evaluation of Southern Region Integrated Pest Management — *B.C. Pass*
Evolutionary Genetics of Developmental and Age-related Changes in Social Signals — *A.J. Moore*
Impacts of Spiders in Food Webs of Crop and Forest Floor Ecosystems — *D.H. Wise*
Insect Stress: Multitrophic Interactions between Parasites, Pathogens, and Allelochemicals — *D.L. Dahlman*
Integrated Management of Arthropod Pests of Livestock and Poultry — *F.W. Knapp*
Isolation of Biologically Active Secretory Products from an Endoparasite — *D.L. Dahlman*
Kentucky's Agricultural Pesticide Impact Assessment Program — *B.C. Pass, M.P. Johnson, L.M. Unger*
Mate Choice and Offspring Fitness — *A.J. Moore*
Molecular Dissection of Polydnavirus Functional Activities — *B.A. Webb*
Nursery Inspections — *B.C. Pass, J.T. Collins, C.W. Harper*
Pathogenicity, Transmission, and Introduction of a Cytoplasmic Polyhedrosis Virus to Fall Webworm — *L.K. Reiske-Kinney*
Pesticide Applicator Training 1996 — *L.H. Townsend*
Real and Apparent Complexity in Polydnavirus Genomes — *B.A. Webb*
Redundancy in Chemical Communication: Evolution of Sex Pheromone Blends — *K.F. Haynes, A.J. Moore*
Semiochemical Mediation of Reproductive Behaviors in Moths — *K.F. Haynes*
Sexual Selection and Plasticity in Social Behavior and Signals — *A.J. Moore, K.F. Haynes*
Simple Dynamical Models for Incorporating Biological Control Agents into IPM Decision Making — *G.C. Brown*
Spatial Dynamics of Leafhopper Pests and Their Management on Alfalfa — *B.C. Pass, J.C. Parr*
The Role of Fluctuating Asymmetry in Sexual Selection — *A.J. Moore*
Translation Factors from a Parasitic Wasp and Its Virus — *B.W. Webb*

Forestry

National, regional, and local interest in the future of forest resources stresses the need for strong research programs to provide information from which sustainable forest policies can be developed for these resources. These needs are further emphasized by conflicting social, economic, and political directions. Kentucky's 12.7 million acres of forest land (50% of its total land area) support important water supplies, habitat for diverse species, as well as important economic industries in forest products and recreation/tourism. The research mission of the Department of Forestry is to support wise management policies by conducting creative and rigorous studies addressing questions on forest ecosystem function and on the products of these ecosystems.

Dynamic programming has been used to model timber stand dynamics and optimal management prescriptions and has been expanded to incorporate site conditions and price fluctuations. Using this approach, improvement thinnings of shortleaf pine and yellow-poplar have been shown to increase economic returns by 5% to 15%. However, depending on market conditions, management for fiber may be preferable to sawtimber. These results suggest that management opportunities for landowners may be greater than previously considered.

There is increasing interest in obtaining accurate resource inventories in order to set effective forest policy. A temporal inventory data model has been developed which provides better process modeling, i.e., reconstruction of long-term forest transactions (growth, mortality, and timber sales). However, there are significant costs associated with such an inventory model in terms of database size, access, and management costs. These costs must be recognized as an important component of developing effective long-range forest policy.

A regional survey of forest ecosystem quality has been initiated using soil invertebrates as measures of ecosystem integrity and quality. Soil invertebrates respond quickly to changes in soil environment and may reflect long-term historical impacts on a forest site. Maintenance of ecosystem quality is a key component of ensuring sustained forest productivity.

Sediment production from forest management (especially timber harvesting and road construction) may have a significant impact on environmental quality. A runoff generation experimental field site has been established at Robinson Forest to characterize the distribution and importance of runoff generation mechanisms in the forested landscape. This study will characterize the natural production of runoff and sediment yield as well as production from human-induced sources, such as timber harvesting. A second experimental watershed has been established to monitor the effectiveness of Best Management Practices in preventing accelerated erosion from forest management activities.

Long-term studies of threatened and endangered species of forest-dwelling bats have determined basic biological requirements for survival and have helped establish management guidelines to ensure conservation of these species. Data on population dynamics, food preference and foraging habits, and roost selection have helped determine especially sensitive forest areas for bat conservation. Land management agencies, such as the Daniel Boone National Forest, have used this information to revise forest management policy and timber harvesting practices.

Studies have been initiated to evaluate the effects of timber harvest on genetic diversity of white oak populations of eastern Kentucky. Timber harvest may influence gene frequencies directly, or may impact mating system characteristics of residual trees and pollen and seed migration. Understanding these relationships may assist design of timber harvesting systems which will ensure sustainability of genetic diversity of this important timber species.

Observed losses of cations from the forest floor of northern hardwood forests have suggested possibly serious consequences for long-term productivity of these forests. Studies have been conducted in a variety of forest conditions to elucidate the cause of such losses. Cation loss was not common across stands of differing ages, as would be expected if acid deposition were the cause; nor was cation loss greatest in most rapidly growing stands, as might be expected if rapid nutrient accumulation in biomass of young stands following harvest were the cause. These results suggest that regional pollution and forest successional patterns cannot explain the observed losses.

Geographic positioning systems using satellite triangulation to determine ground location are among the new technologies being applied to forest management. Computation of area of GPS-traversed lands customarily uses the traditional coordinate method. However, no attempt has been made to examine new area determinations that might have distinctive computational benefits. Recent investigations have revealed that a numerical method, called Areas of Oriented Figures, may have the computational advantage of treating surveying data of convex and non-convex figures of many sides. Efficient algorithms are being developed to enable computer implementation of this numerical method.

Research Projects

Development of Conservation Strategies for Forest-dwelling Wildlife Dependent on Topographic Habitat Features — *M.J. Lacki*

Economic Assessment of Surface Mine Reclamation Alternatives — *J.M. Ringe, M.H. Pelkki*

Effects of Forest Management Practices on Forest Nutrient Status — *M.A. Arthur*

Effects of State Interval Size and Number of Predictors on Dynamic Programming Solutions in Forestry — *M.H. Pelkki*

Evaluating Differential GPS Positioning Accuracies in Forestry Applications — *C.J. Liu*

Indicators of Ecosystem "Quality" in the Mixed Mesophytic Forest — *P.J. Kalisz*

Intraspecific Phylogeography of Plant Mitochondrial DNA — *D.B. Wagner*

Roost Selection of Bats in Forests in Eastern Kentucky — *M.J. Lacki*

Sources of Runoff and Sediment Production in Forested Watersheds — *D.L. Brown*

Horticulture and Landscape Architecture

The Horticulture and Landscape Architecture faculty conduct mission-oriented research, combining basic and applied approaches related to the production and use of horticultural crops and landscape architecture. Research activities are concentrated in the broad topics of integrated crop management, crop improvement, environmental regulation of plant growth and development, and landscape architecture.

Integrated Crop Management

The Controlled Water Table irrigation system consists of a capillary mat placed on a horizontal surface with one end of the mat suspended vertically in a small trough of water or nutrient solution. The amount of water, in a pot of growing medium sitting on the horizontal surface, is determined by the vertical distance from the water to the bottom of a pot. A liquid level controller maintains the water level in the trough. As plants remove water from the growing medium, it is replaced immediately by water from the trough. The system may be used in commercial greenhouse production and residential homes.

A novel approach to rooting cuttings under mist uses capillary mat subirrigation. The capillary mat reduces the amount of water in the rooting medium during misting cycles and prevents the medium from drying during the night when the mist is off. This provides a better environment for root development.

Nursery crop production system research revealed that composted yard trash is an effective container medium component when comprising 25% of a pine bark medium volume. Media comprised of 50% to 100% composted yard trash were not acceptable for outdoor production of two holly species. A three-year field nursery fertilization study revealed that banded application of 250 pounds of nitrogen per acre per year, split into spring and fall applications, is adequate for the production of the seven landscape plants tested. Field herbicide trials resulted in expanded herbicide labels for nursery crops and offer hope for the formulation of herbicides with a broad spectrum of control and tolerance for landscape use.

A study of wholesale prices for selected landscape plants over a 12-year period revealed that annual price increases were fairly constant from 1980 until 1989. A drastic drop in price increases that occurred in the 1989-90 catalog year was attributed to the severe drought of 1988. Price increases rebounded in the 1990-1991 year and leveled off the following years.

Three promising resistant bell pepper varieties were identified after the second year of testing 20 cultivars at two locations under induced and natural epidemic bacterial leaf spot conditions. Rapid adoption of resistant pepper cultivars occurred following recommendations from our 1995 trials; no losses occurred in growers' fields with resistant varieties compared to 50% losses in fields of susceptible varieties at the same localities.

Crop Improvement

The widespread occurrence of genes and transcripts for the $^{\varepsilon}$N-methyltransferase responsible for the methylation of Lysyl residue 14 in the large subunit of Rubisco is present in many plant species. Methyltransferase has an exceptionally high affinity for Rubisco and represents the first demonstration of a protein with a tight and specific interaction with the world's most abundant and important plant protein responsible for the fixation of CO_2 by all green plants. The characterization of this protein and gene has resulted in the identification of a molecular vehicle capable of the selective delivery of positive agents to Rubisco. The significance of this protein and its activity, as well as its potential usefulness in the molecular engineering of higher yielding crop species, is being explored.

The activity of the key enzyme for sorbitol metabolism, sorbital dehydrogenase, in apple fruit is induced by sorbitol, indicating that the source-sink interaction in apple is more dynamic than previously thought. Reduced sorbitol production resulting from defoliation due to disease and insect problems may also create "weaker" fruit, leading to poor quality at harvest.

The human dietary component E-2-hexenal, a natural constituent of all higher plants, was found to be the most effective volatile compound evaluated for controlling microbial pathogens on plant-derived foods such as strawberries and table grapes. Collaborative studies were undertaken to determine the mode of action of this compound and to establish effectiveness in inhibiting bacteria growth. Due to their natural origin and metabolism by the fruit, the volatile compounds may offer a biologically safe, consumer-friendly solution for eliminating postharvest losses due to pathogens such as gray mold.

Somatic embryos developed in legume species often show severe abnormalities and are difficult to convert to seedlings. A system was developed using eastern redbud to initiate adventitious shoots from malformed somatic embryos. Multiple shoots were initiated on each somatic embryo that could be subsequently rooted and converted to plantlets. This system bypasses the problem with germination of malformed somatic embryos and could be applicable to other legume species.

Seed germination in vinca (*Catharanthus roseus*) progresses in a typical triphasic pattern for fresh weight gain. Ethylene evolution was not observed in vinca seeds until radicle emergence (48 hrs) even though detectable levels of 1-aminocyclopropane-1-carboxylic acid (ACC) were present during this period. ACC oxidase activity was not detectable until 48 hours and preceded in vivo ethylene production. Our data suggest that ACC oxidase is a key regulatory step in the biosynthesis of ethylene during early stages of germination and that ethylene has a role in radicle growth.

How arthropods perceive plant-borne chemical repellents is an important aspect of plant-insect interaction. *Lycopersicon hirsutum* is a wild species of tomato that is highly defended from arthropods. Certain genotypes produce repellents in trichome secretions. For the three chemical repellents tested (2,3-dihydrofarnesoate, 2-pentadecanone and laurate), most quantitative behaviors were similar except average distance from the stimulus. For the two acids, distance from the stimulus tended to decrease the longer mites were exposed, indicating that the stimulus to leave becomes stronger as time passes. Data suggest that 2-pentadecanone may act as an attractant when perceived by olfaction, but as a repellent when perceived by touch.

Long-term cultivar and rootstock research is making significant contributions to the Kentucky fruit industry. Blueberry cultivars in descending order of yield (kg/bush) in the second year were Duke (2.2), Sierra (1.9), Bluecrop and Patriot (1.8), Toro (1.5), Blue Gold (1.4), Nelson (1.1), and Sunrise (0.7). The table grape cultivars, in descending order of yield (kg/vine) were Niagara (14.8), Concord (10.5), Moored (8.1), Mars (7.6), Golden Muscat (3.5), Captivator (3.0), Reliance (2.6), Challenger (2.4), Canadice and Himrod (0.25), and Glenora (0.0). The 1990 apple cultivar/rootstock planting is trained to the Dutch slender spindle system and supported by electrical conduit fastened to a wire trellis. Early production via this system allows growers to quickly establish orchards with newer, more profitable cultivars. The semi-dwarf apple rootstock trial utilizes the French vertical axe system. The mortality of trees in this study was higher on M.26 (40% survival) than on the other five rootstocks (98% survival).

Sorgoleone, a long-chain hydroquinone, is present in large quantities (greater than 80%) in most root exudates of various sorghum accessions. It is a potent inhibitor of seedling growth, oxygen evolution, and electron flow in photosystem II. It exhibits similar potent inhibitory activity within PSII as diuron or metribuzin and demonstrates similar competitive binding characteristics within the Qb binding pocket. Also, sorgoleone's binding and 3D configuration in the Qb niche are similar to that of other PSII inhibitors such as lentacil and metribuzin. This is attributed to sorgoleone's quinone moiety and in particular its unique electrostatic charge distribution. Apparently sorgoleone can persist in soil systems for days to weeks, causing inhibition of plant growth.

Environmental Regulation of Plant Growth and Development

Commercial quality cut roses were produced in a single stem production system from single node cuttings. The initial node of origin was significantly correlated to the final stem length of the single stem 'Lady Diana' rose and to the number of days for axillary bud break on the cutting. More than 70% of the cut stems harvested from these cuttings were 46 to 75 cm long. An adaptive neuro-fuzzy inference system was built to predict the rose status and to make critical environmental control decisions based on the principle of economic optimization.

Landscape Architecture

A Geographic Information System (GIS) database has been developed for land use planning in the 28 counties comprising the eastern Kentucky coalfields. A major effort in 1996 was made in analyzing institutional impediments to reuse of devastated lands, particularly in regard to legal/regulatory requirements and interpretations of these in the field. The database will be available through Kentucky Cooperative Extension in 1997.

As part of a restoration/preservation study of downtowns, models for organizing the relationship of parking and pedestrian movement to downtown destinations have been identified, and a method for evaluating pedestrians' circulation experiences has been developed. Recommendations and design criteria will be conveyed as conceptual unifying principles and guidelines and as examples of applications through case study descriptions.

Research Projects

All-American Selection Trial Garden for Annual Flowering Plants — *S. Bale*

Antimicrobial Properties of Naturally Occurring Volatile Compounds from Plants — *T.R. Kemp*

Blackberry and Raspberry Cultivar Evaluation — *G.R. Brown and D. Wolfe*

Composted Yard Trash as a Container Medium Component — *D.L. Ingram and B.R. Roach*

Control of Root Outgrowth by Copper Hydroxide in Capillary Mat Plug Production — *R. Geneve and J. Buxton*

Daylily Cultivar and Production System Evaluation — *W. Dunwell*

Densities and Secretions of Trichomes on *Lycopersicon* — *J.C. Snyder*

Developmental and Environmental Influences on Carbohydrate Partitioning in Fruit Crops — *D.D. Archbold*

Downtown Morphology and Circulation Potential — *N. Crankshaw*

Evaluation of Scab-immune Apple Cultivars Using IPM and Organic Techniques — *J.G. Strang*

Evaluation of Cut Flower Species for Adaptability to Improved Greenhouse Production Practices and Extended Postharvest Life — *R.G. Anderson*

Evaluation of Bacterial Leaf Spot-resistant Pepper Cultivars and Breeding Lines in Epidemic and Disease-free Environments — *B. Rowell, R.T. Jones, and W. Nesmith*

Evaluation of Controlled Atmosphere Anoxia Treatments as a Potential Disinfectation Technique for Thrips and Spider Mites in the Greenhouse — *R.G. Anderson, D.A. Potter, and R.S. Gates*

Fall Vegetable Greenhouse Production — *D. Spalding, R. Anderson, and B. Rowell*

Fertilization Systems for Field-grown Nursery Crops — *D.L. Ingram*

Field Performance of Herbaceous Perennial Plants — *W. Dunwell*

Herbicide Evaluations in Vegetable Crops and Woody and Herbaceous Ornamentals — *L.A. Weston and R.E. McNiel*

Integrated Crop Management Program for Apples — *J. Hartman, G.R. Brown, D. Wolfe, and R. Bessin*

Interaction between Ethylene and Polyamines during Seed Germination and Early Seedling Growth — *R.L. Geneve*

Knowledge-based Manufacturing System for Optimization of Greenhouse Rose Production — *R.G. Anderson and R.S. Gates*

Light, Temperature and CO_2 Effects on Carbohydrate Metabolism in Bedding Plant Seedlings — *J.W. Buxton*

Mechanism and Significance of Post-translational Modifications in the Large Subunit of Ribulose Bisphosphate Carboxylase/Oxygenase — *R.L. Houtz*

Monitoring Wild Ginseng in Kentucky — *R.T. Jones*

Peach Tree Cultivar Evaluation for Hardiness — *J.G. Strang and D.D. Archbold*

Planning Model for the Development of Mountaintop Removal-valley Fill Mining Sites — *T.J. Nieman*

Post-translational Modifications in Ribulose Biosphosphate Carboxylase/Oxygenase — *R.L. Houtz*

Pot-in-pot Tree Production Practices for Kentucky — *R.E. McNiel*

Producing and Marketing Deciduous Holly Berries for Use in Floral Designs — *R.T. Jones, M. Witt, and S. Bale*

Production Research on Artificial Shade and Woods-grown Ginseng and Goldenseal — *R.T. Jones*

Rootstock and Interstem Effects on Pome and Stone Fruit Trees — *G.R. Brown*

Seedless Table Grape Cultivar and Training System Evaluation — *G.R. Brown and D. Wolfe*

Southeast Tree Fruit Cultivar Evaluation — *G.R. Brown, D. Wolfe, J. Strang, and R.T. Jones*

Supersweet Corn Cultivar Evaluations — *J.G. Strang, R.T. Jones, J. Snyder, D. Slone and D. Lowry*

Sustainable N Management: Intensive Crop Production and Improved Water Quality — *D.C. Ditsch, R.T. Jones, R.C. Pearce, and J.H. Grove*

Technical and Economical Efficiencies of Producing and Marketing Landscape Plants — *R.E. McNiel*

The Physiological Bases for Alleopathic Interference of Sorghum spp. as Mediated by Sorgoleone — *L.A. Weston, C.I. Nimbal, and J.S. Pyrek*

The Landscape of Main Street: An Assessment of the Urban Landscapes of Kentucky's Main Street Towns — *N. Crankshaw*

Use of Natural Volatile Compounds for Control of Microbial Spoilage and Quality of Strawberry during Modified Atmosphere Storage — *D.D. Archbold, T.R. Kemp, B. Langlois, and M. Barth*

Use of the Tomcast Model for Disease Management in Processing Tomatoes — *B. Rowell, R. Bessin, and W. Nesmith*

Using Available Tobacco Resources to Diversify Farm Enterprises and Increase Income — *R.T. Jones and D.C. Ditsch*

Nutrition and Food Science

The Department of Nutrition and Food Science is supported by the Agricultural Experiment Station at the University of Kentucky through supplies and salary of four faculty members and one chairperson, each with joint appointments and approved projects in the AES. AES faculty perform extensive research, administrative, service, and instructional assignments for the Department of Nutrition and Food Science.

The main thrust of AES-supported departmental research includes nutrition in relation to eating disorders, cardiovascular disease, cancer, nutrient-drug interactions, and alcohol. All faculty were invited speakers at national and/or international research meetings. All faculty reviewed manuscripts and grant applications for journals and funding agencies. The faculty is committed to research, service, and instruction and will continue to carry out their duties in accordance with the guidelines and goals of the University of Kentucky, the College of Human Environmental Sciences, and the College of Agriculture.

Alcohol

Chen

Acetaminophen or acetaminophen-containing drugs are commonly used analgesics and antipyretics. Tylenol, the most popular preparation of acetaminophen in the U.S., can be obtained without prescription. Although acetaminophen is a safe drug at the therapeutic dose, overdose or long-term use can cause chronic hepatitis or necrosis. The mechanism by which acetaminophen produces hepatotoxicity remains unclear. It has been suggested that oxidative stress may be a possible mechanism. Thus, the possible protective effects of antioxidants and glutathione (GSH) precursors against the APAP-induced alterations of antioxidant defense enzymes in hepatocyte culture were studied. Rat hepatocyte culture plates were divided into five groups and pretreated with none, (α-tocopheryl succinate (TS), L-ascorbic acid (AA), N-acetylcysteine (NAC), or S-adenosyl methionine (SAM). One half of the plates in each group were treated with acetaminophen. The cells were harvested and homogenized, and biochemical assays were performed. Pretreatment with each of the four compounds partially protected against APAP-induced damage of the integrity of the cell membrane, partially prevented the decline of cellular GSH levels, and completely prevented the depression of glutathione reductase (GR) activity. The results suggest that vitamin E, vitamin C, or GSH precursors can lessen APAP toxicity through modulation of APAP-induced depression of antioxidant defenses.

Cancer

Chow

The toxic effect of endotoxin is partly attributable to increased generation of reactive oxygen species by endogenous mediators of inflammations. While a number of studies have shown that endotoxemia is associated with increased generation of lipid peroxidation products and altered activities of antioxidant enzymes, relatively little is known concerning the effect of endotoxin treatment on the status of small molecular weight antioxidants and if protein oxidation occurs during endotoxemia. Acute effect of endotoxin on the generation of oxidation products and status of small molecular weight antioxidants was, therefore, examined in mice. Male B6C3 mice were treated with 0, 20, 40 or 80 mg of endotoxin/kg BW, i.p., for 24 hours. Liver, heart, and lung were measured for the levels of malondialdehyde (MDA), conjugated dienes, protein carbonyls (PC), glutathione (GSH), ascorbic acid (AA), retinol, and tocopherols. Relative to the vehicle controls, endotoxin-treated mice had significantly ($p<0.05$) higher levels of MDA and CD in the liver and heart of endotoxin-treated mice. The levels of PC were not significantly altered by endotoxin in liver, heart, or lung. Endotoxin-treatment resulted in lower levels of GSH in the liver, heart, and lung, of retinol in the liver and heart, and of alpha-tocopherol in the liver, while the levels of AA were higher in the liver and heart.

Cancer

Glauert

The overall project goals are to determine the mechanisms of peroxisome proliferator-induced liver carcinogenesis and to determine the role of dietary antioxidants. The following research accomplishments occurred in 1996:

1. We developed a transgenic mouse which has increased (3 to 4 fold) liver-specific expression of the antioxidant enzyme catalase. This will allow us to determine the role of active oxygen in the promotion of liver carcinogenesis by various agents;
2. We demonstrated that eicosanoids and the peroxisome proliferator ciprofibrate are co-mitogenic in cultured rat hepatocytes. This implies that specific eicosanoids must be present for peroxisome proliferators to exert possibly their promoting effects;

3. We found that transcription factor NF-(B is activated by the peroxisome proliferator ciprofibrate and by phenobarbital in the liver, which may provide a new mechanism by which these agents exert their tumor-promoting activity. Since NF-(B is an active oxygen-activated transcription factor, dietary intervention (e.g., vitamin E, selenium, synthetic antioxidants) may prevent the activation of this transcription factor.

Cardiovascular Disease

Hennig

Kentuckians are experiencing a high incidence of nutrition-related health problems, which may be due to overconsumption of fat and lack of protective nutrients such as antioxidants. Zinc, for example, is an essential component of biomembranes and is necessary for maintenance of membrane structure and function. There is evidence that diet-derived zinc can provide antiatherogenlc properties by preventing metabolic physiologic derangements of the vascular endothelium. Because of its antioxidant and membrane-stabilizing properties, zinc appears to be crucial for the protection against cell-destabilizing agents such as polyunsaturated lipids and inflammatory cytokines. Zinc also may be antiatherogenic by interfering with signaling pathways involved in apoptosis. Most importantly, we have evidence that zinc can protect against inflammatory cytokine-mediated activation of oxidative stress-responsive transcription factor, such as NF-kB and AP-1. It is very likely that certain lipids and zinc deficiency may potentiate the cytokine-mediated inflammatory response and endothelial cell dysfunction in atherosclerosis. Thus, the antiatherogenic role of zinc appears to be in its ability to inhibit oxidative stress-responsive factors involved in disruption of endothelial integrity and atherosclerosis.

Eating Disorder

Mercer

We have accomplished several goals producing new findings placing the central H1 receptor in the hierarchy of regulation of food intake: the central H1 receptor is involved in physiological responses to nutrient-imbalanced and restricted intake diets; food intake is inversely proportional to central H1 concentration in male rats fed diets varying in energy content, protein content, and protein quality; female rats normally have higher H1 receptors than male rats; diet composition affects H1 receptor levels in a gender-specific manner; bioperiodicity is present in central H1 receptor trafficking; parameters of periodicity are gender-specific and modified by diet.

Preliminary findings in our lab carried out on animal tissues received from other laboratories indicates that:

- tumor-bearing mice have increased H1 receptors (consistent with anorexia);
- cigarette-smoking rats have increased H1 receptors (consistent with weight loss);
- Zucker obese rats have impaired H1 response to dietary manipulation (consistent with obesity).

Hypothalamic tissues from humans obtained at autopsy indicate bioperiodicity of H1 receptors.

Research Projects

Dietary Vitamin E/Fat and Oxidative Damage — *C. Chow*
Lipid-mediated Endothelial Injury — *B. Hennig*
Mechanism of Hepatocarcinogenesis by Peroxisome Proliferators and Influence of Dietary Antioxidants — *H. Glauert*
Nutrient-alcohol/Oxidative Drug Interaction — *L. Chen*
The Histaminergic System and Eating Disorders — *L.P. Mercer*

Plant Pathology

Healthy plants are key to sustainable agriculture and a secure food base for the Commonwealth. Plant pathology is an integrative scientific discipline which ranges from the whole plant, to interrelationships in the microbial world, to mechanisms of cellular dysfunction in the disease process. Although the department's research endeavors focus particularly on fungal and viral pathogens, attention is also paid to disease problems created by bacteria, nematodes, and non-living causal agents.

Mycology

Fungi are a constant threat to production agriculture and demand scientific study toward their management. Some pertinent departmental projects are summarized below.

Research on mycorrhizal stunt disease of tobacco is being extended to determine if pathogenic mycorrhizal fungi are involved in the general phenomenon of yield depression associated with continuous cropping without rotation. Systems are being developed to reduce the necessity of having to conduct initial field experiments to detect such yield declines. The approach is to devise greenhouse techniques to mimic field experiments. The approximately two dozen mycorrhizal fungi present in a field soil are isolated. After several cycles of continuous or rotated growth of crop plants, the mycorrhizal fungal communities are again determined and evaluated for crop response.

A long-term research program was initiated to investigate stalk rot of field corn, the primary disease problem of corn in Kentucky. Stalk rot is difficult to control by conventional means because of the extreme variability in incidence and severity between years and locations. The long-term goals of the research are to better understand the genetics and physiology of anthracnose stalk rot of corn and to develop sustainable methods for control of this and other stalk rot diseases.

In order to study the interactions between two related fungi superinfecting a grass plant, two hygromycin-resistant (hygR) transformants of the choke disease pathogen *Epichloe typhina* were introduced into perennial ryegrass seedlings which already possessed the related mutualistic, seed-transmissible symbiont, *Neotyphodium lolii* (*=Acremonium lolii*). Forty-six plants superinfected with *E. typhina* and *N. lolii* were vernalized and tested for seed production, transmission of the fungi in seeds, and hygR of the transmitted fungi. In no instance was *E. typhina* infection sustained through vernalization and seed set, but the original *N. lolii* infections remained stable. Based on these results, *N. lolii* may be able to protect host plants from choke disease.

The first pathway-specific step of ergot alkaloid biosynthesis in the ergot fungus *Claviceps purpurea* is catalyzed by 4-(dimethylallyl) tryptophan (DMAT) synthase. A gene, *dmaW*, thought to encode this enzyme has been cloned. The function of this gene was tested and results confirmed that *dmaW* encoded authentic DMAT synthase. The cloned *dmaW* was used as a probe to identify clones of putative *dmaW* from *Neotyphodium coenophialum (=Acremonium coenophialum)*. Tall fescue infected with this endophyte has enhanced fitness in some environments. The putative *N. coenophialum dmaW* encoded a polypeptide with a 121 amino acid region of similarity to *C. purpurea* DMAT synthase.

Evidence was developed suggesting that polygalacturonase (PG) produced by the chestnut blight fungus *Cryphonectria parasitica* may be a virulence factor. When the gene encoding a basic PG produced in culture by *C. parasitica* was disrupted, however, the disrupted mutant caused cankers similar in size to those induced by the nondisrupted virulent parental strain. The basic PG produced in culture is therefore not required for virulence. Additional PGs, acidic rather than basic, are produced in cankers, and research is in progress to determine if these are required for virulence.

A multidisciplinary research effort culminated in demonstrating that failed stand establishment in alfalfa seeded in spring is often due to the root rot fungus *Aphanomyces euteiches*. As a result of this research effort, the University now recommends only *Aphanomyces*-resistant alfalfa varieties for spring seedings.

Apple scab conidial inoculum dose was positively correlated with infection rates, especially at the lower end of its temperature range for infection.

Research showed convincing proof that *Pyricularia grisea* is causing increasing, sometimes catastrophic, loss of high-maintenance perennial ryegrass golf fairways and provided strong direction for the development of control strategies.

Virology

Plant pathologists discovered viruses some 100 years ago, setting the stage for a new field of endeavor in the agricultural and medical sciences. Certain of the major research emphases in the department concerning viruses are highlighted below.

The virus genes responsible for differential host responses were studied in two systems: the response of Tabasco pepper to tobacco etch virus (TEV) and the response of the tobacco cultivar TN86 to a resistance-breaking strain of tobacco vein mottling virus (TVMV). By construction of chimeric viruses, two regions of the TEV genome and a single region of the TVMV genome were shown to be involved in the responses.

The importance of retention of virus particles in the stylets of aphids to the transmission of potyviruses by these insects was confirmed. The ability of aphids to transmit TEV was abolished or drastically reduced by probing oil-sprayed membranes or leaves prior to virus acquisition, and by probing oil-sprayed leaves after virus acquisition. The lack of transmission correlated with inability to retain virus particles in the stylets. Fasted aphids transmitted TEV more efficiently than unfasted aphids. Results indicated that fasting may eliminate a plant component(s) which interferes with the retention of virus in the stylet food canal.

The NIb protein of TVMV was expressed in *Escherichia coli* as a GST-fusion protein or a his6-tagged protein. His6-NIb is able to undergo nonspecific binding to the 3' - untranslated region of TVMV RNA in the absence of other proteins. The fusion protein possesses the poly (U) polymerase activity that is a hallmark of picornavirus-encoded polymerases. In addition, the protein is able to use full-length TVMV RNA as a template for RNA synthesis. A fusion protein containing a mutation in the highly conserved GDD motif had only 7% of the activity of the wild type protein. Mutants of TVMV in which the tyrosine residue that links the NIa-VPg to the viral RNA were constructed. There was no evidence of accumulation of progeny viral RNA in plants or protoplasts inoculated with mutant transcripts.

A search for the first region in TVMV RNA to be encapsidated by the coat protein during the assembly of virus particles was undertaken. Protoplasts were collected at various times after they had been inoculated. TVMV and the fragments of progeny viral RNA that were protected by coat protein subunits were isolated. The first fragments were detected in protoplasts that had been infected for 35 to 40 minutes, and accumulation of completely assembled progeny virions was noted after 45 minutes.

The dsRNA genome of *Helminthosporium victoriae* 190S totivirus (Hv109SV) was shown to consist of two large overlapping open reading frames (ORFs). The 5' proximal ORF codes for the capsid protein (CP) and the 3' ORF for an RNA-dependent RNA polymerase. Although the capsid of Hv190SV is encoded by a single gene, it is comprised of two major closely related polypeptides, p88 and p78. Whereas p88 is a phosphoprotein, p78 is nonphosphorylated. The finding that p78 and p88 share a common N-terminal amino acid sequence is consistent with the determination that N-terminal, but not C-terminal, CP deletions were incompetent for assembly. Evidence was obtained that p78 is derived from p88 via proteolytic cleavage.

Strains of peanut stunt cucumovirus (PSV) were classified into two distinct subgroups, I and II, based on Western and Northern blot analyses using antisera and cloned cDNA probes to strains PSV-ER and PSV-W. These results were corroborated by nucleotide sequence analyses of full length cDNA clones of RNA3 from representative strains of the two subgroups.

Disease Management

The department pursues a variety of studies to implement research findings for plant disease control, several of which are briefly described below.

Tobacco production was hit hard by a blue mold epidemic in 1996, with production losses in excess of $150 million. However, without appropriate disease management practices, the consequences of blue mold to the tobacco industry might have been catastrophic. The North American and Kentucky Blue Mold Warning Systems were coordinated, and the emergency labeling of Acrobat MZ was organized through the department. Long-term monitoring of the changing sensitivity of the blue mold fungus to Ridomil was instrumental in convincing the Environmental Protection Agency (EPA) that Ridomil was no longer a reliable control, allowing alternative fungicide use for this crisis situation. Likewise, evaluation of experimental fungicides for blue mold control under greenhouse, plant bed and field conditions provided data vital to EPA's granting of emergency-use fungicide treatment. Field and greenhouse evaluations were made of the sensitivities of current burley cultivars to blue mold.

Black shank is a perennial problem to tobacco growers. About 15 pre-plant soil fumigation test plots were monitored over the past two growing seasons. The results obtained from this research indicated the need to recommend pre-plant soil fumigation at problem sites, particularly in light of the recent sharp decline in crop rotation. Other current production practices contributing to increased black shank were also determined.

Efficacy of fungicides for management of dogwood powdery mildew, which has become a more common disease in recent seasons, was assessed.

Efforts to determine the effects of various cropping sequences on soybean cyst nematode (SCN) population densities and associated soybean yields from a multi-year study indicated that a race shift had likely been initiated in the presence of resistant soybean varieties. In most cases, growing corn following the resistant soybean cultivars tested reduced SCN levels.

Research Projects

Altering Ergot Alkaloid Biosynthesis by the *Acremonium* Endophyte of Tall Fescue — *C.L. Schardl*

Basis of Virus Virulence/Host Resistance in Potyvirus-tobacco Interactions — *T.P. Pirone*

Biological Improvement of Chestnut and Management of the Chestnut Blight Fungus — *L. Shain*

Characterization of Viral Genes and Gene Products Which Mediate Aphid Transmission and Cell-to-cell Movement — *T.P. Pirone*

Chemical Controls for Tobacco Diseases under Greenhouse, Float Bed, Plant Bed, and Field Conditions — *W.C. Nesmith*

Cultural Practices for Managing Spring Dead Spot of Bermudagrass — *P. Vincelli*

Corn Stalk Rot Diseases — *L.J. Vaillancourt*

Defining and Mapping the Genes of Caulimoviruses — *R.J. Shepherd*

Disassembly and Early Gene Expression of RNA Plant Viruses — *J.G. Shaw*

Distribution of Bacterial Leaf Scorch in Kentucky — *J.R. Hartman*

Effect of Conidial Inoculum Dose and Temperature on Development of Apple Scab — *J.R. Hartman*

Effect of Cropping Sequence on Soybean Cyst Nematode Reproductive Ability and Soybean Yield — *D.E. Hershman*

Effect of Reduced Tillage on Disease Development in Wheat — *D.E. Hershman*

Evaluation of Disease Management Strategies for Tobacco and Vegetables — *W.C. Nesmith*

Evaluation of Fungicides and Biocontrol Products for Control of Turfgrass Diseases — *P. Vincelli*

Evaluation of Landscape Austrian Pines for Pine Tip Blight Disease and Assessment of Management Strategies — *J.R. Hartman*

Forage Legume Viruses: Identification and Genetic Resistance for Improved Productivity — *S.A. Ghabrial*

Host-pathogen Interactions between *Castanea* sp. and the Chestnut Blight Fungus — *L. Shain*

Identification of Disease-resistant Cultivars of Turfgrasses and Corn — *P. Vincelli*

Integrated Management Program for Sclerotinia Crown and Stem Rot of Alfalfa — *P. Vincelli*

Interactions of Tobacco with the Biotrophic Fungus *Peronospora tabacina*: Potential for Enhanced Disease Resistance — *C.L. Schardl*

Management of Rhizosphere Dynamics to Control Soilborne Pathogens and Promote Plant Productivity — *J.W. Hendrix*

Molecular Basis of Disease in a Virus-infected Plant Pathogenic Fungus — *S.A. Ghabrial*

Mycorrhizal Fungi in Relation to Health and Vigor of English Boxwood — *J.W. Hendrix*

National Dogwood Anthracnose Survey — *J.R. Hartman*

Natural and Modified Grass Endophytes as Agents for Biological Protection — *C.L. Schardl*

Pest Predictive Technology for Apple Disease Management — *J.R. Hartman*

Plant-fungal Endophyte Interactions: Potential for Cultivar Improvement in Species of *Festuca* and *Lolium* — *M.R. Siegel*

Phylogenetics of *Epichloë* Species and Related Grass Mycosymbionts — *C.L. Schardl*

Potyvirus Replication and Pathogenicity — *J.G. Shaw*

Proteinaceous Inhibitors of *Cryphonectria parasitica* in Chestnut Bark — *L. Shain*

Role of Coat Protein and Helper Component in Aphid Transmission of Potyviruses — *T.P. Pirone*

Rotation of Resistance Genes to Maintain *Heterodera glycines* below the Damage Threshold — *D.E. Hershman*

Structure and Function of the Viral dsRNAs of the Plant Pathogenic Fungus *Helminthosporium victoriae* — *S.A. Ghabrial*

The Role of Specific Viral Genes and Gene Products in Potyviral Pathogenicity, Host Range, and Aphid Transmission — *J.G. Shaw and T.P. Pirone*

Transformation of Plant Pathogenic and Plant Mutualistic Fungi — *C.L. Schardl*

Transgenic Resistance to Bean Pod Mottle Virus and Soybean Mosaic Virus in Soybeans — *S.A. Ghabrial*

Urban Tree and Ornamental Plantings Disease Evaluations — *J.R. Hartman*

Viral Satellite RNAs as Riboregulators of Gene Expression in Tobacco — *S.A. Ghabrial*

Wheat Seed Treatment and Foliar Fungicide Screening — *D.E. Hershman*

Regulatory Services

The Division of Regulatory Services administers state laws pertaining to the manufacturing, processing, labeling, and marketing of commercial feed, fertilizer, seed, and raw milk. Its purpose is to protect farmers and other consumers from poor quality, mislabeled, or misrepresented products and to protect agricultural businesses from unfair competition from those who might take short cuts in the quality of their products.

Feed, fertilizer, and seed are monitored in the manufacturing or retail channels for reasonable and acceptable compliance with state laws through label review, product inspection, and sampling and analyzing of products. Raw milk is monitored during marketing to assure an accurate and equitable exchange between producers and processors and to ensure the integrity of milk from farm to processor.

Ten regulatory inspectors and one auditor travel throughout the state, collecting samples, inspecting facilities, and auditing records. Additionally, full-time, temporary inspectors check and sample specialty feed, fertilizer, and seed products throughout the state.

The Division also offers to growers and homeowners seed testing, soil testing, poultry litter and animal manure testing, and water and nutrient solution analyses for greenhouse production and float-bed systems of seedling production.

Auditing Program

H.S. Spencer

Audits of sales and fee payments were made on 267 of 688 milk, seed, feed, and fertilizer businesses in Kentucky to verify check-off and tonnage fees. Fees assessed to help pay the costs of inspecting, sampling, and analyzing commodities in accordance with Kentucky laws are: fertilizer, 50 cents per ton; feed, 35 cents per ton; and seed, 4 to 24 cents per unit. During May, raw milk is assessed a check-off fee of 3 cents per 100 pounds. Although the tobacco seedling law was repealed in 1996, some fees were collected for 1995 in 1996.

Income from fees in 1996:

Feed	$638,656
Fertilizer	616,340
Milk	55,045
Soil testing	149,353
Seed tags, testing, and licenses	357,141
Tobacco seedlings	22,151
TOTAL	**$1,838,686**

These cash receivables were substantiated on 2,688 fertilizer tonnage reports, 3,092 feed tonnage reports, 792 seed reports, and 18 milk reports. These reports were checked for accuracy and compared with field audits of the firms submitting them. An additional $3,000 was realized through auditing and correcting inaccurate reports.

Milk Regulatory Program

B.W. Cox

The milk regulatory program administers the Kentucky Creamery License Law, which establishes regulations for ensuring that dairy farmers are accurately paid for the milk they produce and that the integrity of milk is maintained from the farm to the processor. In 1996 the division:

- Reviewed and issued licenses to 13 milk buyers, 56 testers, 475 sampler-weighers, and 8 raw milk transfer stations.
- Analyzed and administered action on 9,000 official samples and checked 3,500 producer pay records.
- Conducted 64 inspections at 16 milk laboratories.
- Analyzed 1,000 exchange samples from commercial laboratories.
- Trained and examined 71 sampler-weighers and 11 testers.
- Conducted 500 inspections of 225 sampler-weighers.

Feed Regulatory Program

C.E. Miller

The feed regulatory program provides consumer protection for the purchasers of livestock feed and pet foods, maintains a marketplace environment that promotes fair and equitable competition for the feed industry, and helps ensure the safety and wholesomeness of animal products as human food. In 1996 the program:

- Administered actions on 4,434 official samples of commercial feed involving 26,126 official tests to monitor about 3 million tons of commercial mixed feed and feed ingredients distributed in Kentucky.
- Administered a cooperative program with the FDA on six feed mills that mix restricted drugs in feed. An additional 69 state inspections were conducted on mills that mix non-MFA drugs in feed to ensure compliance with medicated feed regulations. Thirty-one mills that mix no drugs were inspected to ensure compliance with labeling, manufacturing, and storage practices.

- Conducted 7,500 label reviews and maintained product registration for about 15,000 products from 900 companies.
- Cooperated with the Association of American Feed Control Officials in conducting the 32nd Annual Feed Management Seminar at Shakertown, Kentucky. Thirty-three professionals from 20 states, Canada, and the FDA attended.

Fertilizer Regulatory Program

D.L. Terry

The Kentucky Fertilizer Law ensures that fertilizers sold in Kentucky are clearly and accurately labeled so that consumers can make informed purchases of fertilizer and be assured of its quality. The law also protects the legitimate fertilizer industry from unfair competition. In 1996 the division:

- Administered actions on 4,606 official and 274 unofficial samples of fertilizer involving 13,277 tests of the 972,000 tons of fertilizer distributed in Kentucky.
- Reviewed labels and registered 3,995 products from 472 firms, including 240 who manufactured custom blends of fertilizers.

Inspection Program

F. Herald

The inspection program aims to achieve industry compliance with the consumer protection laws that the Division is charged with administering. This responsibility is carried out by inspectors strategically located throughout the state, each with an assigned area to cover. They inspect manufacturing plants, processing facilities, storage warehouses, and retail stores; collect official samples of feed, pet food, fertilizer, milk, and seed; review records; and offer advice and assistance to clientele in improving their operations to achieve compliance with the laws. In 1996:

- A team of nine inspectors performed 5,253 inspections of the processing, manufacturing, and marketing of feed, fertilizer, and seed. In addition, three temporary inspectors traveled throughout the state during March, April, and May to inspect and sample specialty feed, fertilizer, and seed products in urban areas, and one full-time permanent milk inspector covered the state to administer the Creamery License Law.
- Inspectors collected the following official samples for laboratory verification of appropriate constituents and quality:

Feed	4,434
Fertilizer	4,606
Seed	2,962
Milk	9,000

Seed Regulatory Program

D.T. Buckingham

The seed regulatory program assures Kentucky farmers of quality seed and promotes fair and equitable competition among seed dealers and seedsmen. In 1996 the program:

- Collected and tested 2,962 official seed samples.
- Issued stop-sale orders on 376 official seed samples and 192 violative seed lots at seed dealer and seed processor locations.
- Conducted a cooperative program with USDA, AMS on trueness-to-variety testing and on interstate shipments of seed.
- Issued 243 permits to label seed and registered 396 seed dealers.

Seed Testing Services

E.E. Fabrizius

The seed testing program provides the seed industry and seed growers of Kentucky with competent, reliable, and timely analyses of their seeds for labeling requirements and quality assurance. In 1996 the seed laboratory tested the following number of samples:

Official seed samples	2,962
Regular seed samples (service)	4,805
Certified seed samples (service)	428
Tobacco seed samples (service)	907
TOTAL	**9,102**

In addition to routine testing for purity, germination, and noxious weed seed, the laboratory offers testing for seed vigor (accelerated aging and cold test), seed moisture, seed size (seed count), and germination following fungicide application. The laboratory also provides tests for the presence of the fungal endophyte present in tall fescue seed and live plant tillers to seedsmen and livestock owners in the state.

Soil Testing Service

V.W. Case (Lexington)
D.L. Kirkland (UKREC, Princeton)

Soil testing provides farmers, homeowners, greenhouse operators, surface mine specialists, and others with scientific information about the fertility status of their soils. In partnership with the Cooperative Extension Service, it also provides them with lime and fertilizer recommendations based on soil tests. We also offer analyses of poultry litter and animal wastes for farmers and farm advisors, water and nutrient solution analyses for greenhouse operators and float-bed seedling producers, and non-routine, optional soil tests for University of Kentucky researchers.

Soil samples analyzed in 1996 were:

Agriculture	27,618
Home lawn and garden	6,200
Strip-mine reclamation	49
Commercial horticulture	627
Greenhouse	84
Research	8,567
TOTAL	**45,480**

The Lexington lab also analyzed 130 soil samples for triazine residue, 72 animal waste samples, and 187 water and nutrient solution samples for greenhouse and float-beds.

Robinson Substation

Research and demonstration trials at Quicksand are primarily conducted by the departments of Agronomy, Horticulture, and Plant Pathology. Agronomy research activities include livestock forage management, no-till corn production, tobacco nitrogen management, variety trials for corn, and the revegetation of surface-mined lands. Horticulture research consists of trials with fruit, vegetable, and ornamental cultivars for both commercial and home gardens and horticultural crop production on reclaimed surface-mined lands. Plant Pathology trials deal primarily with evaluating cultivar resistance in tobacco, peppers, and field corn.

Agronomy

Yield of corn from the long-term no-till plots continued to be good and were exceptionally high in 1996 due to the well-distributed 23 inches of rain received during the period from May to September. Nitrogen yield response in 1996 topped out at 218 bushels per acre with 160 lbs fertilizer nitrogen per acre. Average yield at 160 lbs nitrogen per acre over the 16 consecutive years of no-till corn production in this study is 169 bushels per acre. The range of grain yield for 160 lbs N/A over this time span has been 145 to 218 bushels per acre with yields of more than 170 bushels per acre in eight of the 16 years. Yields in 1996 showed little influence from three years of wheat cover crop as compared to not planting a wheat cover crop.

Soil test levels of phosphorus in the top three inches of soil have been built to and maintained at about 100 lbs per acre, but decrease to 20 to 30 lbs per acre in the 3- to 6-inch soil depth, and to below 20 in the 6- to 12- inch depth. This indicates that sustained high yields of corn can be obtained from surface applications of fertilizer phosphate on no-till fields without having to build up soil test phosphorus levels below the surface three inches of soil.

A study was initiated to evaluate the effectiveness of dormant herbicide applications compared to traditional foliar herbicides for control of kudzu. Kudzu is considered a noxious weed in many locations throughout eastern Kentucky. Dormant herbicide applications were applied in early April before new stem growth occurred for the season. Early evaluations in late May indicated that kudzu stem emergence was delayed when dicamba was applied as a dormant treatment. However, by late summer kudzu growth was equal to the untreated plots based on later evaluations. Best late-season control was obtained with dicamba and glyphosate applied as a foliar treatment in late May.

A 27-acre educational site is currently being developed on the Laurel Fork of the Robinson Forest to demonstrate the agricultural potential of reclaimed surface-mined land. Field trials addressing mined land revegetation for livestock forage production, wildlife habitat, and other herbaceous species/variety identification are available for evaluation and study. Production practices necessary for apple, blueberry, blackberry, and hydrangea production are also demonstrated at this site. In cooperation with Kentucky State University, utilization of irrigation ponds for rainbow trout and freshwater shrimp production is being monitored.

The Robinson Experiment Station serves as one of three primary testing sites for tall fescue, orchardgrass, and red clover varieties in Kentucky. This project is managed by the University of Kentucky Forage Variety Testing Program to assist forage producers in eastern Kentucky with the selection of forage species and varieties evaluated under more site-specific growing conditions, such as surface-mined lands.

The evaluation of pre-sidedress nitrogen tests on burley tobacco continued in 1996. The Robinson Experiment Station is one of several sites where this work has been conducted. Initial results indicated that a soil nitrate test just before sidedressing time had some value of predicting cured leaf yields. Further testing is being conducted to determine the feasibility of using the soil nitrate test to predict the need for additional sidedress nitrogen. The development of such a test could improve the efficiency of nitrogen use on burley tobacco.

In 1996 a demonstration float bed was constructed at the Robinson Experiment Station to promote new tobacco production technologies in eastern Kentucky. The float bed was used for both produce and agent training programs. Interest in float bed use has increased significantly in this region over the past two years.

Poultry litter is a source of plant nutrients, especially nitrogen (N), phosphorus (P), and potassium (K). With the growth of the poultry industry in Kentucky, more litter/waste has become available to grain producers. A field experiment was conducted to compare the availability of plant nutrients contained in litter to that of fertilizer sources in a no-till corn/soybean rotation.

The preliminary data suggest that poultry litter will provide considerable quantities of plant available P and K to the crop in the first year after application. Litter K appears to be fully available the first year, while only about 75% of the litter P is available in that season. To the extent that litter P and K were not removed by corn in the first season, they were available to the following soybean crop.

Horticulture

A summer annual flower cultivar evaluation was conducted as part of a statewide effort to determine which cultivars would develop well and produce attractive bloom and foliage for Kentucky's commercial and home landscapes. Forty annual flower cultivars were evaluated at Quicksand as part of this cooperative trial with Lexington and Princeton. This is the fourth year of annual testing at Quicksand, and several cultivars did well during a very wet year. Recommended annuals in 1996 include Dahlia "Calico Mix," Salvia, Impatiens "Blitz Salmon," Impatiens "Tempo White," Impatiens "Blitz Orange," Begonia "Varsity Rose," Begonia "Rio Scarlet," Celosia "Flamingo Feather," and Zinnia Linearis Orange.

The departments of Horticulture and Plant Pathology continued the field evaluation of 21 bell pepper cultivars with different levels of resistance to bacterial leaf spot (BLS). Nineteen cultivars with some BLS resistance and two susceptible check cultivars were screened against three races (BLS races 1, 2, 3) of the bacterial pathogen. A susceptible inoculated bell pepper cultivar (Merlin) was used as the inoculum source. Last year was an abnormally wet year, and conditions were very favorable for disease spread. Fruit of each pepper cultivar was evaluated not only for yield but for overall appearance. There were significant differences among the resistant bell pepper cultivars in yield, appearance, and BLS disease ratings. Cultivars with the highest marketable yields and quality were XPH 12205, Boynton Bell, and XR3 Aladdin. Other acceptable cultivars included PR 9300-8, Enterprise, and Commandant. Additional trials are planned for 1997.

Market demand for fall decorations resulted in an ornamental corn cultivar trial. Kentucky growers need attractive, highly marketable, large-eared (8-12 in.) cultivars. Nine large-eared ornamental corn cultivars were evaluated in 1996. One cultivar, Earth Shades Indian, produced large, primarily dark red ears that were very attractive and did not exhibit the lodging problems seen in other cultivars. Previously, Rainbow and Fiesta were recommended for commercial use. Cultivar trials in 1997 will evaluate three new hybrid large-eared ornamental corn cultivars in hopes of finding cultivars with bright colors, tight shucks, excellent tip fill, and resistance to lodging. Prior to 1997, all large-eared ornamental corn cultivars were open pollinated. Results from these trials have been used to help expand sales of Kentucky's fall ornamental crop acreage by providing a more diverse sales package.

A study involving fall cole crops as scavengers of residual fertilizer nitrogen was jointly conducted by Agronomy and Horticulture faculty to evaluate the use of fall cole crops (i.e., cabbage and/or broccoli) to recover residual fertilizer N following high-value summer annual cash crops. Summer crops, tobacco and sweet corn, were managed according to University of Kentucky recommendations and received a fertilizer N application of 300 lb N/A and 148 lb N/A, respectively. In 1996, immediately following the harvest of the summer annuals, broccoli, winter rye, and fallow treatments were established. Fertilizer N was applied to the broccoli at rates of 0, 50, 100, and 150 lb N/A. A broccoli yield response to 50 lb N/A was measured in 1996. A cabbage yield response to 50 lb N/A was measured in 1994, whereas no cabbage yield response to fertilizer N was measured in 1993 or 1995. Residual N following sweet corn and tobacco was slightly lower in 1996 and 1994 than in 1993 and 1995, indicating that a yield response to fertilizer N could be expected when residual soil NO_3-N levels fall below 20 ppm. Soil nitrate-N and plant total N uptake were also measured to determine the usefulness of broccoli (compared to winter rye and fallow) to recover residual N and minimize the potential for N loss to the environment. Fall broccoli or cabbage has been found to be as effective as rye in capturing nitrogen that would normally be lost due to leaching. Additional research in 1997 is planned using broccoli again as the fall nitrogen scavenger.

Work on field diagnostic tools for estimating nitrogen needs for fresh market tomatoes is another ongoing cooperative project between Agronomy and Horticulture. Hand-held Cardy meters were found to be effective for rapidly measuring fresh petiole sap nitrate nitrogen levels in fertigated fresh market tomatoes. The Cardy meter was also effective in determining soil nitrate - N levels prior to planting. Four nitrogen (N) fertigation rates were tested, including a 0 N/A rate. Results in 1996 showed that there was a significant US#1 tomato yield increase due to fertilizer nitrogen application, even when an initial soil mineral N test showed 70 lb N/A available for plant growth. 1996 was a very cool, wet year, and plant root growth may have been limited more than in previous years. Early season Cardy meter petiole sap NO_3-N levels temporarily dropped below levels considered optimum for tomato plant growth and yield. The 0 lb/A nitrogen treatment was the slowest to return to optimum levels, whereas the 225 lb/A N treatment was the fastest. Later in the season, petiole sap nitrate nitrogen readings were at adequate levels for all treatments. Previous trials have shown that many Kentucky soils contain high levels of plant available nitrogen prior to fertilization. However, under very cool, wet conditions, early season supplemental (extra) nitrogen may be needed to maintain optimum yields when soil tests indicate that adequate levels of mineral N are not available. Relating soil mineral nitrogen level to tomato N response will eventually enable growers to customize their fertilizer nitrogen applications to specific growing sites and weather conditions.

Work will continue in an effort to determine the correlation between weather, initial soil mineral nitrogen levels, and tomato crop nitrogen requirements. Preliminary petiole sap NO_3 data appears to be less variable and may be a better predictor of tomato yield response than soil tests. Additional tomato nitrogen fertility trials are planned for 1997.

Research Projects

Annual Flower Cultivar Evaluations — *S. Bale and R.T. Jones*

Bacterial Leaf Spot-resistant Bell Pepper Cultivar Evaluations — *B. Rowell, R.T. Jones, and W.C. Nesmith*

Determining Fertilizer Nitrogen Needs for Fresh Market Tomatoes — *R.T. Jones and D.C. Ditsch*

Establishing the Value of the Phosphorus and Potassium Contained in Poultry Litter for a No-till Corn and Soybean Rotation — *J.H. Grove*

Evaluation of Soil and Crop Diagnostic Tools to Improve Nitrogen Management for Burley Tobacco — *R.C. Pearce and D.C. Ditsch*

Fall Cole Crops as Scavengers of Residual Fertilizer Nitrogen — *D.C. Ditsch, R.T. Jones, and R.C. Pearce*

Floral Hydrangea Cultivar Evaluation — *R.T. Jones, S. Bale, and R. McNiel*

High Bush Blueberry Cultivar Evaluation — *R.T. Jones, J. Strang, and J. Brown*

Kudzu Control Study — *J.D. Green and D.C. Ditsch*

Ornamental Corn Cultivar Evaluations — *R.T. Jones and Mary Witt*

Response of No-till Corn to Carryover Soil N Recovered by a Winter Wheat Cover Crop — *K.L. Wells, D.C. Ditsch, and W.O. Thom*

Tall Fescue Adaptability as Affected by Endophyte Fungus Infection — *T.D. Phillips, D.C. Ditsch, L.M. Lauriault, M. Collins, and J.C. Henning*

Tall Fescue, Orchardgrass and Red Clover Variety Trials — *L.M. Lauriault, J.C. Henning, and D.C. Ditsch*

Rural Sociology

The Rural Sociology research program is designed to advance the development and understanding of social structure and social processes in the changing rural society. Through an integrated program of research, extension programs, and instruction, the faculty focus on initiatives which are organized around two major areas: sociology of agriculture and community and human resource development. Within each major area, several substantive areas of specialized activity exist.

Community and Human Resource Development

Social and Economic Factors Affecting Family Well-Being. Rural society's prospects for growth and development ultimately rest with the capacities of people. Human resources refer to the skills, abilities, and understanding required for people to function effectively in families, the workplace, organizations, and communities. Specific areas of study are rural health, youth, family dynamics and functioning, leadership development, aging, and the role of service agencies in human resource development.

Findings from a study of women's home-based work indicate that home-based businesses are often a hidden segment of a local economy. The impacts of home-based businesses on the local economy depend on the characteristics of the rural women operating these businesses, the types of economic activities themselves, and the personal and family consequences of operating the businesses.

Faculty continue working with the Kentucky Kids Count Consortium to produce an annual data book highlighting various indicators of the demographic and socioeconomic status of Kentucky's children and families. Ninety-seven focus groups of families and service care providers have determined social and economic factors influencing family well-being which will be used to guide Kentucky's state plan for family preservation and family support services. The evaluation of extension programs with youth at risk, exploring school and family factors that influence educational achievement and the ability of communities to retain youth, has been conducted.

Other research results on factors affecting family well-being have had important impacts in Kentucky. Faculty have presented results through commissions and publications on the status of families and the state and local social service structures that affect families. These results have been used for legislative recommendations by the Kentucky State Legislative Research Commission on Poverty and for developing social service plans by the Kentucky Cabinet for Human Resources, Department of Social Services.

Community Resource and Rural Development. Communities are the settings in which people interact with the larger society to provide basic human services, employment, and solutions for local problems. Within the sphere of rural development policy, the local community is the context for initiation of economic and social development. Research findings have led to policy proposals based on the concept that programs can gain local legitimacy by sharing policy authority with local citizens. Local rural development efforts would be led by local boards which involve a broad base of local citizens but with federal funding to facilitate implementation of local plans.

Sociology of Agriculture

Trends in Agriculture. As an example of research regarding changing agriculture, findings show that Kentucky's dairy industry is confronting both a changing marketplace and changing conditions of production. Research results have been used to determine educational needs of these farmers for planning and adapting their operations to meet future conditions.

Kentucky is part of a regional study designed to assess how an increasingly globalized agro-food system impacts commodity producers in the region and the state. Changes in commodity programs will be examined as a result of increasing globalization of agricultural markets, as well as how domestic fiscal concerns may impact farm enterprise structure and rural community well-being in rural regions of the South and of Kentucky.

Other research programs are examining the impacts of changes in the international trade system on the structure of agriculture and rural communities, impacts upon Kentucky rural communities from changes in the federal tobacco program and potential decreases in income from tobacco farming, and post-productionist agricultural sector adjustment strategies that emphasize the production of "social goods," such as environmental amenities and landscape preservation, in lieu of traditional commodity production objectives.

Intergenerational Changes in Farm Family Perspectives of the Environment. Environmental and natural resource issues are critical components of rural development policy. Program focus is on natural resource utilization and economic development, impacts of natural resource production, and relationships among environmental factors and quality of life. Findings have led to the development of a conceptual framework of how cultural groups transform the nonhuman environment symbolically and thereby mesh the social, cultural, and nonhuman environments into structures of symbols and beliefs that are shared among members of the group.

Research Projects

Customer Service Initiative of Kentucky Cabinet of Natural Resources and Environmental Protection — *T. Greider*

Family Preservation and Family Support Services Evaluation and Technical Assistance — *P. Dyk and L. Garkovich*

Forest Fire in Eastern Kentucky: How the Role of Fire in the Ecosystem Is Perceived and Controlled — *L. Garkovich*

Harlan Youth Employability Program Evaluation — *P. Dyk*

Home-based Work: The Relationship of Informal Employment to Health among Mid-life and Older Rural Women — *L. Garkovich*

Impacts of Structural Change in the Dairy Industry — *L. Garkovich*

Intergenerational Changes in Farm Family Perspectives on the Environment — *T. Greider*

Kentucky Kids Count — *L. Garkovich and G. Hansen*

Ohio River Valley Development — *L. Swanson*

Reexamining East Asian Land Reform: Class and Culture in Action — *L. Burmeister*

Rural Communities Initiative of the Rural Policy Research Institute — *L. Swanson*

Rural Restructuring: Causes and Consequences of Globalized Agricultural and Natural Resource Systems — *L. Burmeister*

Service Sector Penetration and Household Earning Processes: A Comparative Study of Rural Communities — *R. Harris*

Social and Economic Factors Affecting the Well-being of Kentucky Rural Families — *P. Dyk, R. Harris, L. Garkovich, and G. Hansen*

Social Capital Attributes of Families, Schools, and Communities — *P. Dyk*

Veterinary Science

Maintenance of the health and promotion of the welfare of Kentucky's animal industry continue to be primary concerns of the Department of Veterinary Science. The department's three functional units, the Livestock Disease Diagnostic Center, Maxwell H. Gluck Equine Research Center, and the Equine Blood Typing and Research Laboratory, help support the needs of the state's livestock, horse and companion animal industries through a comprehensive range of nationally and internationally recognized diagnostic, extension, and research programs. Publication of the *Equine Disease Quarterly* continues with the January 1997 issue distributed to 11,400 individuals in 70 countries. In the second year since its inception, six foreign students participated in the Kentucky International Thoroughbred Institute (KITI) program, an equine training program for international students which provides hands-on experience and education in farm and racetrack management.

Maxwell H. Gluck Equine Research Center

The Gluck Center continues to consolidate its reputation, both nationally and internationally, for the quality and success of its programs in selected fields of equine research. Infectious diseases, immunogenetics, immunoparasitology, pharmacology, and reproductive physiology remain the areas of primary research emphasis of the program.

Immunogenetics—A gene map of the horse is being constructed in collaboration with various other laboratories both in the U.S. and throughout the world. The major emphasis is on identifying genetic markers to place on the map and mapping genes to specific chromosomes. In the past year, the gene for combined immunodeficiency disease in Arabian horses was located on horse chromosome 9, thereby confirming identification of a candidate gene for the disease. Other ongoing studies are focused on characterization of the major histocompatibility gene family which controls the immune response to certain infectious and noninfectious diseases.

Infectious Diseases—Infectious diseases remains an area of critical significance for both breeding and racing industries not only nationally, but also with respect to the international movement of horses, semen, or equine embryos.

As in the last few years, research on equine herpesvirus 1 has focused on better defining the immune correlates of protection in the horse to this economically important viral infection. In a collaborative study with the Animal Health Trust, Newmarket, in the United Kingdom, virus-specific cytotoxic T-lymphocytes are being investigated for their role in protecting against abortion caused by the virus. This work will improve our understanding of how to achieve more effective protection against this ubiquitous virus in the horse.

Several significant accomplishments have emerged from the research program on equine influenza. Certainly, the most notable has been the finding that strains of equine-2 virus in the eastern and western hemispheres have evolved independently of one another with some evidence of cross-over. This has led directly to the international adoption of new recommendations for appropriate virus strains representative of each lineage to be included in updated equine influenza vaccines. In collaboration with the equine pharmacology program, the pharmacokinetics of the anti-influenza virus drug, rimantadine, have been established for the horse, and a dosing protocol has been determined which can ameliorate the clinical signs of influenza in horses.

The equine lentivirus that causes equine infectious anemia is an important cause of morbidity and mortality in equids worldwide. Research on equine infectious anemia virus has important implications for equids, and as a model for HIV infection in humans. Our attempts to define the determinants of virulence in this disease have been aided by the generation of an infectious pathogenic clone of the virus through site-directed mutagenesis. Recent research on developing a vaccine to protect equids against infection with equine infectious anemia virus would suggest that multiple viral determinants may be necessary for stimulating sterile immunity against this disease.

Ongoing collaborative studies with the University of California-Davis have helped to better define the location and nature of the neutralization determinants on the genome of equine arteritis virus. In conjunction with researchers at the Animal Diseases Research Institute, Lethbridge, Canada, the RT-PCR assay has been validated for use as a diagnostic test for detection of the carrier state in the stallion. Studies of natural outbreaks of EVA have furthered our understanding of the pathogenicity of semen isolates of EAV in terms of abortion in mares and illness and loss in neonatal foals.

The equine rotavirus vaccine, which received a conditional USDA license permitting its use in the state of Kentucky at the beginning of 1996, is now licensed for use in other states.

Mapping of the protective M protein (SeM) of *Streptococcus equi* has revealed numerous epitopes reactive with equine serum and mucosal antibodies on the N terminal half of the molecule. Great variability in specific epitope responses has been observed among individual horses. During convalescence from *S. equi* infection, the dominant serum antibody response to SeM is IgGb. Strong mucosal IgA and IgGb responses also occur. Commercial vaccines against strangles have been shown to elicit specific serum IgGb responses but

not a mucosal IgA response. A PCR-based technique has been developed and validated for the rapid detection of *S. equi* in nasal swabs from infected horses.

Six proteins of Leptospira kennewicki immunoreactive for the horse have been partially characterized. One of these proteins, Lk90, isolated from the surface of *L. kennewicki* has been sequenced and expressed in *E. coli*.

Parasitology—A major health problem in yearlings with associated mortality was shown to be related to larval stages of small strongyles encysted in the large intestinal lining. Transmission patterns for natural infections with endoparasites were determined in lambs born on a farm in Kentucky in 1993 and 1994; *Haemonchus contortus* was the predominant species incriminated in both years.

Equine protozoal myeloencephalitis (EPM) was reproduced in normal horses by oral dosage with *Sarcocystis* sp. sporocysts from feral opossums. The experimentally infected horses developed *S. neurona*-specific antibodies in serum and cerebrospinal fluid which were detected by immunoblot analysis. Microscopic lesions consistent with EPM were observed in the CNS of experimentally infected horses. Aliquots of the sporocyst stock administered to horses produced sarcocystosis when fed to budgerigars and sparrows. This suggests that *S. neurona,* the etiologic agent of EPM, may be *S. falcatula* or a closely related *Sarcocystis* sp.

Pharmacology and Experimental Therapeutics—The Testing Integrity Program was brought on-line nationally in 1996, and a Testing Proficiency Program based on this initiative is under current development. The development of analytical tests for specific drugs or their metabolites has been assisted greatly by the acquisition of a Micromass Quattro-LC-Mg Mass Spectrophotometer. The Critical Metabolite Synthesis program has synthesized about fifteen important equine metabolites. The sample collection phase of the Musculoskeletal Injury Project in Kentucky was completed during this past year. In the area of new therapeutic approaches to diseases in the equine, we completed a project on endotoxic shock and are in the final stages of completing a research study on the potential value of amantadine and rimantadine for the treatment of equine influenza. A new therapeutic approach to equine protozoal myeloencephalitis was initiated in late 1996 which, hopefully, will provide a more effective, safer, and cheaper means of treating this economically important disease.

Reproductive Physiology—Considerable progress has been made in furthering our understanding of how the oviduct, uterus, and embryo communicate with each other biochemically to ensure a successful pregnancy in the mare. Work on differential gene expression and molecular cloning of gene products from embryonic tissues continues to advance our knowledge of how pregnancy is established and maintained in horses.

Research on the neuroendocrinological control of seasonal breeding in mares has revealed that the environmental cues which normally lead to cessation of the breeding season, though recognized by all mares, may be translated incorrectly in a small proportion of animals, resulting in continuation of breeding activity throughout the year. The possibility that a metabolic cue by way of energy availability may play a pivotal role in this phenomenon is currently under investigation.

Livestock Disease Diagnostic Center

The Livestock Disease Diagnostic Center is a full-service laboratory providing a comprehensive range of diagnostic services in support of the livestock producers and veterinarians of Kentucky. An extension program for large ruminants, both beef and dairy cattle, was reinstituted in early 1996. The following laboratory sections operate both independently and in support of the pathology program: virology, toxicology, serology/immunology, bacteriology, and clinical pathology. The number of pathology accessions increased by approximately 6% over that for the previous year. There were 67,498 diagnostic case submissions that included a total of 5,278 animals necropsied, making it one of the most heavily used veterinary medical diagnostic laboratories in the country.

During 1996, the Virology Section performed 10,121 tests to detect virus infections in a wide range of species together with 62,922 serologic tests to detect antibodies to various viruses. The different testing programs support diagnostic efforts to detect various infectious diseases, as well as regulatory and vaccine monitoring programs for the livestock and poultry producers of Kentucky.

Equine Blood Typing and Research Laboratory

A record number of blood samples (34,727) were tested for a record number of breed registries (30) by the Equine Blood Typing and Research Laboratory in 1996. Collaboration in the development of a gene map of the horse has been and will continue to be an area of major research focus of this program. Studies are in progress to detect genetic markers for disease traits of economic significance in certain species, e.g., *Epitheliogenesis imperfecta* in certain horse breeds, and juvenile cataracts in the Boston Terrier breed. Population genetic studies of the maintenance and significance of genetic variation in domestic and feral horse populations are continuing. A collaborative effort to develop a genetic map for the alpaca was initiated with researchers in Chile in 1996.

Research Projects

A Study of the Prevalence and Distribution of Leptospirosis in the Horse Population in Central Kentucky and of the Significance of *Leptospira* as a Cause of Abortion in Mares and a Study to Determine Whether Certain Wildlife Species Can Serve as Long-term Reservoirs of the Organism on the Affected Farms —*K.B. Poonacha*

Amantadine/rimantadine Prophylaxis of Equine Influenza — *T. Tobin*

Analytical Methods Development — *T. Tobin*

Application of New Technology for the Diagnosis of Equine Infectious Anemia — *C. Issel*

Cell Culture Models for Analysis of Equine Influenza Viral (Host Discrimination) — *T.M. Chambers*

Chemotherapeutic Control and Prevalence of Natural Infections of

Internal Parasites of Equids — *E.T. Lyons*
Control and Transmission of Internal Parasites of Ruminants — *E.T. Lyons*
Critical Metabolite Synthesis — *T. Tobin*
Determining the Importance of Coronavirus in Respiratory Infections of Cattle — *M.L. Vickers*
Development of a Rapid Screening Test for EVA Antibodies — *M.L. Vickers*
Diagnostics for Equine Infectious Anemia — *C. Issel*
Differential Gene Expression During Early Equine Conceptus Development — *K.J. McDowell*
EIAV Vaccine Development — *C. Issel*
Epitope (B Cell, T Cell) Map of the Protective M Protein (SeM) of *Streptococcus Equi* — *J.F. Timoney*
Equine Protozoal Myeloencephalitis: Development of an Antemortem Diagnostic Probe and Epizootiologic Analysis — *D.E. Granstrom*
Equine Protozoal Myeloencephalitis: Isolation and Characterization of the Etiological Agent — *D.E. Granstrom*
Equine Protozoal Myeloencephalitis: Prevention and Control — *D.E. Granstrom*
Equine Respiratory Tract Mucosal Antibody Production in Response to Influenza Infection or Vaccination — *T.M. Chambers*
Functional Characterization of Immunogenic Proteins of *Leptospira Kennewicki* — *J.F. Timoney*
Gene Map of the Horse — *E. Bailey*
Genetic and Mechanistic Analysis of the Equine MX Antiviral Gene — *T.M. Chambers*
Genetic Basis of *Epitheliogenesis Imperfecta* in Saddlebred Horses — *E.G. Cothran*
Genetic Basis of Juvenile Cataracts in the Boston Terrier — *K.A. Graves*
Genetic Management of Feral Horse Populations on Public Lands — *E.G. Cothran*
Genetic Variation and Genetic Relationships of Populations of Domestic Horses — *E.G. Cothran*
Gonadotropin-releasing Hormone in Mares: Development of Methods for Measurement and Factors Affecting Secretion During Anestrus — *B.P. Fitzgerald*
Hemagglutinin Antigen of Equine-2 Influenza Virus: Surveillance and Molecular Characterization of Isolated Virus Strains — *T.M. Chambers*
How Conceptus Proteins Influence of Prostaglandin F2α in Mare Endometrium — *K.J. McDowell*
Identification of the Equine Herpesvirus-1 Proteins and Their Respective Subregions that Elicit Cytotoxic T-lymphocyte Immune Responses in the Horse — *G.P. Allen*
Immunologic Management of Lentivirus Infections: EIAV — *C. Issel*
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Ph.D. Dissertations

(Unpublished)

Agricultural Economics

Griffin, Peter W. Investigating the conflict in agricultural policy between the Federal Crop Insurance and Disaster Assistance Programs and the Conservation Reserve Program.

Ngarambe, Octavien. Income inequality vs. economic growth in United States: Examining causal relations.

Agronomy

Fellers, John P. Potyvirus Nia-Proteinase derived resistance: Evaluation of resistance and Nia interaction with the potyvirus polymerase.

Iin, Handayani. Soil carbon and nitrogen pools and transformations after 25 years of no tillage and conventional tillage.

Prawito, Priyono. Pedogenesis on Karst toposequences of Kentucky.

Ren, Q. Breeding soybean for double-cropping: Soybean mosaic virus resistance and pubescence density effects.

Xu, Dongmei. Genetic engineering strategies for virus resistance: Coat protein mediated resistance in tobacco (*Nicotiana tabacum* L.).

Animal Sciences

Bauer, Marc. Nutritional regulation of small intestinal glucose absorption in ruminants.

Besong, Samuel. Influence of supplemental chromium picolinate on the concentrations of hepatic triglyceride and blood metabolites in dairy cattle.

Girard, Ivan. Characterization of stimulatory activities from *Saccharomyces cerevisiae* on the growth and activities of ruminal bacteria.

Simeone, Ann-Marie. Ammoniation as a detoxification procedure for endophyte-infected tall fescue.

Spring, Peter. Effects of mannanoligosaccharide of different cecal parameters and on cecal concentrations of enteric pathogens in poultry. (Joint degree program with Swiss Federal Institute of Technology, Zurich).

Biosystems and Agricultural Engineering

Chao, Kuanglin. Economic optimization of single stem rose production.

Malone, Robert. Field assessment and modeling surface and subsurface metribuzin transport under three treatments: Yard waste compost amendments, no-till and conventional-till.

Entomology

Beavers, G.M. Utilization of low altitude remote sensing imagery to detect larval habitats of tire-breeding mosquitoes.

Cui, L. Functional studies of the cysteine-rich gene family of the Campoletis sonorensis (Hymenoptera: Ichneumonidae) polydnavirus.

Williamson, R.C. Behavior and ecology of the black cutworm in golf course turf.

Horticulture and Landscape Architecture

Distabanjong, Karsedis. Developing a genetic transformation system in Eastern redbud.

Plant Pathology

Chung, Kuang-Ren. Genetics of the grass symbiont, *Epichloe typhina* (Pers.: Fr.) Tul.

Huang, Shaohua. Organization and expression of the dsRNA genome of a dsRNA totivirus infecting the plant pathogenic fungus *Helminthosporium victoriae.*

Xie, Chengsong. Comparison of tobacco mosaic virus (TMV) and sodium salicylate as inducers of defense compounds and resistance to TMV and *Peronospora tabacina* in tobacco.

Veterinary Science

Mitchell, Eddie E. Addressing the regio- and stereo-selectivity seen in P4502A5 mutants with DHEA.

Fenger, Clara K. Application of the small subunit ribosomal RNA gene sequence of *sarcocystis neurona* toward delineation of a definitive host and serologic studies.

M.S. Theses

(Unpublished)

Agricultural Economics

Cao, Wuhong Cathy. Cigarette consumption and the impact of health trend in East Asia.

Huffman, Dana M. An evaluation of the effects of the Community Reinvestment Act and other bank characteristics on levels of economic development in Kentucky.

Widanski, Adam S. An investigation into the export competitiveness of Polish fruits and vegetables: 1989-1994.

Agronomy

McMurry, Stephen W. Infiltration of fecal bacteria through intact soil profiles.

Montgomery, Elizabeth D. Herbicide and nitrate behavior in a shallow limestone aquifer.

Ralston, Jennifer Lambert. Movement of herbicides in shallow ground water in no-till double-cropped soybean.

Saha, Hemedi M. The influence of corn planting date, cover crop, and fertilizer N rate on the N nutrition of corn (*Zea mays L.*)

Seither, Craig A. Characterization of epoxy fatty acid synthesis in *Vernonia galamensis* and isolation of candidate cDNA clones.

Yan, Xianghe. Studies of signal sequences for cell-wall targeting in plants, and wall-targeting of a glutamine binding protein to effect cadmium tissue partitioning.

Animal Sciences

Burchett, Stephen. Effect of altering starch cook and resistant starch content of extruded food products on nutrient digestibility in the dog.

Clarke, S.M. Interaction between calf sex and calf genetic type for preweaning traits of calves varying in percentage Brahman breeding.

Lu, Mei. Influence of heat stress and calving on antioxidant activity in bovine blood.

Reverte, Daniel. Physiochemical and sensory properties of grass- and grain-fed beef treated with antioxidant and flavor agents.

Silvio, Jennifer. Influence of fiber fermentability on nutrient digestion in the dog.

Biosystems and Agricultural Engineering

Tarhan, Sefa. Evaluation of straw properties for biomass gasification.

Entomology

Anderson, A.C. Influence of soybean canopy closure on generalist predator abundance and predation of corn earworm eggs.

Yu, Z. Autodissemination of a baculovirus for suppression of beet armyworm, *Spodoptera exigua* Hübner (Lepidoptera: Noctuidae).

Plant Pathology

Smigell, Christopher. Development of a polymerase chain reaction-based assay for the detection of *Peronospora tabacina* in tobacco transplants.

Veterinary Science

McManus, Christina J. Influence of glucose deprivation on the secretion of gonadotropins and prolactin in the mare.

Statewide Research

Research activities of the Kentucky Agricultural Experiment Station were conducted at Lexington, Princeton, Quicksand, and Owenton, and in counties throughout the state in 1996.

Efforts are constantly made to ensure that the research studies have application to the problems of all Kentucky farmers and other clientele groups. Locations of the experimental facilities provide conditions representative of most sections of the state.

Campus — Laboratories and specialized equipment for all research program areas.

Coldstream — Maine Chance — Spindletop Farms — Beef and dairy cattle, poultry, horses, sheep and swine, forages and grain crops, tobacco and turf.

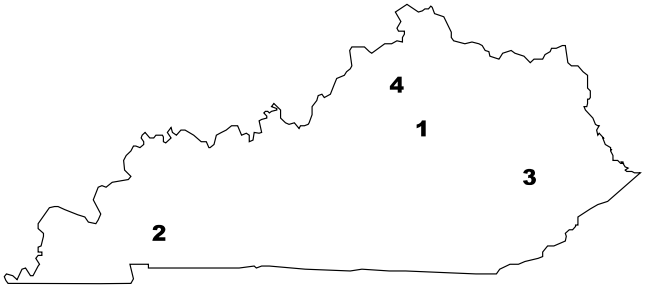
South Farm — Fruits and vegetables, ornamentals.

UK Animal Research Center *(Woodford County)* — This farm was purchased in late 1991 as a location for development of state-of-the-art food animal research programs. The farm is in the initial phase of development as a research facility.

At Princeton *(Caldwell County)* the **Research and Education Center** facilities and the **West Kentucky Substation Farm** are devoted to research on grain crops, beef cattle, swine, fruits and vegetables, forages, and tobacco.

At Quicksand *(Breathitt County)* the **Robinson Substation** is the location of research on fruits and vegetables, ornamentals, forages, grain crops, tobacco, and wood utilization. Quicksand is also the headquarters of **Robinson Forest**, which spreads over parts of Breathitt, Perry, and Knott counties and is the site of forestry and watershed management research.

The **Eden Shale Farm**, located in Owen County near Owenton, is where experimental and demonstration studies are conducted on forage crops, tobacco, and beef management.



1 University of Kentucky, Lexington
2 Research and Education Center and West Kentucky Substation Farm, Princeton
3 Robinson Substation and Forest, Quicksand
4 Eden Shale Farm, Owenton

Financial Statement

Statement of Current General Fund
Income and Expenditures
Fiscal Year 1996

Income

Federal Funds:	
Hatch Amended	$ 3,700,984.00
Regional Research	776,071.00
McIntire-Stennis	392,434.00
Animal Health	80,701.00
Total Federal Funds	**$4,950,190.00**
Non-Federal Funds	**21,755,039.46**
Total Funds	**$26,705,229.46**

Expenditures

	Federal	Non-Federal	Total
Personal Services	$4,176,223.74	$13,838,894.07	$18,015,117.81
Travel	106,963.34	103,856.72	210,820.06
Equipment	140,197.06	565,070.00	705,267.06
Other Operating Expenses	526,805.86	7,247,218.67	7,774,024.53
Total Expenditures	**$4,950,190.00**	**$21,755,039.46**	**$26,705,229.46**

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