

*The Kentucky
Agricultural Experiment Station*

110th

Annual Report
1997

U.K.

College of Agriculture
University of Kentucky • Lexington, Kentucky 40546

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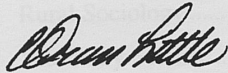
College of Agriculture
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Contents

To His Excellency,
The Honorable Paul Patton
Governor of Kentucky

I herewith submit the one hundred and tenth annual report of the Kentucky Agricultural Experiment Station for the period ending December 31, 1997. 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, 1998

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, 1927. 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 the Kentucky State Legislature, approved February 10, 1888, accepting the provisions of the act of Congress.

Very respectfully,

C. Carlisle Dutton,
Experiment Station,
June 30, 1928

Contents

Purpose	7
Agricultural Economics	9
Agronomy	11
Animal Sciences	14
Biosystems and Agricultural Engineering	16
Entomology	18
Forestry	20
Horticulture and Landscape Architecture	22
Nutrition and Food Science	25
Plant Pathology	27
Regulatory Services	30
Robinson Substation	33
Rural Sociology	36
Veterinary Science	38
Publications	41
Statewide Research	54
Financial Statement	55
Staff	56

Contents

Purpose	1
Agricultural Economics	2
Agronomy	11
Animal Sciences	14
Bioystems and Agricultural Engineering	16
Entomology	18
Forestry	20
Horticulture and Landscape Architecture	22
Nutrition and Food Science	23
Plant Pathology	25
Regulatory Services	30
Robinson Institution	33
Rural Sociology	36
Veterinary Science	38
Publications	41
Statwide Research	54
Financial Statement	55
Staff	56

Agricultural Economics 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 1997. 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.

The research reviewed the means of various insurance offerings. Kentucky and other southern states have had poor experience with traditional federal crop insurance. Growers should be aware that there are many new alternatives emerging from a variety of sources. Some of these alternatives may prove useful for Kentucky growers.

Risk sharing alternatives that can improve the efficiency of the farm and food system continue to be investigated. Among the alternatives considered is the use of insurance to share food safety risks in the meat-processing system. The work suggests that such alternatives could improve information systems about pathogens in the food system. Another alternative is to consider how growers manage input use to compensate for weather risks. Some growers apply extra fertilizer and other chemicals to compensate for weather risks. Is it possible to compensate for these weather risks with market mechanisms? This could lead to environmental improvements and enhance farm revenues.

Enhancing Farm Profitability and Management Efficiency

The department conducted a thorough review of the Kentucky Farm Business Management (KFBM) Program in 1997. A team of faculty and KFBM farmers visited each area of the state and discussed the current state of services to the membership and area farm management education. As a result of this review, the department and the governing board of KFBM are instituting several changes to upgrade its services to the 500 farmer cooperatives in order to improve farm management and financial performance. New computer software is being adopted to enhance the tracking of on-farm produc-

tion and processing activities. This will help farmers track the farm's production and improvement opportunities for workers. A study covering more than 100 U.S. counties identified specific policies that can be used to local growth plans to assist food processing. Separate analyses are carried out for meat, dairy, fruit and vegetables, grain and bakery, confectionery, fats and oils, beverages, and miscellaneous food product industries.

Results show that the presence of a processor in a given county is a county significantly reduces the ability of that county to attract another processor in the same industry, all else equal. Counties with smaller populations tend to have an advantage in attracting meat, dairy, fruits and vegetables, confectionery, and fats and oils processors in spite of a lack in the case of grain, oil, bakery, and miscellaneous food and manufacturers. The effect of other variables, including transportation infrastructure, workforce characteristics, and local taxes, on the location of food manufacturing firms is also examined in this study.

2. Entrepreneurship

One of the main research foci of TVA Rural Studies is research for ways to expand rural business opportunities. A strategy that has been advanced by many is trying to foster higher levels of rural entrepreneurship. This is seen as an alternative to traditional recruitment approaches in places where recruitment has not worked or where previously recruited firms are now leaving. A focus on entrepreneurship is also consistent with the widely held belief that small business is the main engine for economic growth in all economies. Two regions from elsewhere looked at the potential for increased entrepreneurship within two distinct subpopulations of the rural South—African-Americans and Appalachians, two groups that have historically had low rates of entrepre-

Purpose

Although much Department Station research has been directed 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 many key areas of research applicable to agriculture.

The Annual Report summarizes Department Station research highlights for 1997. 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.

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The Kentucky Agricultural Experiment Station has provided research results to farmers for more than 100 years. The continued growth of Kentucky's agriculture stems from 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 environmental, international trade, food processing, nutrition, community development, soil and water resources, and the environment.

Agricultural Economics

Research in Agricultural Economics involves diverse subjects including improving profitability, risk management, the impact of tobacco production, value-added and welfare reform, and entrepreneurship.

Risk Management Research

Risk management alternatives offered to crop farmers continue to undergo significant change. New revenue insurance is being offered in Kentucky. This product is the Crop Revenue Coverage. The product pays for low revenues when either price or yield causes gross revenues to be below a selected level (up to 75 percent of average revenue). It also allows farmers who have yield shortfalls to replace those shortfalls with a higher market price between the sign-up and harvest increase. This option will allow growers to be more aggressive in marketing before they know their yields.

This research reviewed the merits of revenue insurance offerings. Kentucky and other southeastern states have had poor experience with traditional federal crop insurance. Growers should be aware that there are many new alternatives emerging from a variety of sources. Some of these alternatives may prove useful for Kentucky growers.

Risk-sharing alternatives that can improve the efficiency of the farm and food system continue to be investigated. Among the alternatives considered is the use of insurance to share food-safety risks in the beef-processing system. This work suggests that such alternatives could improve information systems about pathogens in the food system. Another alternative is to consider how growers manage input use to compensate for weather risks. Since growers apply extra fertilizer and other chemicals to compensate for weather risks, is it possible to compensate for these weather risks using market mechanisms? This could lead to environmental improvements and enhance farm revenues.

Enhancing Farm Profitability and Management Efficiency

The department conducted a thorough review of the Kentucky Farm Business Management (KFBM) Program in 1997. A team of faculty and KFBM farmers visited each area office and discussed the current state of services to the membership and area farm management education. As a result of this review, the department and the governing board of KFBM are instituting several changes to upgrade its services to the 500 farmer-cooperators in order to improve farm management and financial performance. New computer software is being adopted to enhance the tracking of on-farm produc-

tion and financial data while also improving research capability. KFBM will begin training on this software in May 1998. In addition, new area farm management extension education efforts are being outlined to improve education with non-KFBM members in central and western Kentucky. And a new schedule for reports and analysis of farm profitability is being prepared to enhance the timeliness of KFBM information to the farmers and agribusinesses across the state. These changes will enhance the farm profitability and management efficiency for Kentucky farms.

Economic Development

A. Value-added Activities

State and local governments frequently look to value-added food processing activities to provide both local markets for farmers' products and employment opportunities for workers. A study covering more than 3,000 U.S. counties identified specific policies that can be used by local governments to attract food processors. Separate analyses are carried out for meat, dairy, fruits and vegetables, grain mill, bakery, confectionary, fats and oils, beverages, and miscellaneous food products industries.

Results show that the presence of a processor in a given industry in a county significantly reduces the ability of that county to attract another processor in the state industry, all else equal. Counties with smaller populations tend to have an advantage in attracting meat, dairy, fruits and vegetables, confectionary, and fats and oils processors, and a disadvantage in the case of grain mill, bakery, and miscellaneous products manufacturers. The effect of other variables, including transportation infrastructure, workforce characteristics, and local taxes, on the location of food manufacturing firms is also examined in this study.

B. Entrepreneurship

One of the main research themes of TVA Rural Studies is a search for ways to expand rural business opportunities. A strategy that has been advanced by many is trying to foster higher levels of rural entrepreneurship. This is seen as an alternative to traditional recruitment approaches in places where recruitment has not worked or where previously recruited firms are now leaving. A focus on entrepreneurship is also consistent with the widely held belief that small business is the main engine for economic growth in our economy. Two reports from contractors looked at the potential for increased entrepreneurship within two distinct subpopulations of the rural South—African-Americans and Appalachians, two groups that have historically had low rates of entrepre-

neurial activity. We were interested in identifying factors that could lead to a greater interest in starting small businesses.

In both studies the lack of role models was an important factor, as were more typical factors, including access to finance and support services like legal, management, marketing, and accounting support. Most importantly, in both studies small business owners were surveyed, and a significant factor, in most cases, was prior experience working for another company in a similar line of business. This was a common way for entrepreneurs to gain the skills and contacts to prepare them for running their own firm. One significant conclusion is that it may be necessary to encourage young people to initially leave a community to gain experience and then return with both the financial and human capital to start their own firm for entrepreneurship to be a successful rural development strategy.

Tobacco Production Impact

The 25 largest tobacco-producing counties in Kentucky were analyzed to gauge the economic contribution of tobacco production and processing and overall agricultural production to local economies. Accounting for direct, indirect, and

induced effects, tobacco accounted for more than 10 percent of total personal income for 10 of these counties, while accounting for more than 10 percent of the employment for 16 of these counties. Structural variables, including the number of farms, number of farms growing tobacco, and the average tobacco production size per farm, were also evaluated over time. The census data revealed that while consolidation of tobacco farms is occurring in Kentucky, it is occurring at a much slower pace relative to all United States farms.

Research Projects

- Analyzing the Future International Competitiveness of the U.S. Food Industry — *M.R. Reed, R.H. Brannon, M. Marchant, and L. Mather*
- An Evaluation of International Markets for Southern Commodities — *M. Marchant and M.R. Reed*
- Evaluation of Public Policy Alternatives Designed to Help U.S. Cash Crop Farmers Manage Risk — *J.R. Skees and H.H. Hall*
- Economic Analysis of Biotechnological Innovations in the U.S. Beef Cattle Industry — *B. Bobst*
- Economic and Environmental Impacts of Water-quality Protection Policies on Kentucky Agriculture — *H.H. Hall and J.R. Skees*
- Analyzing Impacts of Structure of U.S. Agriculture on Structure of Non-farm Rural Communities — *D.L. Debertin and S.J. Goetz*
- Rural Economic Development: Alternatives in the New Competitive Environment — *S.J. Goetz and D. Freshwater*

Agronomy

The Department of Agronomy conducts research in four broad scientific fields: soil science, crop ecology and management, crop genetics, and plant biology. Agronomy faculty are investigating numerous issues of current and future importance to Kentucky. Our work ranges from crop production tests in the field to cutting-edge laboratory studies of gene expression and plant metabolism. Research objectives include improving the yield and value of crop plants, while conserving soil and water resources. Many investigations explore the potential of the most sophisticated new technology, for example, plant molecular biology or precision agriculture. Other scientists continue to refine agronomic management systems to provide farmers with globally competitive production technology. The widespread public concern over environmental issues in Kentucky, particularly those related to agricultural production, has greatly increased the emphasis on analysis of soil and water quality. Examples of interesting and potentially important research accomplishments during 1997 are described here.

- No-till wheat studies at the University of Kentucky and on experienced no-till wheat farmers' fields indicate that this practice is beneficial and economically feasible for many growers in the state. Through research and education, the newly formed Wheat Science Group at UK is leading a Kentucky Small Grain Grower's initiative to have 75 percent of the wheat no-till planted by the year 2005. The Wheat Science Group is a coordinated group of specialists from all disciplines with a structure that will allow a more effective and practical approach for solving problems and creating new opportunities to serve the small grain growers of Kentucky.
- A continuing goal of our burley tobacco breeding program has been the development and release of cultivars with increased resistance to *Phytophthora parasitica* var. *nicotianae*, the causal agent of black shank. Toward this goal, KY 909 (KX94148) will be released to seedsmen in 1998. KY 909 has been evaluated in Kentucky under disease pressure at our black shank nursery in Franklin County and in field performance trials for three years. This new cultivar was released for its high resistance to Race 0 of black shank, medium resistance to Race 1, early maturity, and virus resistance.
- A large portion of maintenance budgets for golf courses can be attributed to fungicide applications. Research was conducted investigating cultural control of fungal diseases while reducing fungicide inputs. Results showed that even without fungicides, dollar spot disease may be consistently reduced by as much as 50 percent on golf greens and up to 80 percent on creeping bentgrass fairways through cultural practices alone.
- An enzyme capable of detoxifying multiple types of pesticides has been cloned from corn and expressed in yeast. This gene has the potential for developing new crops with multiple pesticide resistance, being used by industry for studies of pesticide degradation, and aiding in the development of integrated pest management through better understanding of how pesticides interact to cause corn injury.
- Research data from the Weed Science field program supported the registration of Spartan herbicide for morningglory control in tobacco.
- Due to its superior yielding ability in the Kentucky Soybean Performance Tests, soybean line KY 91-1214 was released as a new maturity group IV soybean variety by the Kentucky Agricultural Experiment Station.
- A new tobacco sucker control option was promoted through field days, demonstrations, and winter meetings. Utilization by producers increased from an estimated 1 percent in 1996 to 35 percent in 1997. Improved sucker control and increased yields are expected while MH residue levels should decline. Lower residues could improve the standing of Kentucky burley tobacco in the world market.
- Predicting corn seed deterioration would provide a valuable management tool for the seed industry. A four-year study investigated the effect of constant storage temperature and seed moisture on seed deterioration across six corn hybrids of various initial seed vigor levels. Both the hybrid and initial seed vigor affected the rate of seed deterioration with low vigor seed lots deteriorating faster. A model was developed that accurately predicted the time to loss of corn seed germination (± 10 percent) across 17 storage environments.
- We are developing new ways to express multiple genes in plants. We tested a strategy for simultaneously expressing several enzymes in different subcellular compartments of plants. Our studies provide a means by which complicated metabolic pathways may be introduced in plants, with a minimum of transgenic and genetic manipulation.
- Our research on the fertilization of tobacco transplants in the float system identified nitrite toxicity as the primary cause of poor growth of transplants fertilized with urea. In 1994 and 1995, urea-based fertilizers caused an estimated \$2 million in damage to burley tobacco transplants. As a result of our float system fertility studies, tobacco growers have learned to avoid fertilizers containing urea.
- Bioassays detected the first evidence of an interaction between alkaloids of endophyte-infected tall fescue. Toxicity of ergotamine and N-formyl loline appears to be mediated by the same membrane-bound receptor. This dis-

covery could lead to a better understanding of fescue toxicosis and the development of new methods of managing this perennial problem, which costs the Kentucky livestock industry \$100 million annually.

- Genetic engineering methods have been used to introduce coat protein (CP) genes from both tobacco and soybean viruses into the respective host crops. We have demonstrated in laboratory, greenhouse, and field experiments that transgenic lines carrying nonpathogenic CP genes are stably inherited and provide usable field levels of resistance to virus attack. Two burley tobacco transgenic lines carrying a viral CP gene were promising enough in a variety evaluation test in 1997 that the two lines will be entered in the preliminary regional variety test in 1998.
- Research on no-till production of corn, soybeans, wheat, and tobacco continues. Kentucky continues to lead the nation in percentage of no-till crops (44 percent in 1994; 48 percent in 1997), with 94 percent of double-crop and 49 percent of full season soybeans, and 52 percent of the full season corn no-tilled. Hickman and Trigg counties led the state and produced 85 percent of their corn, soybean, and wheat acreage by no-till in 1997. The erosion control this provides is very notable.
- Wetlands may play an important ecological role in the bioremediation of trichloroethylene (TCE) because they support three different bacterial groups that cometabolize TCE: methanogens, sulfidogens, and methanotrophs. We enumerated all three physiological groups in wetlands receiving discharge from a TCE-contaminated aquifer beneath the Paducah Gaseous Diffusion plant. Methanogens and methanotrophs dominate these wetland environments and appear to be influenced by the seasonal flooding management of each wetland.
- Our research has demonstrated that fecal bacteria from poultry litter can rapidly infiltrate soil during rainfall. The infiltration has considerable spatial variability and is associated with macropore flow. Tillage, which disrupts macropore continuity, will impede but not prevent microbial infiltration to shallow groundwater. This ongoing research will be used to devise appropriate management practices for animal waste disposal on land.
- A major goal of the Kentucky Forage Variety Testing Program has been to encourage use of improved proprietary forage varieties. Since 1994, farmers have bought significantly more proprietary alfalfa and red clover varieties compared to public lines. Based on surveys, purchase of proprietary alfalfa varieties is up 42 percent since 1994. If 25 percent of Kentucky's 300,000 acres of alfalfa are reseeded annually and 42 percent of farmers choose to upgrade to a better variety of alfalfa, this would total \$9.45 million additional revenue in farm receipts. Sales of improved proprietary varieties of red clover have increased by at least 90,000 pounds of seed compared to 1994 levels. This quantity would seed 9,000 acres of red clover, and this improved forage would be worth an additional \$2.3 million in farm receipts than if they had seeded unimproved red clover varieties.

Research Projects

- A Silica/Fly-ash-based Technology for Controlling Pyrite Oxidation — *V.P. Evangelou*
- Altered Fatty Acid Varieties: Does Our Climate Give Us an Edge? — *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*
- Amount and Quality of Herbage Ingested by Cattle Grazing Tall Fescue Clover Grasslands — *C.T. Dougherty*
- Analysis of mRNA Polyadenylation and Metabolism in Plants — *A.G. Hunt*
- Assessment of Constructed Wetlands for Animal Waste Phase II — *W.O. Thom, Y. Wang, and J. Dinger*
- Backup of Clover (CLO) Accessions in the NSSL — *N.L. Taylor*
- Biochemistry and Molecular Biology of Sesquiterpene Cyclase and Squalene Synthetase from Tobacco — *J. Chappell*
- Breeding Improved Varieties of Wheat, Oats, and Burley for Kentucky — *D. Van Sanford*
- Cellular and Molecular Biology Initiative in Dark Tobacco — *G.B. Collins*
- Characterization, Classification, and Use Interpretations of Kentucky Soils — *A.D. Karathanasis*
- Characterization of Phytoalexin and Sterol Biosynthetic Genes in Tobacco — *J. Chappell*
- Characterization of a Plant PolyA Polymerase — *A. Hunt*
- Classifying Soils for Solute Transport as Affected by Soil Properties and Landscape Position — *E. Perfect*
- Cloning and Heterologous Expression of Pesticide Metabolizing Cytochrome P450 Genes — *M. Barrett*
- Cloning Epoxy Fatty Acid Genes — *D. Hildebrand*
- 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*
- 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 Rates of Several Nutrient Sources for Optimum Crop Production and Soil — *W.O. Thom*
- Development of a Basic Soil Morphology Training Course for Onsite Sewage Disposal Treatment System Personnel — *A.D. Karathanasis*
- Development of an Efficient Soybean Regeneration and Transformation System for Introduction of Protein Modification Genes — *G.B. Collins and R. Dinkins*
- 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 and Plant Population on Corn Yields — *M.J. Bitzer and J.H. Herbek*
- Effect of Row Width on Corn Yields — *M.J. Bitzer and J.H. Herbek*
- Effect of Tillage and Land Use on Physical and Chemical Properties of Kentucky Soils — *G.W. Thomas, R.L. Blevins, and J. Thompson*
- Effects of Suckering Practices on Growth Characteristics, Yield, and Quality of Burley, Dark Fire-cured, and Dark Air-cured Tobaccos — *J. Calvert*
- Assessing Transport of Colloid Bound Herbicides and Heavy Metals to Groundwater: EPA/EPSCOR — *A.D. Karathanasis and R.E. Phillips*

- Establishing an Advanced Techniques Course in Biotechnology — *J. Chappell*
- Evaluation of Soybean Varieties and Breeding Lines for Use in Kentucky — *T.W. Pfeiffer 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 Genetics and 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 Engineering of Dark Tobaccos — *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, Faculty Research — *J. Chappell*
- Identification, Characterization, Seed Increase of Clovers — *N.L. Taylor*
- Improving Nutrient Management in Animal Wastes by Dietary Manipulation and Cropping System Optimization — *G.L. Cromwell and J.H. Grove*
- Improving Switchgrass Productivity as a Biofuel Crop — *M. Rasnake*
- Increased Desaturation of Soybean Triacylglycerol — *D. Hildebrand*
- Influence of Soil Structural Heterogeneity on Transport of Fecal Pathogens and Solutes with the Vadose Zone — *E. Perfect*
- 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*
- Integrated Management of Arthropod Pests of Livestock and Poultry — *F.W. Knapp, J.W. Webb, and C.T. Dougherty*
- Isolation of Scleroel/Labdenediol Synthase — *G.J. Wagner*
- Lignin Content in Soybean Seedcoats — *D.M. TeKrony, D.B. Egli, and T. Pfeiffer*
- Maintenance of Seed of Trifolium Species — *N.L. Taylor*
- Manipulation and Regulation of Oxylinin Formation in Plant Tissues — *D. Hildebrand*
- Mechanisms for Vacuolar Storage/Sequestration of Cd, Zn, Mn, Ni — *G.J. Wagner*
- Mineralogical Controls of Colloid Dispersion and Solid Phase Speciation of Soil Contaminants — *R.I. Barnhisel and A.D. Karathanasis*
- Molecular Regulation of Isoprenoid Metabolism in Plant Pathogen Interactions — *J. Chappell*
- Multiplicative (Linear-bilinear) Models for Genotype X Environment Interaction in Crop Cultivars — *P.L. Cornelius*
- 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 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 — *J.G. Shaw and A.G. Hunt*
- Predicting Changes in Corn Seed Quality during Storage — *D.M. TeKrony*
- Regulation of C6-Aldehyde and Alcohol Formation in Plant Tissues — *D. Hildebrand*
- Relationship between Photosynthesis, Assimilate Supply, and the Size of the Reproductive Sink — *D.B. Egli*
- Screening Soft Red Winter Wheat Varieties and Breeding Lines for Resistance to Head Scab — *D.A. Van Sanford*
- Searching for New Yield Genes for Kentucky — *T. Pfeiffer*
- Seed Biology and Technology Investigations — *D.M. TeKrony and D.B. Egli*
- Significance of Loline Alkaloids in Ecosystems Predominated by Grass/Endophyte Associations — *L.P. Bush*
- Site-specific Nutrient and Biosolids Management on Agricultural Lands — *R.I. Barnhisel and S.A. Shearer*
- Soft Red Winter Wheat Breeding and Variety Development for Kentucky — *D.A. Van Sanford*
- 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*
- Species and Crop Management Effects on the Yield and Quality of Round Bale Silage — *M. 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 of and Efforts to Engineer the Metabolism in Plant Trichomes — *G.J. Wagner*
- Soil and Crop Nitrogen Testing to Improve Nitrogen Management for Burley Tobacco — *R.C. Pearce, J.G. Grove, and D.C. Ditsch*
- Survival Characteristics of Inbred Corn Seeds during Storage — *D.M. TeKrony and D.B. Egli*
- Terpene Cyclases: Functional Domains and Structures — *J. Chappell*
- The Role of Ammonium-potassium-calcium Exchange Interactions in Regulating Nitrification Rates in Soil — *V.P. Evangelou and M.S. Coyne*
- To Enhance National Efforts for Scab Evaluation Research and Develop Scab Resistance in Wheat for Specifications by the National Program Staff — *D. Van Sanford*
- Understanding Recombination and Modifying its Frequency in Soybean and Corn — *T.W. Pfeiffer*
- 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*
- Variable Rate Seeding: A Cooperative Study with Kentucky Corn Producers — *R.I. Barnhisel, S.A. Shearer, and M.J. Bitzer*
- Weed Management of Deep-rooted Perennials with a Minimum-till Cultivator — *J.D. Green and W.W. Witt*
- 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

This is an exciting time to be involved in research, teaching, and extension. So much information is being generated by research efforts that our teachers and extension personnel have to look for new ways to disseminate knowledge. This is particularly true in a diverse department like Animal Sciences. Through this knowledge explosion, we strive to advance technology, but at the same time be selective in promotion of technology that will sustain animal agriculture by improving efficiency of livestock production, increasing profitability for the producer, and ensuring the consumer a high quality and safe food supply.

Food Science

The addition of a natural beef flavoring agent to raw and precooked restructured steaks from cull cow carcasses masked objectionable flavors resulting from differences in animal age and improved the overall acceptability of the steaks as evaluated by a trained taste panel. The beef flavoring agent did appear to have a detrimental effect on fresh but not precooked beef color after thawing.

Of eight populations of bacterial species studied, Z-2-hexenal showed the most promise for controlling mold growth during shipping and storage of blackberry and strawberry fruit.

Research to elucidate and ultimately inhibit the major undesirable flavor compounds from soy protein products has demonstrated that 2-pentyl pyridine is the strongest documented flavor compound in commercial soy protein isolates (SPI). With a flavor threshold in water of 12 parts per trillion, it contributes a grassy/throat-catching flavor. SPI from a soybean variety null for all three lipoxygenase enzymes exhibited no increase in 2-pentyl pyridine from pro-oxidants.

Ruminant Nutrition

Carbohydrate utilization by anaerobic bacteria of agricultural importance is still not well understood. Oligomeric forms of sugars are probably important energy sources for ruminal bacteria. A novel biosynthetic pathway involving UDP-glucose was elucidated. The results of these metabolic studies of rumen bacteria will help in designing strategies for manipulating ruminal fermentation and improving performance of livestock fed high fiber diets.

Fibrous carbohydrates in agricultural, municipal, and forestry waste are potential renewable resources for alcohol fuel production. Bioconversion of this material by thermophilic bacteria is an attractive alternative to current technology involving yeast fermentation of corn. A xylose utilization operon was completely sequenced and characterized from

Thermoanaerobacter ethanolicus. This is the first in-depth genetic study of xylose utilization in a thermophilic bacterium and represents a significant advancement in our understanding of these biotechnologically important organisms. These results form the basis for further studies which will be useful in designing strategies to use thermophilic bacteria in bioconversion processes.

Beef cows and calves grazing endophyte-infected tall fescue during spring, summer, and fall do respond to an ad libitum molasses-based supplementation program. Implementation of this program produces optimum body condition scores during breeding, high reproductive rates, and increased calf weaning weights.

Feeding supplemental vitamin E to lactating dairy cows fed endophyte-infected tall fescue decreased symptoms associated with fescue toxicosis; however, results were quite variable.

Physiology and Breeding

Dietary supplementation of prepartum Holstein heifers with copper proteinate resulted in advantages in copper status at calving compared with heifers receiving copper sulfate or heifers receiving no supplementary copper. Heifers receiving copper proteinate had significantly higher percentage uninfected quarters and lower percentage coagulase-negative staphylococci infections than the other dietary groups.

Experiments were conducted to identify how hormones and the embryo interact to control the activity of enzymes involved in the successful establishment of pregnancy. Failures in this system are a major contributing factor to the high incidence of early embryonic mortality in cattle. Other experiments were conducted to identify hormonal imbalances that lead to the formation of ovarian follicular cysts, the most common reproductive disorder in dairy cows.

Current research emphasis in beef cattle breeding involves evaluation of level of production, measured in terms of weaning weight differences imposed through sire selection, on subsequent reproductive performance of the cow herd.

Sheep

Treatment of ewes with methscoplamine bromide reduced milk production at weaning and was even more effective in conjunction with reduced feed intake before weaning. This should be a valuable technique for managing ewes whose lambs are early weaned or whose lambs are lost in mid-lactation.

Inclusion of the calcium salts of palm oil fatty acids into a fescue-based lactation diet reduced lactation feed costs and increased production of higher quality milk that produced

more efficient lamb gain, than feeding an alfalfa-based diet with or without ruminal bypass lipid supplementation.

A 32-percent protein, molasses-based supplement (pork blood and feather meal) can replace 30 percent of the supplemental soybean meal protein in lamb growing-finishing diets without affecting lamb performance or carcass merit.

Horses

Calorie availability and ratio of roughage to concentrate in the diet affects the metabolic responses of horses to exercise and to a meal feeding challenge. Dietary roughage availability also affects water balance in horses by altering the water-holding capacity of the hind gut. Horses consuming a diet high in soluble fiber consumed more water per kilogram of diet dry matter and had higher fecal water content. In young horses, weaning creates a repeatable but transient decline in average daily gain. There was no apparent benefit to weaning foals at 6.0 months compared to 4.5 months.

Swine

Research was conducted with a mutant corn that contained a majority of the phosphorus in an inorganic form rather than as phytic acid, which is poorly available to nonruminants. The phosphorus in low-phytic acid corn was three to four times as bioavailable to pigs and chicks as the phosphorus in normal corn. In diets containing low-phytic acid corn, less inorganic phosphorus was needed to maximize performance and bone mineralization.

Reducing the dietary protein level and adding amino acids reduced the amount of nitrogen excretion in pigs and reduced ammonia release from their manure. Similarly, feeding a low phosphorus diet supplemented with microbial phytase reduced the phosphorus excretion in the manure.

A by-product resulting from the process of extraction of heparin from porcine intestines was found to have excellent properties as a protein source for weanling pigs, and chromium picolinate was found to improve carcass leanness to a greater extent than chromium chloride.

Poultry

Studies with laying hens and broilers produced enhanced nutritional quality of eggs and meat using novel ingredients. Pearl millet used as the major dietary grain increased omega-3 fatty acid concentrations. Use of selenized yeast in place of inorganic selenium increased selenium levels in meat and eggs.

Studies with broilers demonstrated lower nitrogen content and ammonia production in litter by using low protein

diets and increased amino acid supplementation, and a nutritional evaluation of a high oil corn variety showed that it has higher energy for chickens and can modify carcass fatty acids. Results indicate that high oil corn is very well suited for broiler diets.

Research Projects

- Animal Manure and Waste Utilization Treatment and Nuisance Avoidance for a Sustainable Agriculture — *Gary Cromwell*
- Antimicrobial Resistance and Plasmid-mediated Virulence Attributes of Fecal Colonic Bacteria from Pigs — *Bruce Langlois*
- Beef Cattle Grazing: Endophyte-infected Tall Fescue with Alfalfa and Water Quality in Stream Pastures — *Brian Larson*
- Bioenergetics of Nutrient Transport and Growth of Gram-negative Ruminal Microorganisms — *Herbert Strobel*
- Breeding to Optimize Maternal Performance and Reproduction of Beef Cows in the Southern Region — *Fred Thrift*
- Comparison of Forage Finishing Systems, Carcass Traits, and Processing Technologies — *William Moody*
- Effect of Additives and Processing Methods on Cheese Agglutination and Cheese Yield — *Clair Hicks*
- The Effect of Dietary Fiber Type and Amount on Large Intestinal Volatile Fatty Acids and Water Balance in Horses — *Laurie Lawrence*
- Endocrine Mechanisms Contributing to Establishment of Pregnancy in Ruminants — *William Silvia*
- Enhancing Food Safety Through Control of Foodborne Disease Agents — *Bruce Langlois*
- Evaluation of Supplemental Chromium on Glucose Tolerance and Performance of Swine — *Merlin Lindemann*
- Evaluation of Tall Fescue in Dairy Cattle — *James Jackson*
- Functional Properties of Food Proteins — *Youling Xiong*
- Genetic and Phenotypic Aspects of Cow Productivity Using Field Records Collected on Angus Cattle — *Debra Aaron*
- Hydrolyzed Feather Meal as a Supplement for Lambs Consuming High Concentrate or High Roughage Diets — *Don Ely*
- Impact of Level of Prewaning Performance on Subsequent Cow Herd Reproduction — *Fred Thrift*
- Increased Efficiency of Sheep Production — *Don Ely*
- Induction of Puberty Onset in Beef Cattle — *Keith Schillo*
- Lipid-derived Flavors-odors and Their Association with Food Proteins — *William Boatright*
- Mastitis Resistance to Enhance Dairy Food Safety — *Robert Harmon*
- Metabolic Relationships in Supply of Nutrients for Lactating Cows — *David Harmon*
- Microbial Strategies for Improving the Efficiency of Ruminant Production by Enhancing Propionate Metabolism in the Rumen — *Karl Dawson*
- Molecular Characterization of Carbohydrate Utilization by Anaerobic Bacteria — *Herbert Strobel*
- Nutrition and Exercise on Development of Horse Skeletal and Muscular Tissue and Subsequent Performance — *Laurie Lawrence*
- Nutritional Systems for Swine to Increase Reproductive Efficiency — *Merlin Lindemann*
- Optimizing Digestion and Absorption in the Ruminant Small Intestine — *David Harmon*
- Requirements and Bioavailability of Phosphorus for Swine — *Gary Cromwell*
- Resistance to Mastitis in Dairy Cattle — *Robert Harmon*
- Skeletal Problems in Poultry — *Austin 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 development methods of protecting foods and other farm products that are consumed or used by the public. Six 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-powered 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, groundwater 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 sub-surface 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 that 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 extra-

cellular 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 productions, 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. A microprocessor system has been developed to control temperature in greenhouses. Evaluation of a portable frame and field-curing systems 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. More than 2,600 field-curing structures of varying design were used in the burley-producing area last year.

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. A fiber optic sensor developed from this research has been installed and is being tested in a cottage cheese-making facility in Winchester.

Other ongoing research that 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 Na-

tional 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 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*
- 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*
- Dark Tobacco Mechanization — *L.D. Swetnam*
- Determination of Design Weather Parameters — U.S. and International Locations — *D.G. Colliver*
- Determination of Infiltration Characteristics of Mine Spoil Planted with Hardwoods — *R.C. Warner*
- Determination of the Hydrologic and Sedimentation Response of Loose and Compacted Mine Spoil Planted with Hardwoods — *R.C. Warner*
- Developing an Effective, Economical Tobacco Tray Sanitation System — *G.A. Duncan*
- Development and Application of Comprehensive Agricultural Ecosystems Models — *D.R. Edwards*
- Development and Testing of Individual Bird Feed and Water Use — *R.S. Gates*
- Development of a Traction-control Hydrostatic Transmission for Low-draft Applications — *S.A. Shearer*
- Development of a Tractor-powered Burley Spearing Machine — *G.A. Duncan*
- Development of a Variable-rate, Two-bin Granular Fertilizer Applicator — *S.A. Shearer*
- Development of Analytical Methods to Predict Stream/Aquifer Interactions in Alluvial Valleys — *S.R. Workman*
- Development of Geographical Information Systems (GIS) in the University of Kentucky 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 Systems (GIS) Format — *K.T. Priddy*
- Dietary Manipulation to Reduce Aerial and Effluent Nitrogen Concentration in Broilers — *R.S. Gates*
- Dynamic Mist Control Strategies for Poinsettia Propagation — *R.S. Gates*
- Economic and Environmental Impacts of Water Quality Protection Policies on Kentucky Agriculture — *J.L. Taraba*
- Electric 4-H Projects Manuals — *G.A. Duncan*
- 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*
- Evaluation of a Bag-type Geothermal Ground Heat Exchanger — *W.E. Murphy*
- Evaluation of Sediment Pond Design — *R.C. Warner*
- Field Test of Low-cost Greenhouse Ventilator 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*
- Grading Practices and Dockage Impacts on the Value of Kentucky Wheat — *S.G. McNeill*
- Improved Information Delivery by Developing Internet Gopher/Web Server in the University of Kentucky 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*
- Measurement of Factors that Influence Soil Development, Water Transport, and Tree Growth in Reclaimed Surface Mines in Eastern Kentucky — *S.R. Workman*
- Measuring and Predicting Soil Compaction Caused by Machinery — *L.G. Wells*
- Mechanics of Granular Solids — *I.J. Ross*
- Model Development and Calibration for Predicting the Persistence and Efficacy of Chlorothalonil on Tomatoes — *S.E. Nokes*
- 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 Poultry and Livestock Facilities — *R.S. Gates*
- Optimization of Process Variables for Solid State Fermentation Production of Xylanase — *S.E. Nokes*
- Passive Dewatering Systems for Sediment Ponds — *R.C. Warner*
- Physical and Bioremediation of Hazardous Waste Contained Soils Through Incorporation of Coal Fines and In-situ Environmental Managements — *R.C. Warner*
- Reducing Heat Stress in Dairy Cows and Swine Through Forced Evaporative Cooling — *L.W. Turner*
- Reducing Nitrogen, Phosphorus, and Ammonia Erosion in Swine Waste Through Diet Manipulation — *L.W. Turner*
- 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 Nutrient Management for Agricultural Lands — *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 an Aseptic 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 Groundwater Quality — *D.R. Edwards*
- Time-integrated Variable Control Strategies for Animal and Plant Environments — *R.S. Gates*
- Vapor Pressure Deficit Control for Plant Propagation and Production — *R.S. Gates*
- Ventilation Strategies for Small Greenhouse Owners — *R.S. Gates*

Entomology

The Department of Entomology conducts mission-oriented research combining basic and applied studies with two major goals: (1) understanding the biology of insects and related arthropods and their interactions with plants and animals and (2) developing and implementing safe and effective management tactics and strategies for pest species. Three broad areas of research are pursued, and the highlights of accomplishments under each area are reported here.

Insect Behavior, Ecology, and Evolution

- The ecological impacts of three gypsy moth management strategies on forest arthropod biodiversity were measured. Gypsy moth suppression tactics negatively impacted predatory spiders and ground beetles, as well as detritivorous bristletails.
- Pest insects may evolve resistance to their own sex pheromones when these are used for direct control. Heritable variation was found in the composition of the pheromone blend of the cabbage looper moth, *Trichoplusia ni*. This suggests that natural selection could result in an evolutionary change in the pheromone blend.
- One pheromone strain of male cabbage looper was favored over another in the presence of a particular formulation of a disruptant pheromone. However, because females of the two strains were not affected in the same manner, the emergence of a resistant strain would not be simple.
- The effectiveness of indigenous generalist predators as biocontrol agents in vegetable production was measured. Increased densities of wolf spiders and ground beetles marginally decreased potato leafhopper numbers in potatoes. Increased predator densities did not improve potato production in this year's study.
- Rates of predator immigration into fenced plots planted in cucumbers or squash were manipulated to uncover the effects of different predator combinations. Single-predator treatments (spiders or beetles alone) yielded diverse effects, either increasing vegetable production or decreasing yield through negative impacts on other predators. However, when present together, ground beetles and wolf spiders increased yield.
- Identification keys to the 404 genera of Western Hemisphere braconid wasps, most of which contain species that attack insect pests, were published in "A Manual to the New World Genera of Braconidae."
- Illustrated interactive identification keys to the genera of Braconidae of the New World are in preparation and are available in various stages of completion on the World Wide Web at <<http://www.uky.edu/~mjshar0>>.

Insect Molecular Biology, Physiology, and Genetics

- The structural organization of polydnavirus gene segments is repeated within viral genomes. At least two and probably four gene segment families exist with the *Camponotus pennsylvanicus* virus genome. This recurring theme of structural organization is linked to effective delivery of viral genes to the host insect and ultimately to disruption of the insect immune response to the invading parasite.
- A polydnavirus protein that inhibits host cell translation was purified. This protein inhibits host cell translation possibly as a means to inhibit insect growth and immune systems. We are raising antisera and attempting N-terminal sequence analysis in order to clone the gene encoding this protein and then evaluate the potential utility of this protein in insect control.
- Focused on producing useful quantities of a protein (TSP16) secreted by teratocytes (cells derived from the extraembryonic serosal membrane of eggs of the braconid parasite, *Microplitis croceipes*).
- Extended the in vitro life of teratocytes so that they secrete proteins for a longer time.
- Developed a different virus expression and cell culture system with which to express TSP16 because yield of TSP16 is low when a baculovirus and insect cell line are. Presumably, secreted TSP16 causes suppression of protein synthesis in the insect cell line.
- Different components of a pheromone can have different functions, and the functional integration of the pheromone is maintained by genetic integration. Individual pheromone components develop along the same lines as their function.
- In insect development, reproduction can be limited by developmental constraints, and genetic differences among individuals may be less important than variation in development.
- The introduced ladybird beetle *Harmonia axyridis* is an efficient colonizer because there is tremendous variation in the responses of individuals to different quality diets. Individual responses are influenced by genetic differences. Antipredatory reflex bleeding by these ladybird beetles does not influence other ecologically important traits.

Pest Management and Applied Ecology

- Field studies continue to support the efficacy of a new termite bait being marketed to homeowners in Kentucky. Of 22 chronically infested houses baited and monitored since 1995, none showed evidence of termites during 1997. The first commercial U.S. field trials with another promising new class of termiticide (fipronil) were conducted.
- Biodiversity of predatory arthropods was studied in pastures, home lawns, and golf course habitats, and the importance of predators, especially ants, in regulating pest populations was documented.
- Two important new soil insecticides with unique mode of action were shown to have relatively little impact on beneficial species.
- Plant secondary compounds involved in host selection Japanese beetles were investigated, and aspects of the beetles' behavior, including habituation to feeding deterrents, food aversion learning, and daily behavioral cycles, were documented.
- Factors that predispose woody plants to outbreaks of gall wasps and spider mites were identified.
- A prototype system was developed whereby greenhouse crops can be disinfected of insects through anoxia (low oxygen atmospheres).
- Migrating potato leafhoppers preferred alfalfa and a fescue meadow over a hardwood forest for colonization.
- *Heterorhabditis bacteriophora*, strain 'Oswego,' a parasitic nematode of the clover root curculio was released in 1996 in a red clover field and recovered during 1997 indicating its establishment.
- Parasitism of alfalfa weevil larvae by *Bathyplectes anurus* averaged 45.3 percent (range 36.2-51.6) in Fayette County alfalfa fields.
- The first adult potato leafhopper caught by sticky traps and sweeping alfalfa occurred on May 1 and 5, respectively.
- Predatory harvestmen frequently consume corn earworm eggs in soybean fields. Pitfall trapping in such fields showed that a single species, *Phalangium opilio*, accounted for >99 percent of the harvestmen sampled during May through August.
- In laboratory tests of three predatory species commonly found in soybean fields, *Nabis roseipennis* was more cannibalistic than either *Orius insidiosus* or *Geocoris punctipes*.
- Adult populations of the predator *Coleomegilla maculata* were significantly higher on two varieties of sweet corn than on two varieties of field corn during anthesis.
- The predator *Coleomegilla maculata* frequently lays eggs on hopornbeam copperleaf plants in or near corn fields; tiny, newly hatched larvae soon abandon these plants and can travel across bare soil for distances of at least 8 meters.
- Adult male bolas spiders retain the juvenile hunting behavior of attracting psychodid flies, while older female bolas spiders switch to the hunting tactic of attracting moths.
- 399 nurseries were licensed and 351 of these were inspected. There were 659 nursery dealers licensed to sell nursery stock in Kentucky.
- 1,465 Federal Phytosanitary Certificates were issued in 1997. Commodities certified included lumber, popcorn, flower and vegetable seed packets, and tobacco seed. There were 27 Federal Re-export Certificates, 39 Federal Processed Plant Certificates, and 13 State Phytosanitary Certificates issued.
- The evaluation of insecticide ear tags containing organophosphates and synthetic pyrethroids for their efficacy against horn and face flies continued in 1997. Reformulated tags containing these compounds alone, or combinations of the two, provided control of face and horn flies for 12 to 15 weeks.
- Resistance of horn flies still continues to be a problem with pyrethrin-based formulations, and it is still recommended that pyrethroid tag use be interrupted every 1 to 2 years with 1-year use of organophosphate ear tags.
- Effective control of horn and face fly populations was attained by the use of synthetic pyrethroids in dust bags. Pour-on formulations of pyrethrins proved to control horn flies for more than 30 days and were found to be effective as a supplement to other methods of control or a way to extend fly control at the end of the season.
- Resistance of horn flies to organophosphates has not been documented in Kentucky.
- An interdisciplinary research project on bacterial leaf scorch on landscape trees has shown the disease is distributed statewide and is potentially vectored by a leafhopper in the genus *Graphocephala*.
- The genera of treehoppers present on pin oaks was determined, and the adult seasonal occurrence and activity patterns in relation to height in tree canopy was recorded.
- The usage levels of herbicides important to vegetation management was determined.

Research Projects

- Aggressive Chemical Mimicry in Bolas Spiders — *K.F. Haynes, K.V. Yeargan*
- Biocontrol by Native Generalist Predators: A Strategy for Reducing Pesticide Use in Vegetable Production — *D.H. Wise*
- 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. McNeil*
- Development and Integration of Entomopathogens into Pest Management Systems — *G.C. Brown*
- Development of Sustainable IPM Strategies for Soybean Arthropod Pests — *K.V. Yeargan*
- Dynamic Soybean Insect Management for Emerging Agricultural Technologies and Variable Environments — *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*
- Evolution of Pheromone Blends — *K.F. Haynes, A.J. Moore*
- Evolutionary Genetics of Developmental and Age-related Changes in Social Signals — *A.J. Moore*
- Gypsy Moth Suppression Tactics: Comparative Effects on Arthropod Biodiversity in Kentucky Forests — *L.K. Rieske-Kinney*
- Identification Manual for the New World Genera of the Family Braconidae — *M.J. Sharkey*
- 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*
- Insect Immunity Limits Virus and Parasite Host Range — *B.A. Webb*
- 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*
- Mating Disruption and the Evolution of Pheromone Communication in Moths — *K.F. Haynes*
- Molecular Dissection of Polydnavirus Functional Activities — *B.A. Webb*
- Nursery Inspection — *B.C. Pass, J.T. Collins, C.W. Harper*
- Pathogenicity, Transmission and Introduction of a Cytoplasmic Polyhedrosis Virus to Fall Webworm — *L.K. Rieske-Kinney*
- Pesticide Applicator Training 1997 — *L.H. Townsend*
- Phytochemical and Physiological Effects of Herbivore Feeding Guild Interactions: The Impact of Bud Herbivory on Gypsy Moth Success — *L.K. Rieske-Kinney*
- 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*
- Systematics and Biodiversity of Biological Control Agents with Special Reference to the Braconidae — *M.J. Sharkey*
- The Role of Fluctuating Asymmetry in Sexual Selection — *A.J. Moore*
- Translation Factors from a Parasitic Wasp and Its Virus — *B.W. Webb*

Forestry

Kentucky's forest land, its management, and the potential for value-added production and development of nontimber income alternatives have become major concerns for the state. Timber occupies 12.5 million acres of land in the state and has been increasing in volume and acreage as marginal farmland is allowed to return to a forested condition. More than 70 percent of the timber is low quality as a result of poor management, forest fires, and grazing. The potential for value-added production is being emphasized. This value-added concept is to begin on the land itself by producing higher quality timber, water, wildlife habitat, recreational areas, and alternative crops.

Dynamic programming was used to assist landowners in developing plans to improve financial returns from shortleaf pine and yellow-poplar stands in Kentucky and the central United States. Financial gains from managing these stands improve long-term income by as much as 15 percent in natural yellow-poplar stands and 10 percent in shortleaf pine stands. Predictive equations were developed to estimate the volume and value of yellow-poplar in eastern Kentucky for new composite wood products markets. It was found that landowner marketing of yellow-poplar stands could further increase landowners' gains from timber sales by 30 percent. Attitudes of forest landowners and the general public were surveyed concerning a variety of forest management topics. Neither the general public nor forest landowners opposed harvesting timber on public lands when given assurances of environmental protection.

The effects of white oak genetic diversity of various timber harvesting treatments are presently unknown. Therefore, in collaboration with the Daniel Boone National Forest, the possible genetic effects of several harvesting methods are being compared. The intent is to determine whether or not timber harvesting (followed by natural regeneration) has the harmful effect of increasing inbreeding and/or decreasing genetic diversity in white oak populations. During 1997 methods were developed to use white oak DNA to identify uniquely nearly every individual tree in a typical white oak stand. These methods will enable the assessment of the effects of timber harvesting on inbreeding and diversity in 1998, in comparison between cut tracts and uncut "control" tracts. The results will be of immediate use to forest managers in choosing strategies that will permit utilization of wood fiber while protecting diversity for future forests.

It is useful to have available "genetic markers" that can be used to identify populations with unique qualities and that therefore deserve special attention in genetic conservation and management programs. Recent work suggests that the DNA in mitochondria may be useful for this purpose. Thus,

the utility of mitochondrial DNA as a genetic marker of unique populations in a model species, lodgepole pine (*Pinus contorta* Dougl.) is being explored. During 1997 public databases were screened and literature reviewed with the aim of discovering potentially highly variable mitochondrial DNA sequences that would be suitable for research.

A study was initiated in 1989 in western Kentucky to establish herbaceous vegetation and black locust on an abandoned coal washing site that was 80 years old. The site had a pH of 1.8 and was devoid of vegetation. The soil was loose, pyritic sand-sized material. In addition to lime and fertilizer, soil amendments included hardwood bark; straw and manure; bark, sawdust, and manure; and a mixture of sewage sludge and kiln dust. Economic efficiencies of the various treatments were assessed using benefit/cost ratios. The control (i.e., lime, but no organic mulch) was the most cost effective, efficient, and economical producer of herbaceous cover as well as black locust survival, growth, and biomass. These results suggest that acidity, not compaction, was the most limiting factor on the site. The importance of compaction as a limiting factor in surface mine restoration is being supported by preliminary results from a study in eastern Kentucky. White ash, yellow-poplar, and northern red oak seedlings were planted in three levels of compacted soil and two organic mulches (bark and barn straw). First-year results indicate significantly lower survival under heavy compaction and no significant mulch effect.

Fire of various origins, planned and unplanned, as well as the absence of fire through suppression, is of critical importance to the health and productivity of upland oak forests in the Cumberland Plateau. As the effects of fire suppression throughout this region continue to be manifested by increasing dominance by red maple, white pine, and blackgum, the use of fire on some sites will contribute to the conservation of diversity of forest communities. Research has documented that a single prescribed fire achieves the immediate goal of killing regeneration by invasive tree species with minimal combustion of the forest floor. Additionally, base cation pools, nitrogen, and pH in the organic soil horizon were increased by fire for up to one year. The results of a study of seedling physiology and growth suggest that a single prescribed fire may further promote red maple performance without increasing oak performance sufficiently to compete with red maple. Combined with current data suggesting the importance of repeated burning for control of invasive species in the midstory, it is evident that repeated burning and the resultant increase in light availability will be necessary to maintain these forests as the oak forests they are today.

Preliminary research has been initiated to evaluate the yield impacts in hardwood processing facilities related to the

adoption of new nondestructive machining technologies such as scanning and optimized cutting. Initial yield impacts associated with alternative product designs demanded by consumers in the U.S. and world marketplace are being evaluated. Employment and leadership opportunities for women wood products professionals in wood products organizations around the world are being investigated.

Studies on big-eared bat species are complete. Both Virginia big-eared bats and Rafinesque's big-eared bats feed predominantly on moths. Virginia big-eared bats foraged primarily near cliffs with forest cover, whereas Rafinesque's big-eared bats foraged in oak and hickory forests. Both species require expanses of closed forest in which to forage, to protect roosting sites from disturbance, and to sustain reproduction of their moth prey base. Studies on diurnal roost selection of red bats are near completion. Bats are radio-tracked in both the northern and southern portions of the Cumberland Plateau in eastern Kentucky. Data showed red bats used the outer canopy of 12 different species of hardwood trees as diurnal roosting sites, with hickories and yellow-poplar used most frequently. Red bats preferred roost sites in upland habitat (i.e., near ridge tops). Red bats foraged in forested habitat, but also used streams, fields, and human residential areas. There was substantial overlap in foraging areas of red bats.

GPS positioning techniques compiled with an electronic distance measurement device were used to map road centerlines, structures, and public service facilities in a rural

county in the mountainous region of eastern Kentucky. Kinematic GPS was used to accurately position road centerlines, while the electronic distance measurement device was used to remotely sense the amount of offset from structures to the GPS receiver's antenna. The resulting geographically referenced locational data of roads, structures, and service facilities, such as fire hydrants, will be used by emergency services such as the fire department, police, and ambulance services. Currently available data indicate that the techniques employed are operational in the mountainous area, and locational data meet accuracy requirements.

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*
- 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*
- Genetic Consequences of Silvicultural Practices in Eastern Kentucky — *D.B. Wagner*
- 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*

Horticulture and Landscape Architecture

The Horticulture and Landscape Architecture faculty conducts 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, and landscape architecture.

Integrated Crop Management

Apple fruit sorbitol dehydrogenase activity has been shown to be affected by source-sink ratio and inducible *in vitro*. High levels of competition for sorbitol among sinks from situations such as excessive crop loads or foliar damage from pests might reduce sink activity or demand for carbohydrate. This emphasizes the need to adjust crop load appropriately and control pest problems through harvest.

Commercial quality cut roses can be grown economically in a single-stem system from cuttings using 6 to 10 cm containers on mobile trays with ebb and flood subirrigation. Marketable yields for the greenhouse space are significantly increased over conventional production systems, although capital costs and management intensity are increased. Estimated internal rates of return were 77 percent for year-round rose production and 175 percent for rose production specifically targeted to the Valentine's Day market while integrated with other greenhouse products over the rest of the year.

Carbohydrate accumulation in marigold seedlings was not only affected by light intensity and CO₂ concentration but was reduced by the initial carbohydrate concentration at sunrise. Night temperatures in greenhouses can be controlled to maximize accumulation of carbohydrates, growth, and plant quality while minimizing energy costs.

The Controlled Water Table (patent pending) irrigation system automatically maintains an optimum water/air relationship in growing media with no runoff. Seedlings in plug trays, flower and vegetable transplants, flowering pot plants as well as hydroponic lettuce were produced with the system.

Pruning the radicle tip of selected oak seedlings increased root regeneration and could be effective in producing container-grown oak liners with a more fibrous root system.

A cabbage Integrated Pest Management program was conducted with commercial growers in south central and eastern Kentucky. Insect and disease data resulted in recommendations published as *An Integrated Crop Management Manual for Kentucky Cabbage*.

Weed barrier mats with a shallow bark mulch resulted in excellent strawberry root development and production and reduced weed populations.

Herbicide evaluation for weed management in woody ornamentals, ground covers, annual bedding plants, and vegetables was performed in field sites. Newly labeled products, experimental products under evaluation, and industry standards were compared in each cropping system. Resulting data are contributing to the expansion of herbicide labels to include more plants important to Kentucky.

Crop Improvement

In addition to the existing protein methyltransferase specific for Lys-14 in the large subunit of Rubisco (enzyme in photosynthesis), a second protein methyltransferase has been discovered in the chloroplast of spinach plants with specificity for the N-terminal Met in the small subunit of Rubisco. While there does not exist any nucleotide or amino acid sequence homology between this newly discovered methyltransferase and other known methyltransferases, functional homology does exist with the pilin processing peptidases from Gram⁺ pathogens. This functional homology may be indicative of mechanisms involved in subcellular communications between chloroplasts and represent new biochemical pathways and processes that can be exploited for increase in carbon fixation by plants.

L-isoaspartyl protein methyltransferase is an enzyme found to specifically methylate several proteins in the seed during germination. This is the first enzyme found in seeds that is involved in protein repair and can have a direct bearing on reduced seed vigor and viability.

Sorgoleone, produced by living sorghum roots, is an extremely potent inhibitor of Photosystem II and could be utilized, with reformulation, as an active, soil applied herbicide, or a model for synthetic herbicide development. As we progress toward understanding the biochemical basis for sorgoleone production in higher plants, we may be able to manipulate production of this and other related compounds to enhance weed suppression provided by a living crop, and later by its residues.

The natural, antimicrobial, and volatile compound E-2-hexenal was shown to inhibit growth of *Botrytis cinerea*, an economically important pathogen of strawberries and grapes, at higher concentrations and stimulate its growth at very low concentrations. The observation that natural volatile compounds from fruit can both inhibit and stimulate disease spread provides a basis for understanding the role of these chemicals in the "real world" and should provide new strategies for control of disease on foods of plant origin.

Hybrids (F1 and BC1) between *Lycopersicon hirsutum* and *L. pennellii* (tomato) that were highly resistant to *Bemisia argentifolii* (spider mite) and with low concentrations of acyl

sugars esters were identified. This indicates that acyl sugar ester concentration is not the only mechanism of mite resistance in these populations.

The high temperature (31°C) responses of two populations each of strawberry, *Fragaria chiloensis* and *F. virginiana*, revealed no differences between the Kentucky and the Canadian *F. virginiana* populations in mean net assimilation rate or relative growth rate, but the South American *F. chiloensis* relative growth rate was more stable than that of the North American group. Overall, *F. virginiana* was more stable than *F. chiloensis* at high temperature. Strawberry cultivars with significant proportions of their parentage from *F. chiloensis* might perform poorly in Kentucky compared to those with more *F. virginiana* genetics, especially during periods of higher temperatures.

Cooperation in a regional research project provides continued identification of improved rootstocks and cultivars required by the Kentucky fruit industry. Currently, rootstock effects on high density apple, peach, and plum production are being evaluated. Included in the evaluation are candidate rootstocks from around the world. One of the most interesting aspects is a Chinese peach rootstock that is delaying bloom.

Bacterial leaf spot has been identified as the most serious disease affecting commercial pepper production in Kentucky and in all states bordering Kentucky. High-yielding, resistant varieties with good horticultural characteristics have been identified after the third year of extensive testing under induced and natural epidemic leaf spot conditions.

Transgenic virus-resistant summer squash cultivars were evaluated for the first time in Kentucky in 1997 together with conventionally bred varieties and breeding lines. Several transgenic and new conventionally bred cultivars exhibited excellent virus resistance, yields, and quality.

Daylilies (*Hemerocallis spp.*) were evaluated for inclusion in the Fall U-Pick and roadside markets to complement pumpkins, chrysanthemums, and ornamental gourds. Of 105 cultivars evaluated, many bloomed in early fall, but only 'Cisty' consistently bloomed in September each year from 1993 to 1997.

Landscape Architecture

As electronic land use/land cover data becomes more readily available, planning for crop variety and production potential will become more feasible. By establishing a model with physiographic and cultural varieties, Extension agents and farmers will be aided in their decision making relative to maximum production efficiency.

Small historic downtowns possess a tension between providing adequate parking, preserving historic resources, and creating a livable human environment. Economically thriving downtowns that have maintained a comfortable human environment while providing parking for large numbers of cars were studied. The most successful strategies were the on-street, block interior, and alley slot models because they avoid encroachment of the street into the block. All models have specific strengths that may make them appropriate for application in a particular downtown.

Research Projects

- Activity and Mode of Action of Natural Products with Fungicidal Properties — *L. Weston, P. Jeandet, C. Jaubert, and R. Harmon*
- Antimicrobial Properties of Naturally Occurring Volatile Compounds from Plants — *T.R. Kemp*
- Comparison Fertilizer Application Methods on Nutrient Release and Growth of *Pelargonium hortorum* — *D.L. Ingram and J.W. Buxton*
- Controlled Water Table Irrigation for Container Plant Production — *J.W. Buxton*
- Dayhily 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*
- Evaluation of Scab-immune Apple Cultivars Using IPM and Organic Techniques — *J.G. Strang, G.R. Brown, R.T. Jones, J. Hartman, and Ric Bessin*
- 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 Disinfestation Technique for Thrips and Spider Mites in the Greenhouse — *R.G. Anderson, D.A. Potter, and R.S. Gates*
- Evaluation of Conventional and Transgenic Summer Squash Cultivars for Yield, Quality, and Disease Resistance — *B. Rowell and W. Nesmith*
- Herbicide Evaluations in Vegetable Crops and Woody and Herbaceous Ornamentals — *L.A. Weston and R.E. McNiel*
- Interaction between Ethylene and Polyamines during Seed Germination and Early Seedling Growth — *R.L. Geneve*
- Economic Analysis of a Knowledge-based Manufacturing System for Greenhouse Rose Production — *T. Woods, R.G. Anderson, and R.S. Gates*
- Mechanism and Significance of Post-translational Modifications in the Large Subunit of Ribulose Bisphosphate Carboxylase/Oxygenase — *R.L. Houtz*
- Mechanisms of insect resistance in *Solanum berthaultii* and *S. mammosum* — *J. Snyder*
- Monitoring Wild Ginseng in Kentucky — *R.T. Jones*
- Land-use Planning for Rural Development in the Coal-producing Counties of Eastern Kentucky — *T.J. Nieman*
- Pesticide Residues and Longevity — *G. Antonious and J. Snyder*
- Potential of Pungent Pepper for Pest Control — *J. Snyder and R. Hadad*
- Postharvest Quality Evaluations of Leaf-spot-resistant Pepper Cultivars — *B. Rowell, W. Nesmith, and R.T. Jones*
- Post-translational Modifications in Ribulose Bisphosphate Carboxylase/Oxygenase — *R.L. Houtz*
- Pot-in-pot Tree Production Practices for Kentucky — *R.E. McNiel*
- 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*
- Spatial Models for Parking and Pedestrian Circulation in Historic Downtowns — *N. Crankshaw*
- Supersweet Corn Cultivar Evaluations — *J.G. Strang, R.T. Jones, J. Snyder, D. Stone, 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 Allelopathic Interference of Sorghum spp. as Mediated by Sorgoleone — *L.A. Weston, C.I. Nimba, and J.S. Pyrek*
- Use of Natural Volatile Compounds for Control of Microbial Spoilage and Quality of Strawberry during Modified Atmosphere Storage — *D. Archbold, T.R. Kemp, B. Langlois, and M. Barth*
- 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 (AES) 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.

Based on the following finding—"For the two out of three adult Americans who do not smoke and do not drink excessively, one personal choice seems to influence long-term health prospects more than any other—what we eat" (DHHS, 1988)—the Department of Nutrition and Food Science strives to maximize quality of life and human potential at the state, national, and international levels through prevention and reduction of nutritional deficiencies and diet-related noncommunicable diseases by the improvement of dietary practices and other related behavior.

Research on human nutrition, diets, and health helps to provide the means to achieve optimal health and well-being through improved nutrition with a high quality food supply. As part of research strategy for developing "A Healthy Educated Citizenry," the President's Science Advisor has identified the need for human nutrition research "that is ultimately aimed at promoting health, preventing disease, and reducing health care costs." The main thrust of AES-supported departmental research includes nutrition in relation to cardiovascular disease, cancer, eating disorders, nutrient-drug interactions, antioxidant status, and alcohol abuse. Department goals are to support the design, implementation, and evaluation of basic studies of nutrition and dietary modulation of gene expression and cellular and metabolic processes that can affect outcomes to prevent both nutritional deficiencies and nutrition-related chronic disease. Interdisciplinary collaborations are sought with other units since the National Academy of Sciences has recognized nutrition and food sciences as the most interdisciplinary of all sciences.

Alcohol

Chen

Acetaminophen (APAP) is a commonly used over-the-counter analgesic and antipyretic. Overdose or a long-term use of acetaminophen or medicinal preparations containing acetaminophen (such as Tylenol) can cause fatal hepatic necrosis or chronic nephropathy in humans or in experimental animals. Although the exact mechanism of acetaminophen toxicity is not well understood, a possible mechanism suggested for acetaminophen-induced liver toxicity is oxidative stress produced during the metabolism of this drug. We have

demonstrated that acetaminophen-induced liver cell injury involves depression of the liver antioxidant defense system and oxidative stress. The possible protective effects of two antioxidants, vitamin C and vitamin E, and two glutathione (important antioxidant in the body) precursors, N-acetyl cysteine and S-adenosyl methionine, against acetaminophen-induced depression of the antioxidant defense system were studied using liver cell culture system as a toxicity model. The results showed that pretreatment with each of the four compounds partially protected against injury to the cell membrane and partially prevented the decline of cellular glutathione levels and the depression of antioxidant enzyme activities caused by acetaminophen.

Cancer

Chow

The toxic effect of endotoxin is partly attributable to increased generation of reactive oxygen species by endogenous mediators of inflammations. Manganese superoxide dismutase (Mn-SOD), which catalyzes the dismutation of superoxide radicals, is an important antioxidant enzyme in aerobic organisms. To understand the role of superoxide radicals in the endotoxemia, studies were conducted to determine if increased express of Mn-SOD gene alters oxidative damage resulting from endotoxin treatment. The results obtained support the view that increased oxidative damage to membrane lipid plays a role in the pathogenesis of acute endotoxemia, and that increased expression of Mn-SOD gene may be attenuating endotoxin-induced oxidative damage.

Cancer

Glauert

Our objectives were to examine if hepatocarcinogenesis by peroxisome proliferators (PP) is related to the induction of oxidative damage or cell proliferation. We have studied the effect of PPs on the activation of the transcription factor NF- κ B. We first found that the PP ciprofibrate (CIP) increased the DNA binding activity of NF- κ B in rat liver. NF- κ B was also activated in rat hepatoma H4IIEC3 cells, which are responsive to PPs. We next found the antioxidants vitamin E or N-acetyl cysteine inhibited NF- κ B activation in H4IIEC3 cells. We next tested whether overexpression of a hydrogen peroxide-producing enzyme in Cos1 cells was sufficient to activate NF- κ B. Transfection of this construct into Cos1 cells in the presence of the substrate, linoleic acid, resulted in increased levels of an NF- κ B-regulated reporter gene. These

studies provide evidence for the hypothesis that hydrogen peroxide is responsible at least in part for NF-kB activation. These studies show that oxidative mechanisms may be important in the development of cancer. Dietary antioxidants therefore may be important in inhibiting cancer. Production of foods with higher antioxidant concentrations therefore may be important in the future.

Cardiovascular Disease

Hennig

Epidemiological studies indicate that dietary plant fats are negatively and dietary cholesterol positively correlated with the incidence of cardiovascular disease. However, recent research suggests that unsaturated fats may be atherogenic because of their contribution to cellular oxidative stress and that cholesterol may exhibit antioxidant properties. To test this hypothesis, rabbits were fed diets supplemented either with corn oil (CO) or CO plus added cholesterol (CO+C) for 10 weeks. Relative to native lipoproteins, endothelial cells exposed to lipolyzed lipoprotein remnants experienced a significant increase in oxidative stress, as evidenced by increased DCF fluorescence. NF-kB, an oxidative stress sensitive transcription factor, was markedly induced in cells treated with both native and lipolyzed lipoproteins derived from the CO group, compared to the CO+C group. Independent of lipolysis, oxidative stress was markedly decreased in cells exposed to lipoproteins derived from animals fed CO+C. Furthermore, dietary cholesterol supplementation protected endothelial cells against lipolytic remnant-mediated barrier dysfunction. These data continue to support the hypothesis that lipolytic lipoprotein remnants are atherogenic and that small amounts of supplemental cholesterol may provide antioxidant protection.

Eating Disorders

Mercer

The interactions among diet, food intake, and physiological status are an integral part of the profile of optimal health in human nutrition. However, the regulation of food intake, including the influence of diet composition, is not well understood. Appropriate food intake, efficiency of nutrient utilization, efficiency of growth, and effects of dietary insufficiency (qualitative or quantitative) all contribute to quality of life and resistance to disease. We have shown that food intake in male rats is correlated with central nervous system (CNS) histamine receptor binding. Our operating hypothesis is as follows: "Elevated CNS histaminergic activity is anorexigenic, and diets which activate the histaminergic system cause anorexia." Based on recent findings in our laboratory, we have extended our original hypothesis to include the observation that male and female histaminergic responses are significantly different. Differential histaminergic responses in males and females offer a possible insight into the preponderance of female eating disorders, particularly anorexia nervosa (AN), a serious health problem in the United States, with occurrences ranging up to 5 in 100 in teenage females. More than 90 percent of anorexics are female. AN has the highest mortality rate of any psychiatric disorder.

Research Projects

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

Plant Pathology

Research efforts are directed toward three major goals: a) understanding determinants of infection and pathogenesis in viruses and microorganisms which invade plants; b) understanding determinants of resistance in higher plants; and c) managing plant diseases in as environmentally benign and economically viable manners as are practical.

Infection and Pathogenesis

A bioassay was developed to measure aggressiveness of *Colletotrichum graminicola* to corn pith. Most of the fungal isolates were vigorously invasive, but one was not. Matings between this isolate and more aggressive ones were initiated to clarify the genetics underlying virulent behavior. The bioassay is potentially valuable to corn breeders, since current screens for resistance to anthracnose stalk rot are time-consuming. Progress was also made toward determining a method for conducting insertional mutagenesis in *C. graminicola*. Clarification of the genetics of *C. graminicola* should improve control options for this damaging pathogen.

Polygalacturonase (PG) may be a virulence factor for the chestnut blight fungus, *Cryphonectria parasitica*. However, when the gene encoding the basic PG produced in culture was disrupted, mutants induced cankers similar in size to those induced by the parental strain, demonstrating that this PG was not a virulence factor. The PG produced *in vivo* was acidic. Attempts were made to characterize a major acidic PG produced in cankers for additional gene disruption studies.

Magnaporthe grisea is a pathogen of diverse grasses. In Kentucky, it has caused serious losses to golf course fairways seeded with perennial ryegrass. It is also a pathogen of worldwide renown through inciting blast in rice. The *M. grisea* *BUF1* gene suffers high frequency mutation in certain sexual crosses. Characterization of the *BUF1* locus in a number of mutant progeny revealed that the gene had been deleted through intrachromosomal recombination, and that these events affected the chromosome of just one of the parental strains. High frequency *BUF1* deletions occurred only in heterozygotes resulting from crosses between parents with different *BUF1* alleles. Molecular and genetic characterization of *M. grisea* should shed light on its notorious pathogenic variability.

Tobacco mosaic virus (TMV) particles undergo bidirectional disassembly when introduced into host cells. Progeny negative-strand viral RNA begins to be produced at about the same time that 3'-to-5' disassembly is initiated. Particles containing mutant forms of the viral RNA in which large sections of the 126 kDa and 183 kDa protein open reading frames were missing were not disassembled in the 3'-to-5' direction when

introduced into cells. However, they were disassembled when the inoculum contained purified TMV RNA. The 126 kDa and/or the 183 kDa protein may play(s) a role in the completion of disassembly of TMV particles at the onset of infection.

Specific binding between the coat protein (CP) and the helper component (HC) of the tobacco vein mottling potyvirus (TVMV) was characterized. The HC interacted with either virions or CP monomers originating from the aphid-transmissible TVMV-AT but not from the non-aphid-transmissible TVMV-NAT. There was a strong correlation between the aphid transmissibility of a series of TVMV variants having mutations in a particular amino acid domain of the CP and their ability to bind HC. Mutants of TVMV with key amino acid substitutions in the CP failed to infect tobacco plants systemically. A certain net charge evidently must be maintained near the CP N-terminus for systemic virus movement to occur.

Infectious RNA transcripts representing the genomic RNAs of two strains of peanut stunt virus, PSV-ER (supports replication of satellite RNA) and PSV-W (defective in satellite RNA support) were used to construct reassortants. Support of PSV satellite RNA replication mapped to RNA 1 of PSV-ER. Infection of tobacco with PSV subgroup II strains induced unusual cytoplasmic ribbon-like inclusions, the induction mapping to PSV-W RNA3.

The first pathway-specific step of ergot alkaloid biosynthesis in the fungus *Claviceps purpurea* is catalyzed by 4-(gamma,gamma-dimethylallyl)tryptophan (DMAT) synthase. Ergot alkaloids are also produced by fungal endophytes of forage grasses. The ergot alkaloids can cause episodes of toxicity to livestock. The DMAT synthase gene was cloned from *Claviceps fusiformis* and two isolates of *C. purpurea*. Amplification of the DMAT synthase gene from the endophyte, *Neotyphodium coenophialum* (= *Acremonium coenophialum*), revealed a product of expected size. Obtaining the DMAT synthase gene is essential for genetic modification of the endophyte to reduce or eliminate its ability to cause livestock toxicosis.

Resistance

The endophytic grass symbionts belonging to the fungal genera *Epichloe* and *Neotyphodium* increase plant resistance to stress. One of the bioprotective mechanisms involves symbiosis-specific alkaloids. Among the various classes of alkaloids produced, the most abundant are the saturated 1-aminopyrrolizidines (loline). N-formyl loline was demonstrated to be a fungal product. A genetic analysis of loline alkaloid expression by *Epichloe festucae* was conducted. Strains differing in their ability to elicit loline accumulation

were crossed; of 49 F1 progeny, 29 caused expression (Lol+) and 20 did not (Lol-). A Lol+ was then backcrossed to the Lol- parent, and 88 backcross progeny (BC1) were tested; the ratio was 44 Lol+:44 Lol-. The segregation pattern supported the hypothesis that allelic separation at one genetic locus determines segregation of the Lol+ and Lol- phenotypes. Analysis of amplified polymorphic DNA among 53 BC1 progeny indicated a marker in all 26 Lol+ progeny but in none of the 27 Lol- progeny. Since research is ongoing to reduce or eliminate production of the livestock-toxic ergot alkaloids, it will be essential to understand the expression and roles of protective alkaloids remaining. Findings may also be foundational to the use of lolines as protectants for other cultivated plants.

The double-stranded (ds) RNA isometric viruses associated with a debilitating disease of *Helminthosporium victoriae*, the causal agent of victoria blight of oats, were characterized and designated Hv190S and Hv145S. The Hv190S virus has an undivided dsRNA genome. Its complete nucleotide sequence revealed two large overlapping open reading frames, one coding for the coat protein and the other containing the consensus RNA-dependent RNA polymerase motifs. The 190S and 145S dsRNAs are not related. Each of the 145S dsRNAs has unique sequences. Highly purified 145S virions contained four dsRNAs; their capsids were essentially those typical of the 190S virions. Evidently, the 145S dsRNAs are packaged in capsids encoded by the 190S virus and the 145S dsRNAs are satellites. Virus-infected isolates of *H. victoriae* secrete a broad-spectrum antifungal polypeptide, "victoriocin." Purified victoriocin was resolved as a single band with an estimated molecular mass of 8 kDa. The aim is to isolate the gene encoding victoriocin and to transform plants with this gene. The transgenic plants would likely be resistant to several fungi.

A putative protein kinase, designated Hv p68, was overexpressed in virus-infected *H. victoriae*. The activated form of Hv p68 is proposed to play a role in inhibition of fungal protein synthesis, contributing to loss of virulence, and possibly providing the means for novel disease control.

Management

Research was pursued to address biological control of soilborne plant pathogens for sustainable crop production. One necessary step here is to understand the natural mycorrhizal fungal populations in soil. Spores of glomalean (arbuscular) mycorrhizal fungi indigenous to soils in a central Kentucky cropping system were about 50 percent viable. The range was 35 to 60 percent, regardless of spore population density, time of year, or crop. Viability sometimes rose at the time new spores were produced in late summer and fall, but not appreciably.

Factors influencing important tobacco diseases—in particular, blue mold—were studied to improve management options. Computer monitoring of environmental parameters indicated that site characteristics, including soil type and moisture, may affect blue mold intensity. Knowledge gained from monitoring shifts in the blue mold pathogen popula-

tion, from metalaxyl-sensitivity to metalaxyl-resistance, as well as from understanding changes in production practices favoring build-up and spread of the disease, was essential to the Commonwealth's obtaining from the Environmental Protection Agency an emergency exemption for the use of Acrobat MZ to protect the tobacco crop in 1997. Evaluation of experimental fungicides, and the pursuit of labeling for these as appropriate, was continued. While commercially acceptable burley cultivars highly resistant to blue mold are unavailable, assessment of current and experimental varieties revealed that Tennessee 90 has significant tolerance. An unexpected consequence of these various observations was the realization of how much greater a contribution to loss is systemic blue mold than had been appreciated.

Continuing investigations into the effect of cropping sequences on soybean cyst nematode (SCN) population densities and soybean yields indicated the importance of achieving a proper match between the SCN race and the resistant soybean variety grown as well as the importance of testing for SCN levels before planting a susceptible variety.

The detrimental effect of *Aphanomyces* root rot in alfalfa was shown to persist beyond the seeding year. However, use of appropriate resistant varieties can save growers the loss of more than \$500 per acre in stand establishment costs and first-year yield income. Moreover, since many alfalfa fields are on highly erodible land, and since stand establishment requires inputs of agrichemicals and tillage operations, improving the rate of successful establishment reduces the run-off of chemicals and soil.

Although the epidemiology of apple scab primary infections has been studied extensively, less is known of environmental parameters affecting secondary infections by conidia and consequent disease spread. Research was undertaken to clarify these latter issues. Results indicated that: a) infection levels increase with increasing inoculum doses up to about 100,000 conidia/ml; b) apple seedling susceptibility varies with the time of year; c) infection levels increase with increasing duration of leaf wetness; and d) apple leaf susceptibility varies with leaf size. Individuals who create epidemiological models for field management of apple scab will now have data that can be used to help manage secondary infections.

Research Projects

- Aggressiveness and Pathogenicity Determinants in Anthracnose Stalk Rot of Corn — *L.J. Vaillancourt*
- Altering Ergot Alkaloid Biosynthesis by the *Acremonium* Endophyte of Tall Fescue — *C.L. Scharld*
- Basis of Virus Virulence/Host Resistance in Potyvirus-tobacco Interactions — *T.P. Pirone*
- Biological Control and Management of Soilborne Plant Pathogens for Sustainable Crop Production — *J.W. Hendrix*
- 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*
- Development of a Cucumovirus-based Tobacco Transient Expression Vector — *S.A. Ghabrial*

- 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*
- Genes of Grass Endophytes Determining Expression of Protective Alkaloids — *H.H. Wilkinson*
- Genetic Analysis of Avirulence/Virulence in *Magnaporthe grisea*, a Pathogen of Rice and Other Grasses — *M.L. Farman*
- Genetic Analysis of Bioprotective Alkaloids Produced by Grass Symbionts — *C.L. Schardl*
- Genetic Determinants of Parasitism and Pathogenicity in *Colletotrichum graminicola* — *L.J. Vaillancourt*
- Host-pathogen Interactions between *Castanea* sp. and the Chestnut Blight Fungus — *L. Shain*
- Identification of Disease-resistant Cultivars of Turfgrasses and Corn — *P. Vincelli*
- Improvement of Alfalfa Stand and Yield Using *Aphanomyces*-resistant Varieties — *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*
- Mechanisms of Transmission of Plant Viruses that Have a Nonpersistent Vector Relationship — *T.P. Pirone*
- Mechanisms of Virus Particle Disassembly during the Establishment of Plant Virus Infections — *J.G. Shaw*
- Molecular Basis of Disease in a Virus-infected Plant Pathogenic Fungus — *S.A. Ghabrial*
- Molecular Systematics of Grass Symbionts of the Fungal Family Clavicipitaceae (Hypocreales) — *C.L. Schardl*
- Mycorrhizal Fungi in Relation to Health and Vigor of English Boxwood — *J.W. Hendrix*
- Mycovirus-host Interactions in Diseased Isolates of *Helminthosporium victoriae* — *S.A. Ghabrial*
- National Dogwood Anthracnose Survey — *J.R. Hartman*
- Optimizing and Testing the Utility of a PCR Technique to Detect the Tobacco Blue Mold Pathogen — *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*
- Rotation of Resistance Genes to Maintain *Heterodera glycines* below the Damage Threshold — *D.E. Hershman*
- Speciation of *Stenocarpella* Fungi Causing Ear Rot in Kentucky — *P. Vincelli*
- Strategic Utilization of Resistance Genes to Prevent Virus-induced Yield Losses — *S.A. Ghabrial*
- Structure and Function of the Viral dsRNAs of the Plant Pathogenic Fungus *Helminthosporium victoriae* — *S.A. Ghabrial*
- Systemic Induced Resistance in Corn — *L.J. Vaillancourt*
- The Potential for "Vaccination" of Corn against Stalk Rot Diseases — *L.J. Vaillancourt*
- The Role of Signal Transduction in Pathogenicity of *Collectotrichum graminicola* to Corn — *L.J. Vaillancourt*
- Urban Tree and Ornamental Plantings Disease Evaluations — *J.R. Hartman*
- Viral Satellite RNAs as Riboregulators of Gene Expression in Tobacco — *S.A. Ghabrial*
- Wheat Head Scab Survey — *D.E. Hershman*
- 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 processor 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, a full-time, temporary inspector checks and samples 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 296 of 638 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.

Income From Fees in 1997:

Feed	\$650,548
Fertilizer	660,228
Milk	63,229
Soil testing	157,498
Seed tags, testing, and licenses	367,101
TOTAL	\$1,898,604

These cash receivables were substantiated on 2,634 fertilizer tonnage reports, 3,056 feed tonnage reports, 788 seed reports, and 16 milk reports. These reports were checked for accuracy and compared with field audits of the firms submitting them. An additional \$2,600 was realized through auditing and correcting inaccurate reports.

Milk Regulatory Program

C. D. Thompson

The milk regulatory program administers the Kentucky Creamery License Law and Regulations. The program's primary objective is to ensure the proper payment for milk produced in Kentucky. These payments must be based on a series of accurate weights and tests. The program provides a marketplace environment that is fair and equitable for all individuals and firms involved in the dairy industry. In 1997 the Division:

- Reviewed and issued licenses to 13 milk buyers, 56 testers, 407 sampler-weighers, and eight raw milk transfer stations.
- Analyzed and administered action on 3,216 official samples.
- Conducted nine producer pay record audits.
- Conducted 64 inspections at 16 milk laboratories.
- Trained and examined 49 sampler-weighers and 12 testers.
- Conducted 327 inspections of 165 sampler-weighers.
- Conducted 10 inspections of raw milk transfer stations.

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 1997 the program:

- Administered actions on 4,029 official samples of commercial feed involving 25,886 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 eight feed mills that mix restricted drugs in feed. An additional 33 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 33rd Annual Feed Management Seminar at Shakertown, Kentucky. Thirty-six professionals from 18 states, Canada, and the FDA attended.
- Implemented the new Kentucky feed labeling requirements for livestock and poultry feeds.

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 1997 the program:

- Administered actions on 3,658 official and 177 unofficial samples of fertilizer involving 11,258 tests of the 1,000,000 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 1997:

- A team of nine inspectors performed 4,785 inspections of the processing, manufacturing, and marketing of feed, fertilizer, and seed. In addition, one inspector traveled throughout the state to inspect and sample specialty feed, fertilizer, and seed products in urban areas. One inspector covered the state to administer the Creamery License Law.
- Inspectors collected the following numbers of official samples for laboratory verification of appropriate constituents and quality:

Feed	4,029
Fertilizer	3,658
Seed	2,770
Milk	3,216

Seed Regulatory Program

D.T. Buckingham

The seed regulatory program assures Kentucky farmers and urban consumers of quality seed and promotes fair and equitable competition among seed dealers and seedsmen. In 1997 the program:

- Collected and tested 2,770 official seed samples.
- Issued stop-sale orders on 340 official seed samples and 535 violative seed lots at seed dealer and seed processor locations.

- Cooperated with the USDA-Seed Branch regarding shipments of seed into Kentucky that were in violation of the Federal Seed Act.
- Issued 259 permits to label seed and registered 437 seed dealer locations.

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 1997 the seed laboratory tested the following number of samples:

Official seed samples	2,770
Regular seed samples (service)	4,776
Certified seed samples (service)	490
Tobacco seed samples (service)	1,108
TOTAL	9,144

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 to seedsmen and livestock farmers for the presence of the fungal endophyte in tall fescue seed and live fescue tillers.

Soil Testing Service

F.J. Sikora (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.

Samples analyzed in 1997 were:

Soil	Number	% Increase
Agriculture	33,862	23
Home lawn and garden	6,107	-2
Strip-mine reclamation	35	-29
Commercial horticulture	616	-2
Greenhouse	48	-43
Research	10,259	20
Atrazine residue in soil	144	11
Animal waste	239	232
Nutrient solution	97	-48
TOTAL	51,407	18

Robinson Substation

Research and demonstration trials at Quicksand and Robinson Forest are primarily conducted by the departments of Agronomy, Horticulture, and Plant Pathology. Horticulture research consists of trials with fruit, vegetable, and ornamental flower and shrub cultivars for both commercial and home gardens. Agronomy research includes livestock forage, grain, and burley tobacco production systems.

Agronomy

Kura clover (*Trifolium ambiguum* Bieb.) is a long-lived perennial legume that closely resembles white clover but spreads vegetatively by rhizomes. Unfortunately, low seedling vigor has been identified as a limitation to successful establishment of kura clover.

A field study was initiated in 1997 on a Pope silt loam soil at University of Kentucky's Robinson Experiment Station at Quicksand to evaluate the success of vegetative establishment of kura as affected by sprigging rate and method of incorporation. The study tested four sprigging rates (187, 374, 560, and 747 lbs/A) and four methods of sprig incorporation (surface broadcast, cultipak, disk, and disk plus cultipak). Kura sprigs were harvested for this study by USDA-NRCS Plant Materials Center personnel using a Bermuda King sprig digger. All treatment were replicated four times in a split-plot design where incorporation method is the main plot and subplots are sprigging rates. Sprigging dates for 1997 and 1998 were March 13 and March 17, respectively.

Vegetative establishment success is measured by counting the number of live plants within a randomly tossed 5ft² quadrant for each plot. Plant counts are made three times during each growing season. At the end of the 1997 growing season, plant counts ranged from 22 to 0 plants/5ft² quadrant. Highest live plant numbers were measured at the 374 lbs of sprigs/A rate incorporated with cultipacking only. This study will be repeated in 1999.

The Robinson Experiment Station continues to serve as one of the primary testing sites for tall fescue, orchardgrass, and red clover varieties in Kentucky. This project is managed by the UK Forage Variety Testing Program to assist forage producers in eastern Kentucky with the selection of forage species and varieties evaluated under more regional growing conditions.

A 27-acre educational site on the Laurel Fork property of the Robinson Forest is being developed to demonstrate the agricultural potential of reclaimed surface-mined land in eastern Kentucky. Field trials addressing forage species selection, establishment, and management for livestock production and wildlife habitat are available. 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 channel catfish production is being monitored.

Three years of data have been collected at the Robinson Experiment Station on the effects of rate and time of N application on the yield and quality of burley tobacco. At this site, the maximum cured leaf yield was obtained at 200 lbs N/A. At higher rates of N, yield did not increase, but residual soil nitrate at harvest increased significantly. This site was also used to evaluate pre-sidedress soil nitrate testing as a tool for making N fertilizer decisions. The pre-sidedress test was well correlated to cured leaf yields.

Use of ammonium sulfate (AS) for surface application of nitrogen (N) onto no-till corn has been reported to improve yields by increasing the proportion of fertilizer N as ammonium (NH₄) as compared to nitrate (NO₃), and possibly due to a response to sulfur (S).

A study was initiated in 1997 on a Pope silt loam soil at the Robinson Experiment Station to determine what effect ammonium sulfate (AS) in a nitrogen (N) fertilization program would have on yields of no-till corn. The study tested rates of N (0, 80, 160, 240 lbs/A), sources of N (ammonium nitrate (AN), half AN and half from AS), and AN plus S (from granular elemental S). Treatments tested provided NH₄/NO₃ ratios of 3/1 and 1/1 at three rates of N application. Additionally, S was tested for a yield response at three rates of S application. All fertilizer was broadcast over the corn about five weeks after emergence and all treatments were replicated four times in a complete randomized block design. Corn (var. Pioneer 3140) was no-till planted at 25,000 seeds/A on May 16, into corn residues from the previous year. Ear leaf samples were taken at silking and tasselling to measure content of N and S. Grain yields were taken October 15, at a moisture content of 21.6 percent. Neither varying NH₄/NO₃ ratios nor applying S significantly affected yields or N and S content of the ear leaves. Grain yields were increased at each rate of N applied. This study will be continued in 1998.

Horticulture

The departments of Horticulture and Plant Pathology continued for the third year the field evaluation of bell pepper cultivars with different levels of resistance to bacterial leaf spot (BLS). Thirteen cultivars with BLS resistance and three 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. The spring of 1997 was abnormally wet, and conditions were very favorable for early 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 Boynton Bell, PR 9701R-5, Summer Sweet 890, Yorktown, and XR3 Aladdin.

Increased market demand and profits for fall decorations (pumpkin and ornamental corn) have caused tremendous increases in production. To be competitive, Kentucky growers need attractive, disease-tolerant, highly marketable pumpkin and ornamental corn cultivars. In 1997 five pumpkin cultivars were evaluated for fall jack o'lantern production. The cultivar Gold Rush was found to be an excellent selection. It produced a higher yield and had a superior storage life when compared to the standard Howden. Kentucky growers also needed an attractive large-eared (8 to 12 in.) ornamental corn cultivar. Because most ornamental corn is open pollinated, cultivars tested in the past were subject to disease and environmental stress problems that made them unsuitable for our growing conditions. Five large-eared ornamental corn cultivars were evaluated in 1997. Three of these cultivars were new hybrids just released for commercial trial. The three "new Indian Art hybrids" had attractive well-developed ears and good resistance to stalk lodging and ear rot problems. Another cultivar, Earth Shades Mixed, was the best-producing open-pollinated cultivar in the 1996 trials. It produced attractive ears again in 1997. However, Earth Shades did have 2 percent to 3 percent Fusarium ear rot, whereas the Indian Art hybrids had none. Additional cultivar trials will be conducted in 1998. We now have four commercially available large-eared ornamental corn cultivars with bright colors, tight shucks, excellent tip fill, and resistance to lodging. Results from these trials are being used to help expand sales and acreage of Kentucky's fall ornamental crops by providing a reliable diverse sales package.

A study involving field diagnostic tools for estimating nitrogen needs for fresh market tomatoes was jointly conducted by Agronomy and Horticulture faculty. Hand-held Cardy meters were found to be effective for rapidly measuring fresh petiole sap nitrate nitrogen levels in fertigated fresh market tomatoes. Four nitrogen (N) fertigation rates were tested, including a 0 N/ac rate. Results in 1997 showed that there was a significant increase in total US# 1 tomato yield due to fertilizer nitrogen application, even when an initial soil mineral N test showed 164 lb mineral N/ac available for plant growth. Early season (when tomato fruit were 1½ in. dia.) Cardy meter petiole sap NO₃-N levels temporarily dropped just as they did in 1996. Growers applying some preplant nitrogen would avoid this drop. There was no significant difference in total yield for any treatment receiving nitrogen. In fact, treatments receiving 225 lb of N were not significantly different in yield of US#1 large tomatoes than those receiving no nitrogen. Kentucky growers in many cases

are applying too much nitrogen to their tomato crop and may actually be reducing potential yields. Previous trials have shown that many Kentucky soils contain high levels of plant-available nitrogen prior to fertilization. Trying to relate soil mineral nitrogen level to tomato N response may prove to be too difficult. However, work will continue in an effort to determine the correlation between weather, initial soil mineral nitrogen levels, and tomato crop nitrogen requirements. Petiole sap NO₃ data appear to be less variable than soil mineral N data and a better predictor of tomato yield response.

Because Kentucky growers produce approximately 15,000 acres of sweet corn each year, 36 Supersweet sweet corn cultivars were evaluated for commercial production in 1997. The cultivars were planted in late spring for a late summer harvest. Supplemental irrigation was required to successfully mature the sweet corn. Hot and dry weather during much of the growing season was a good test of cultivar adaptability. Flagship, Fortune, Jupiter, and Envy were the best yellow sweet corn cultivars tested. Sweet Symphony, SummerSweet 7902BC, and SummerSweet 8102BC were the best bicolored corn cultivars. Sweet Ice, Snow Mass, Summer Sweet 7631W, Summer Sweet 8101W and Summer Sweet 7101W were the best white cultivars tested.

Research Projects

- Effect of Beef Cattle Stocking Rates on Herbaceous Species Composition and Nutrient Recycling on Mine Lands — *M.Collins, D.C. Ditsch, C.D. Teutsch, J.W. Turner, and T. Hamilton*
- Bacterial Leaf Spot Resistant Bell Pepper Cultivar Evaluations — *Brent Rowell, R.T. Jones, and William C. Nesmith*
- Determining Fertilizer Nitrogen Needs for Fresh Market Tomatoes — *R.T. Jones and D.C. Ditsch*
- Effects of Ammonium N to Nitrate N Ratio and S on Yield of No-till Corn — *K.L. Wells, D.C. Ditsch, J.E. Dollarhide, and J.W. Turner*
- Evaluation of Acrobat MZ for Blue Mold Control in a Tolerant vs. Susceptible Burley Tobacco Using a High-pressure Sprayer — *W.C. Nesmith and Mason Morrison*
- Evaluation of Burley Tobacco Varieties and Breeding Lines as to Their Susceptibility to Blue Mold under Field Conditions — *W.C. Nesmith and Mason Morrison*
- Evaluation of Experimental Fungicides for Control of Tobacco Blue Mold — *W.C. Nesmith and Mason Morrison*
- 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. McNeil*
- High Bush Blueberry Cultivar Evaluation — *R.T. Jones and Chris Lindon*
- Ornamental Corn Cultivar Evaluations — *R.T. Jones and Chris Lindon*
- Supersweet Sweet Corn Evaluations in Eastern Kentucky — *R.T. Jones, Chris Lindon, John Strang, and Darrell Slone*
- Tall Fescue, Orchardgrass, and Red Clover Variety Trials — *J.C. Henning, R. Spitaleri, and D.C. Ditsch*
- Vegetative Establishment of Rhizo Kura Clover — *D.C. Ditsch and J.W. Turner*

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 and 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 employment continue to show the value of home-based businesses to local economies. Reasons for operating home-based businesses are the flexibility in work time and location of work, the desire to be at home with children, and the independence and satisfaction from being one's own boss.

Faculty conduct research in conjunction with the Kentucky Kids Count Consortium, which includes an annual data set of various indicators of the demographic and socioeconomic status of Kentucky's children and families. Research continues on family service care providers and families receiving service support as part of a statewide study used for program planning and evaluation by Kentucky's state family preservation and family support service agencies. This ongoing study has had much influence on the directions of state family agencies in Kentucky.

Other research results on factors affecting family well-being have had important impacts in Kentucky. Faculty have presented results to public commissions and distributed publications on the status of families and the state and local social service structures that affect families. The impacts of welfare reform and the transition of welfare recipients to the work force have been examined recently. As new federal and state guidelines take effect through the new Temporary Assistance for Needy Families programs, data have been used by state agency personnel and local officials in determining

how welfare reform transition should be conducted and potential impact on Kentucky communities. These various results have been used for legislative recommendations by the Kentucky State Legislative Research Commission on Poverty and for developing social service plans and evaluating impacts 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 results have concentrated on characteristics of communities that have been successful with economic and social development. Results have also been used by local communities to help determine local resources that can be utilized for economic development planning.

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. A panel of 30 to 50 dairy farm families has been established to participate in a five-year study of the dairy farming community. The panel study has addressed farm characteristics, practices, operations and performance, labor management, family structure, business strategies and goals, perceptions and priorities, and off-farm employment. Research results have been used to determine educational needs of these farmers for planning and adapting their operations to meet future conditions.

Kentucky was 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 were 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 projects examined the impacts of changes in the international trade system on the structure of agriculture and rural communities, impacts on rural communities from changes and proposed changes in the federal tobacco program and potential decreases in income from tobacco farming, and post-productionist agricultural sector adjustment, such as environmental amenities and landscape preservation, in lieu of traditional commodity production objectives.

Research Projects

- Family Preservation and Family Support Services Evaluation and Technical Assistance — *P. Dyk*
- Forest Fire in Eastern Kentucky: How the Role of Fire in the Ecosystem is Perceived and Controlled — *L. Garkovich*
- 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 and P. Dyk*
- 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, L. Garkovich, and G. Hansen*
- Social Capital Attributes of Families, Schools, and Communities — *P. Dyk*

Veterinary Science

The Department of Veterinary Science serves as the Commonwealth's major provider of field and laboratory programs aimed at safeguarding the health and welfare of Kentucky's animal industry. Highlights of 1997 included increases in the overall number of accessions examined at the Livestock Disease Diagnostic Center, the number of samples tested at the Equine Blood Typing and Research Laboratory, and an exceptional output of scientific publications and presentations from the Maxwell H. Gluck Equine Research Center and the two other units of the department.

The department was identified as one of a select group of programs at the university that were considered to have achieved a significant level of national/international recognition for the quality of their respective research and graduate education programs.

Maxwell H. Gluck Equine Research Center

The Gluck Center continues to serve as a major resource for the equine industry in Kentucky as well as nationally and internationally.

Immunogenetics — Major emphasis was on development of a gene map for the horse, mapping genes with human homologues to horse chromosomes. Other ongoing studies focused on characterization of the major histocompatibility gene family which controls the immune response to various infectious and allergic diseases in the horse.

Infectious Diseases — The re-emergence of certain old diseases and the emergence of a previously undescribed equine infection in 1997 underscore the continued importance of infectious diseases as a source of economic loss for the horse industry.

Research on **equine herpesvirus-1 (EHV-1)** focused on achieving a better understanding of the immune mechanisms of the horse necessary for engendering resistance to EHV-1 abortion. Studies have identified antiviral cytotoxic T lymphocytes (CTLs) and local immunity within the respiratory mucosa as essential parts of the protective immune response against EHV-1.

The research program on **equine influenza** has made a major contribution to helping explain the high incidence of this disease in horses previously vaccinated against this infection. The finding that conventional vaccination of foals at too young an age is ineffective at stimulating an antibody response has significantly impacted current vaccination protocols. Maternally derived antibodies have been found responsible for vaccine interference.

Research on **equine infectious anemia** focused on improving the accuracy of diagnostic tests for this disease.

Models were developed to study pathogenicity of the virus in different equid species and the ability of immunized horses to resist infection with heterologous virus. A complete map of the virus genome has been developed, and investigations are under way to identify the virulence factors through modifying particular genes in the virus.

A multi-national collaborative research study has provided a unique insight into the genetic relatedness of a diversity of ancestral and more recent isolates of **equine arteritis virus**. Efforts aimed at validation of the RT-PCR and ELISA tests as internationally acceptable tests for the diagnosis of this infection in the horse are in progress.

Intranasal vaccines containing the immunogenic region of SeM, the protective M protein of **Streptococcus equi**, have been constructed using polylactide microparticles, cholera toxin chimaeras, and avirulent salmonella vectors. Large doses of microparticles elicited SeM specific mucosal IgA. CT chimaera and avirulent salmonella vaccines stimulated systemic but not mucosal antibodies to SeM.

A PCR assay has been developed and validated for the rapid detection of **Leptospira spp** in equine uveitic fluids and urine. A highly immunogenic heat shock protein (Lk74) of *Leptospira kennewicki* has been sequenced and expressed in *E. coli*. An ELISA test based on this protein has been developed and is effective in measuring ocular and serum antibody to *L. kennewicki* in horses.

Parasitology — The ability of certain parasites to develop resistance to various anthelmintics has been the focus of a multi-year study of long-term drug resistance, especially in small strongyles. Research on equine tapeworms has confirmed the therapeutic efficacy of pyrantel tartrate and pyrantel pamoate at certain dosages against the cecal tapeworm *Anoplocephala perfoliata*.

Ongoing studies into the taxonomic classification of *Sarcocystis neurona*, the cause of **equine protozoal myeloencephalitis**, suggest this organism, though related to the earlier described *S. falcatula*, is genetically distinct from it. While both *Sarcocystis spp.* utilize the opossum as a host, *S. neurona* was the more commonly found organism in a limited number of feral opossums that have been examined.

Pharmacology and Experimental Therapeutics — "Threshold levels" for the commonly used local anesthetics lidocaine, mepivacaine, and ropivacaine have been determined. A new analytical method based on LC-MS-MS was developed for the detection and quantitative estimation of bupivacaine and ropivacaine. Support continues for the national "Testing Integrity Program (TIP)" to ensure the effectiveness of drug testing in various racing jurisdictions. Results of an extensive field and experimental trial suggest that

diclazuril is a safe and reasonably effective treatment for severe cases of equine protozoal myeloencephalitis.

Reproductive Physiology — Neuroendocrinological control of seasonal breeding in mares has revealed that the timing of the nonbreeding season occurs earlier in young versus older mares. Furthermore, in a small proportion of mature mares, breeding activity may occur throughout the year. Currently under investigation is the possibility that age or metabolic status based primarily on energy reserves play a critical role in this phenomenon.

Studies are continuing into determining the nature of the "communications" between the maternal uterus and the embryo to ensure maintenance of a normal pregnancy. For the first time, the equine uterus has been shown to produce oxytocin. Both the equine estrogen and progesterone receptors have been cloned, and studies are ongoing into how these steroids control gene expression in the uterus. Among other products which we have shown are produced by the conceptus during early pregnancy are phospholipase A2, calcyclin, and pregnancy associate-glycoprotein.

Livestock Disease Diagnostic Center

The Livestock Disease Diagnostic Center is a full-service animal health and disease diagnostic laboratory. The overall number of accessions increased by approximately 6 percent over that for 1996. 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.

Different *salmonella* serotypes cultured from equine necropsies conducted at the Livestock Disease Diagnostic Center over the past two years were investigated for their association with illness and death in foals and older horses. In approximately 50 percent of the cases, death was considered attributable to the salmonella infection. No one serotype was found to be especially prevalent in this study.

Equine Blood Typing and Research Laboratory

In 1997, 36,844 blood samples were tested for 33 breed registries. Testing of genetic markers to develop a linkage map of the horse and identification of genetic markers for disease traits of economic significance, e.g. *Epitheliogenesis imperfecta*, in certain horse breeds, and juvenile cataracts in the Boston Terrier breed are under investigation. Population genetic studies into the genetic variation in domestic and feral horse populations are continuing as is a collaborative study with researchers in Chile to develop a gene map for the alpaca.

Research Projects

- 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*
- 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 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*
- Gene Mapping of New World Camelids — *E.G. Cothran*
- Genetic and Mechanistic Analysis of the Equine MX Antiviral Gene — *T.M. Chambers*
- Genetic Basis of *Epitheliogenesis imperfecta* in the Horse — *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*
- Hemagglutinin Antigen of Equine-2 Influenza Virus: Surveillance, and Molecular Characterization of Isolated Virus Strains — *T.M. Chambers*
- How Conceptus Proteins Influence Prostaglandin F2 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*
- Immunological Significance of the Hypervariable Region of M-like Protein of *Streptococcus zooepidemicus* — *J.F. Timoney*
- In vivo* Evaluation of Infectivity, Pathogenicity, and Immunogenicity of Different Novel Candidate Live Equine Influenza Virus Vaccines — *T.M. Chambers*
- Mapping the Gene for Combined Immunodeficiency Disease in Horses — *E. Bailey*
- Mechanism of Influenza-induced Cytopathology in the Respiratory Tract of the Horse — *T.M. Chambers*
- Melatonin and Seasonal Reproduction in Mares — *B.P. Fitzgerald*
- M-like Proteins of *Streptococcus equi* in Virulence and Immunity — *J.F. Timoney*
- Molecular Cloning and Characterization of Estrogen and Progesterone Receptors from Horse Endometrium: Comparisons between Pregnant and Nonpregnant Mares — *K.J. McDowell*
- Molecular Cloning and Expression of Oxytocin in Equine Endometrium — *K.J. McDowell*
- Mucosal Immunogenicity for the Horse of a Chimaera of Cholera Toxin and the Protective M Protein (SeM) of *Streptococcus equi* — *J.F. Timoney*
- Musculoskeletal Injury Program — *T. Tobin*
- New Therapeutic Approaches to Equine Protozoal Myeloencephalitis (EPM) — *T. Tobin*

Pathogenesis of Natural Infection of Horses with *Sarcocystis neurona* — D.E. Granstrom
Regulation of EIAV Replication and Disease — C. Issel
Research in Equine Pharmacology — T. Tobin
Sequence Analysis of Class I and Class II MHC Genes in Equidae — E. Bailey
Synteny Mapping of the Horse — K.A. Graves
Testing Integrity Program (TIP) — T. Tobin

The Effect of Electrolytes and Minerals on the Gastrointestinal Flora — T.W. Swerczek
Thresholds Research — T. Tobin
Use of Avirulent Salmonella Vectors for Stimulation of Mucosal and Systemic Antibody Responses to the Protective M Protein (SeM) of *Streptococcus equi* — J.F. Timoney
Use of Microencapsulation for Stimulation of Nasopharyngeal Mucosal Responses in the Horse — J.F. Timoney

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(In addition, members of the department published 58 abstracts.)

Other Research in Nonrefereed Publications

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- Mello, Indaue Ieda Giriboni.* The effect of high oil and high protein varieties of corn on growth performance, carcass yield and fatty acid composition of broiler chickens.
- Noel, David Chris.* Textural and sensory characteristics of low-fat beef sausages with added water and polysaccharides at various pH.

- Ntirampea, Godelive.* Effects of exposure to selected natural volatile compounds on the survival of bacteria in vitro and on the microflora of strawberry and blackberry fruits during storage.
- Parker, A.L.* The effects of niacin supplementation on exercise metabolism and niacin status in horses.
- Strickling, Judy.* Evaluation of oligosaccharide addition to dog diets: Influences on nutrient digestion and microbial populations.
- Turner, Maquel.* Functionality differences between red and white chicken muscle fibers.

Biosystems and Agricultural Engineering

- Huang, Qian.* The impact of building operation of ground source heat pump underground heat exchanger design.
- Lim, T.* Filter strip length effects on quality of runoff from grazed pastures.
- Nan, Tao.* Sunlit plant growth chamber with vapor pressure modification.

Entomology

- Dixon, Thomas J.* Biology and ecology of *Clubiona abbotii*, a predator of Lepidopteran egg.
- Melcher, Heidi L.* Biology of the introduced pine sawfly, *Diprion similis* (Hartig) (Hymenoptera: Diprionidae), with emphasis on diapause induction, its parasitoid complex, and appearance of gynandromorphs in Kentucky.

Forestry

- Blankenship, Beth A.* Response of eastern white pine, soil nutrients, and microbial biomass to prescribed fire in the Red River Gorge.
- Hilpp, Gene K.* Multiple product volume equations for yellow-poplar in eastern Kentucky.
- Hurst, Tracy E.* Foraging area, habitat use, population estimates, and food habits of Rafinesque's big-eared bat in southeastern Kentucky.
- Larkin, Jeffery L.* A comparison of avian communities occupying tall fescue and native warm-season grassland habitats.
- Swenk, David W.* An analysis of the effects on hillslope hydrologic processes by forest roads in eastern Kentucky.

Horticulture and Landscape Architecture

- Finneseth, Cindy.* Propagation of North American pawpaw (*Asimina triloba*).

Veterinary Science

- Dirikolu, Levant.* Anti-inflammatory agents in Thoroughbred racehorses.
- Stamper, Shelby.* Seroprevalence of antibodies in two selected populations of horses—one occurring in central Kentucky and the other in horses on land controlled by the federal government.
- Sullivan, Nicole.* Molecular cloning and chromosomal localization of the equine estrogen receptor.

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 1997.

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.

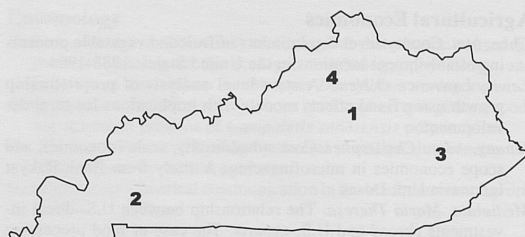
Coldstream — Maine Chance — Spindletop Farms — Beef and dairy cattle, poultry, horses, sheep and swine, forages and grain crops, tobacco and turf.

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 Phase I 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, or-



- 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

naminals, 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, fruits and vegetables, and beef management.

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Statement of Current General Fund Income and Expenditures Fiscal Year 1997

Income

Federal Funds:		
Hatch Amended		\$ 3,685,870.00
Regional Research		769,670.00
McIntire-Stennis		390,808.00
Animal Health		69,783.00
Total Federal Funds		\$4,916,131.00
Non-Federal Funds		21,019,067.00
Total Funds		\$25,935,198.00

Expenditures

	Federal	Non-Federal	Total
Personal Services	\$4,142,572.00	\$13,843,321.00	\$17,985,893.00
Travel	107,923.00	90,245.00	198,168.00
Equipment	125,571.00	557,873.00	683,444.00
Other Operating Expenses	540,065.00	6,527,628.00	7,067,693.00
Total Expenditures	\$4,916,131.00	\$21,019,067.00	\$25,935,198.00

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