Approved: 2-5-97
Date

MINUTES OF THE HOUSE COMMITTEE ON ENVIRONMENT.

The meeting was called to order by Chairperson Steve Lloyd at 3:30 p.m. on January 28, 1997 in Room 526-S of the Capitol.

All members were present except: Rep. Richard Alldritt - excused

Committee staff present: Raney Gilliland, Legislative Research Department
Hank Avila, Legislative Research Department
Mary Torrence, Revisor of Statutes
Mary Ann Graham, Committee Secretary

Conferees appearing before the committee: Dr. Marc Johnson, Dean, Kansas State University
Michael Byington, Wichita Industries and Services for the Blind
Dale Lambley, Assistant to Secretary of Agriculture
Sally Nellor, Dairy Farmer
Kent Moore, President, Board of Directors Water PACK

Others attending: See attached list

Chairman Steve Lloyd called the meeting to order at 3:30 p.m. Minutes of the January 21, 22 and 23 meetings were distributed for the committee to review. A map and information on an advisory group meeting concerning Kansas Surface Water Quality Standards, scheduled for January 30, were distributed and explained by Rep. Laura McClure. These meetings are open to the public and are being held at the State Defense Building, Rm 11, 2800 S. Topeka Blvd., Topeka, KS.

The Chairman had two bill introductions from the Kansas Department of Health and Environment, Bureau of Waste Management. The first was amendments to solid waste statutes. Rep. Joann Freeborn made a motion the bill be introduced, Rep. Sloan seconded. Motion passed.The second was operating flexibility at small exempt landfills, Rep. Tom Sloan made a motion the bill be introduced, Rep. Kent Glasscock seconded. Motion passed.

The Chairman stated that Monday, February 3 is the final day for the committee to draft a bill.

Chairman Lloyd welcomed Michael Byington, Wichita Industries and Services for the Blind, to the committee. (See attachment 1) Mr. Byington had a bill introduction concerning hunting and fishing permits for handicapped persons. Rep. Kent Glasscock made a motion the bill be introduced, Rep. Joann Freeborn seconded. Motion passed.

The Chairman welcomed Dr. Marc Johnson, Dean, Kansas State University. Dr. Johnson distributed a memorandum he received from Daniel L. Devlin, Extension Specialist and Coordinator Environmental Quality, (See attachment 2) answering questions raised at a House hearing the week of January 20. He also gave the committee an annual report by the Kansas State University Agricultural Experiment Station and Cooperative Extension Service "Promoting Conservation and Protecting the Environment", (See attachment 3) and information from the Kansas State Research and Extension on "Water Quality". (See attachment 4) Dr. Johnson introduced Dale Lambley, Assistant to Secretary of Agriculture; Sally Nellor, Dairy Farmer, and Kent Moore, President Board of Directors of Water Protection Association of Central Kansas.

The Chairman welcomed Dale Lambley, Assistant to the Secretary of Agriculture to the committee. Mr. Lambley spoke to the committee concerning the roles and needs of the Kansas Department of Agriculture and Kansas State University. KSU's role is education and research, the Department of Agriculture is principally regulatory. Education and research support is essential to regulatory programs. The three key areas the state regulatory agencies are working with include: pesticides and groundwater state management plan, requirements of Clean Water Act and the Governor's Water Quality Initiative. KSU has positioned itself to provide KDA, KDHE and other agencies strong support as they attempt to deal with these issues. KDA and KSU have pooled their financial resources and have an excellent working relationship. Discussion and questions followed.

Chairman Lloyd welcomed Sally Nellor to the committee. Mrs. Nellor and her husband Dick Nellor own and operate a dairy farm in southern Johnson county. She spoke to the committee concerning a livestock waste management system they installed with the help of the Kansas State Extension program, which helped with the design and the on going operations of the system. She described the waste system and how it operates. Discussion and questions followed.

The Chairman welcomed Kent Moore, President Board of Directors for Water Protection Association of Central Kansas. Mr. Moore gave a report to the committee in support of Kansas State University Agricultural Experiment Station and Cooperative Extension Service. (See attachment 5) The mission of the Water Protection Association is to promote, foster, and encourage the beneficial, economical and sustainable use of quality water. Discussion and questions followed.

Dr. Johnson gave a brief summary on the Swine Lagoons Study in southwest Kansas. These studies are currently on going. Discussion and questions followed.

The Chairman reviewed the committee agenda for Wednesday, January 29, which will be a Post Audit Report: Reviewing the Department of Health and Environment's efforts to protect water from pollution caused by confined livestock feeding operations and response by KDHE.

The Chairman thanked Dr. Johnson, staff members and guests for their presentation. He asked if there was a motion to approve the minutes, Rep Don Myers made a motion they be approved, Rep. David Huff seconded. Motion passed.

The meeting adjourned at 5:03 p.m

The next meeting is scheduled for January 29, 1997

# HOUSE ENVIRONMENT COMMITTEE COMMITTEE
# GUEST LIST

DATE: 1-28-97

| NAME | REPRESENTING |
|---|---|
| Alan Steppat | Pete McGill & Associates |
| KENT L. MOORE | WATER PROTECTION ASSOC. OF CENTRAL KS. |
| Kim Sellers | Farmer |
| Sally Neeser | " |
| Marc Johnson | K-State |
| Steven W. Wyatt | Ks Farmers Union |
| Marty Vanier | KS Ag Alliance |
| Karl Mueldener | KDHE |
| Steven Graham | KSU |
| Leslie Kaufman | KS Farm Bureau |
| SUE PETERSON | K-STATE |
| Mike Jensen | Ks Pork Council |
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PLEASE REPLY TO: Michael Byington
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(913) 233-2539 (FAX)

January 28, 1997

TO: House Environment Committee

SUBJECT: Bill request

I am here on behalf of Wichita Industries and Services for the Blind (WISB). Despite the "Wichita" in our name, we have several programs which we operate State-wide, and we have manufacturing facilities which employ large numbers of persons who are blind and severely visually impaired in Pittsburg, Kansas, and Kansas City, Kansas. Later this spring, we will announce a name change to better reflect our State-wide status. This bill request comes from some of our Pittsburg employees.

We have several employees who were avid hunters before losing all or most of their vision. These individuals continue to enjoy going with their sighted friends as they hunt, but they also miss the opportunity to purchase a hunting license, and take game under that license for use by their families.

Although current statutes contain some accommodations for disabled hunters, the current provisions do not address the needs of someone who wishes to take game, but who is unable to safely and effectively use a firearm or other hunting equipment due to visual or physical disabilities.

The attached legislation would allow such an individual to obtain a hunting license and take game under that license by directing other hunting companions, also licensed hunters, in the shooting or use of hunting equipment.

I have also added provisions which provide the same accommodations with regard to bow hunting. This is placed in a separate statute only because current K.S.A. structures necessitate doing so.

A proposed draft to achieve the above referenced legislative intent is attached. The existing statutes are





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shown by the left collumn and the proposed changes are shown by the right collumn. Additions are underlined.

Thank you. Please let me know if you have questions concerning this proposal.

Sincerely yours:

Michael Byington
Director of Governmental Affairs

MB/mjb

Statute # 32-931
Chapter 32.--WILDLIFE, PARKS AND RECREATION
Article 9.--LICENSES, PERMITS, STAMPS AND OTHER ISSUES
Title Handicapped hunting and fishing permit.

(a) Whenever a disabled person is unable by reason of physical infirmity to hunt and fish in the normal manner, the secretary may issue a handicapped hunting and fishing permit upon receipt of the fee prescribed pursuant to K.S.A. 32-988, permitting such person to hunt and fish from land or water vehicles, but such permit shall not authorize any person to shoot from any highway, as defined in K.S.A. 8-1424 and amendments thereto.

**(PROPOSED LANGUAGE WILL BE UNDERLINED. LANGUAGE PROPOSED TO STRIKE WILL BE IN STRIKEOUT MODE.)**

**(a) Whenever a disabled person is unable by reason of physical infirmity to hunt and fish in the normal manner, the secretary may issue a handicapped hunting and fishing permit upon receipt of the fee prescribed pursuant to K.S.A. 32-988, permitting such person to hunt and fish from land or water vehicles, but such permit shall not authorize any person to shoot from any highway, as defined in K.S.A. 8-1424 and amendments thereto.**

**(new section b) Any person having a permanent physical or visual disability to the extent that such person cannot safely hold, aim, or shoot a firearm, or to the extent that such person cannot hold, operate, or safely and appropriately utilize other equipment involved hunting or fishing, as certified by a person licensed to practice optometry, ophthalmology, or medicine and surgery, in this state, shall be eligible to obtain a hunting or fishing license having all privileges and restrictions of such license when issued to a non-disabled person, except that, such license shall be clearly marked with the designation "DISABILITY ASSISTANCE PERMITTED." Such marking and designation shall permit a companion, also holding the hunting or fishing license appropriate to the activities being carried out, to operate firearms or other**

hunting or fishing equipment for and on behalf of the "DISABILITY ASSISTANCE PERMITTED" hunter or fisher as that individual directs. The "DISABILITY ASSISTANCE PERMITTED" hunter and fisher shall have all rights, privileges, responsibilities and restrictions available to all hunters and fishers, including those connected with obtaining of special stamps, and permits, and shall have the right to take game as allowed by such stamps and permits.

(b) The secretary may adopt, in accordance with K.S.A. 32-805 and amendments thereto, rules

~~(b)~~ (c) The secretary may adopt, in accordance with K.S.A. 32-805 and amendments thereto, rules

32-932

32-932

Title Physical disability, crossbow permits.

Title Physical disability, crossbow permits.

(a) Any person having a permanent disability to the extent that such person cannot physically use a conventional long bow or compound bow, as certified by a person licensed to practice medicine and surgery in this state, shall be authorized to hunt and take deer or antelope with a crossbow.

(a) Any person having a permanent disability to the extent that such person cannot physically use a conventional long bow or compound bow, as certified by a person licensed to practice medicine and surgery in this state, shall be authorized to hunt and take deer or antelope with a crossbow.

(new section b) Any person having a permanent physical or visual disability to the extent that such person cannot safely hold, aim, or shoot a conventional long bow or compound bow, as certified by a person licensed to practice optometry, ophthalmology, or medicine and surgery, in this state, shall be eligible to receive a hunting license clearly marked with the designation "DISABILITY

ASSISTANCE PERMITTED." Such marking and designation shall permit a companion, also holding a hunting license, to operate a conventional long bow or compound bow, for and on behalf of the "DISABILITY ASSISTANCE PERMITTED" hunter as he or she directs. The "DISABILITY ASSISTANCE PERMITTED" hunter shall have all rights and privileges to hunt and take deer or antelope as are afforded to any and all hunters holding licenses for that purpose.

(b) The secretary of wildlife and parks shall adopt, in accordance with K.S.A. 32-805, and amendments thereto, rules and regulations requiring permits to hunt deer or antelope pursuant to subsection (a) and providing for the approval of applicants for such permits and the issuance thereof. In addition, the secretary may adopt rules and regulations limiting the times and areas for hunting and taking deer and antelope and limiting the number of deer and antelope which may be taken pursuant to subsection (a).

~~(b)~~ (c) The secretary of wildlife and parks shall adopt, in accordance with K.S.A. 32-805, and amendments thereto, rules and regulations requiring permits to hunt deer or antelope pursuant to subsection (a) and providing for the approval of applicants for such permits and the issuance thereof. In addition, the secretary may adopt rules and regulations limiting the times and areas for hunting and taking deer and antelope and limiting the number of deer and antelope which may be taken pursuant to subsection (a).

(c) Falsely obtaining or using a permit authorized by this section is a class C misdemeanor.

History

History: L. 1989, ch. 117, S. 1; July 1.

(c) Falsely obtaining or using a permit authorized by this section is a class C misdemeanor.

History

History: L. 1989, ch. 117, S. 1; July 1.

KSU
KANSAS STATE UNIVERSITY

**Cooperative Extension Service**

Extension Agronomy
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FAX: 913-532-6315

January 27, 1997

TO: Marc Johnson

FROM: Daniel L. Devlin
Extension Specialist and Coordinator
Environmental Quality

RE: Answering Legislative Questions

Steven Graham asked me to respond to some questions that legislators raised at a House hearing last week.

1. *A question was asked concerning a comment in the KSU publication,* ***Best Management Practices for Atrazine****.* The sentence, "However, some of these herbicides do not control ALS-resistant weeds," is included in the description section of Practice 7 - Alternative herbicides or nonchemical weed control methods. ALS-resistant weeds are weeds that have developed tolerance/resistance to herbicides whose mode of action (or how they control weeds) is to inhibit the acetolactate synthase enzyme (ALS) in plants. These ALS-resistant weeds were previously controlled by a particular ALS-inhibiting herbicide but are no longer controlled by a normal rate of the herbicide. Many of the newer herbicides developed in the last 10 to 15 years target the ALS enzyme as their method of killing weeds. This group of herbicides contains many of the alternatives to atrazine for controlling weeds in corn and grain sorghum. However, there are fields in Kansas that have developed weed populations that are resistant to the ALS-inhibiting herbicides. The comment in the publication referring to ALS-weed resistance was included to remind farmers who know they have ALS-resistant weeds in their fields that switching to the alternative herbicides listed in the publication may not provide acceptable weed control.

An explanation of ALS-resistant weeds was not included in this publication because: (1) KSU already has an active educational program teaching farmers and dealers about managing herbicide resistant weeds. Herbicide resistance strategies are taught at county meetings and at intensive weed management schools. A publication on herbicide resistance was printed several years ago and an update is planned. Pesticide manufacturers also have educational brouchures on informing farmers and dealers about herbicide resistance by weeds. Therefore, we believe most farmers that have had ALS-resistant weeds identified in their fields understand the statement as listed in the publication; and (2) space was limited in the publication:



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most of the space in the publication was used to explain atrazine runoff and best management practices.

2. *Is atrazine a groundwater concern?* Yes and no. It may be a concern in private drinking water wells in Kansas. A survey by the Kansas Department of Health and Environment in 1994 found that 16% of 825 private drinking water wells in Kansas showed detectable levels of atrazine contamination. However, only 2 or 3 of the wells had levels above the 3 parts per billion (ppb) public drinking water maximum contaminant level (MCL). The results of the 1994 survey were similar to those collected in a 1985 survey by KSU. However, I do not feel this is a result of widespread contamination of ground water by field application of atrazine. Rather, it is the result of past activities - mixing and filling sprayers near wells and also sprayer cleanout near wells following atrazine applications. Several studies in Kansas have examined atrazine leaching to ground water from field applications of atrazine. These studies found that atrazine generally stays in the upper portion of the soil profile and does not readily leach through soil and into ground water. A summary of some research conducted in Kansas on atrazine leaching is included in KS extension publication, **Best Management Practices for Atrazine**. However, management practices should still be used when applying atrazine that reduce the possibility of atrazine moving to ground water. Care should particularly be used in locations with a sandy soils and shallow depth to ground water.

3. *Once atrazine moves into surface or ground water, what happens it? Does it stay as atrazine (like nitrate) or does it break down and be eliminated over time?* When atrazine is applied and enters the environment, it starts to degrade to chemicals that have less herbicidal activity. In a typical silt loam soil in which atrazine is applied in Kansas in May, the half-life - time span required for half of the herbicide to degrade - of atrazine is approximately 60 days. When atrazine runs off into surface water, the degradation rate is much slower. For example, the half-life in reservoirs may be 1 to 2 years. However, most of our Kansas reservoirs release water throughout the year and may turn over several times a year. Therefore, generally, the degradation rate of atrazine in our surface water does not greatly impact the concentration of atrazine in surface water. When atrazine moves down through the soil profile and away from the root zone and oxygen becomes less available, the persistence of atrazine is longer. When atrazine enters ground water, the degradation rate would be longer than in surface water. However, in ground water, atrazine would still be expected to degrade to metabolites.

4. *What are the safety risks of atrazine?* First, I am not a toxicologist, so this is my opinion based on published information. Atrazine is not especially hazardous to humans as far as acute oral toxicity. For example, if ingested orally, atrazine is less toxic than table salt or aspirin. There are concerns about the chronic toxicity of atrazine. Chronic toxicity is an estimate of how a substance would affect an

organism over a long period of time. Long-term chronic toxicology studies on test animals are used to determine the "maximum tolerated level" and the "no observable effect level" for pesticides and other substances. Additional safety factors are applied to the no observable effect level, to determine the EPA's (Environmental Protection Agency) drinking water standard, which is referred to as the "maximum contaminant level" or MCL. Several years ago the EPA officially classified atrazine as a possible human carcinogen (class C) and set the MCL at 3 ppb. This is the concentration that the EPA considers safe to consume in drinking water over an average 70-year human life span. It was classified as a possible human carcinogen following a study, in a high dose group, on a strain of rats with a high spontaneous background for mammary tumors. The study found a higher rate of mammary tumors in a two generation rate study. This triggered a much higher safety factor built into the MCL. The 3 ppb MCL has a 1000 fold safety factor built in. There are no direct studies with human subjects. It is important to remember that the MCL is based on 70 years of drinking water containing 3 ppb atrazine. Health advisory levels for atrazine that are substantially higher have been established for shorter periods of time.

I hope this information is useful to you. If additional information is needed, please call me.

cc: Steven Graham

# PROMOTING CONSERVATION AND PROTECTING THE ENVIRONMENT

## SELECTED EXAMPLES

AN INFORMAL REPORT TO THE KANSAS LEGISLATURE

*by the*

**KANSAS STATE UNIVERSITY**
**Agricultural Experiment Station**
*and* **Cooperative Extension Service**

**January 1997**

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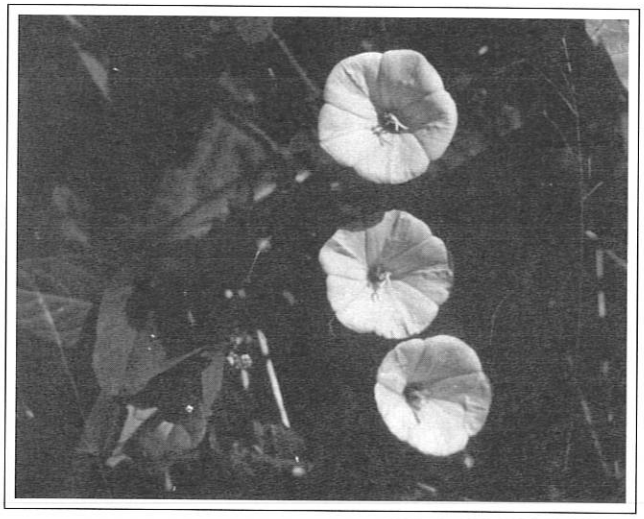
# PROMOTING CONSERVATION AND PROTECTING THE ENVIRONMENT

## SELECTED EXAMPLES

## CONTROLLING INSECTS

### The Biological Control of Field Bindweed

Field bindweed is a perennial weed that is capable of reducing crop yields by 20 percent to 80 percent. It is the most difficult perennial weed in Kansas to control and is a significant weed problem throughout the Great Plains. Field bindweed has a vining nature and is capable of reproducing from seed or from its extensive root system. It commonly occurs in roadside areas, pastures, and cropped fields where it is especially troublesome. Part of the reason why it is difficult to control is because its seeds remain dormant in the soil for up to 50 years. Secondly, the extensive root system fully infests the soil profile. Traditional control practices, including tillage and herbicides, are costly and must be repeated yearly. For these reasons, the development of new management strategies are essential and must be cost effective, self-sustaining, and provide long-term control. Biological control may offer an acceptable alternative or supplement to traditional management strategies for this weed—an approach that is sustainable, environmentally and agronomically compatible, and of benefit to farmers and others concerned with weed management.



For the past two years, KSU researchers in agronomy and entomology have been studying a moth and a gall mite from Europe that are specific feeders on field bindwind. The long-term goal is to establish these organisms as self-perpetuating components of the agroecosystem, expecting that their impact on field bindweed will reduce the weed's competitive ability. The primary focus of current research has been on the bindweed moth. Thus far, findings indicate that the moth is capable of successfully overwintering in Kansas and that it feeds equally well on a number of field bindweed biotypes. Greenhouse studies are in progress to assess the impact of the caterpillars of this moth on bindweed growth and productivity. Studies on the gall mite have focused only on assessing its overwintering potential.

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### Identifying Sorghum Hybrids Resistant to Chinch Bugs

Progress is being made in identifying commercial sorghum hybrids that are less susceptible to chinch bug infestation. Chinch bugs are a common problem during dry years, especially for sorghum growers in the eastern areas of Kansas. To protect against infestation, growers currently use soil-applied insecticides. By identifying sorghums that are less susceptible to chinch bug attack, growers may be able to reduce the amount of insecticide treatment that is currently used. In addition, the use of seed treatment insecticides—only the seed but not the soil is treated—offers an additional means to decrease the amount of environmental contamination.

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## Developing Greenbug Resistant Sorghum

K-State has been involved in a long-term effort to identify and develop germplasm that is resistant to sorghum greenbug. Since the early 1970s, a number of inbreeds has been identified and released to commercial breeders. Currently, almost half of the commercial hybrids grown in Kansas contain biotype E resistance developed by KSU and other regional universities. The search for new and better sources of greenbug resistance continues. By utilizing greenbug resistant hybrids, growers have been able to reduce the amount of foliar insecticides applied (reduction of about 100,000 acres per year in Kansas) and thereby reduce the amount of environmental contamination.

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## Important New Test Developed

A K-State entomologist has developed a single, inexpensive, and quick test that can be used to detect whether greenbugs are resistant to the organophosphate insecticides used to control greenbugs on wheat and sorghum. The technique involves placing greenbugs in a plastic dish treated with an insecticide at a concentration that discriminates between resistant and susceptible greenbugs. After two hours, resistant greenbugs are alive while susceptible greenbugs are dead. This method will allow growers, aerial applicators, consultants, and researchers to monitor greenbug populations and their resistance to insecticides.

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## Seeking Ways to Control Pests without Chemicals

Long-term research is being done on nonchemical control of insect pests. One focus has been on mechanisms for disrupting the protective coverings of the exoskeleton and skin of the insect. Another has been on the membranous lining that insects secrete to protect the alimentary canal from ingested food particles. Insects must form a new exoskeleton at each stage of growth and molt the old one in order to grow and develop to adults. Interference with the formation of this outer protective covering during the molting cycle can terminate development of crop pests and also prevent reproduction in the adult stages. Likewise, disruption of the continuously formed protective envelope that surrounds ingested food causes cessation of feeding by crop pests and eventually death. KSU research has led to discoveries of the chemical processes that insects use to form the rigid exoskeleton. Selective pest control through disruption of exoskeletal formation at critical stages is the goal. A second approach is to disrupt the peritrophic membrane envelope lining of the alimentary canal of insects. Electron microscope studies have revealed that wheat germ agglutinin interferes with the formation of peritrophic membrane and allows food particles to damage the delicate cells lining the larval midgut. Further studies have indicated that wheat germ agglutinin selectively binds to certain proteins and chitin in the peritrophic membrane and disrupts its formation. The goal of this research is to exploit the use of plant lectins or their derivatives for selective control of insect pests. Transgenic crop plants producing these larvicidal proteins in their tissues would reduce the use of toxic chemical treatments and environmental damage.

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**Entomology**
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## Finding an Alternative to a Banned Granular Pesticide

Insecticide tests by K-State researchers on sorghum showed that Gaucho, a seed treatment insecticide, is effective in controlling chinch bugs and greenbugs on sorghum. The treatment could be used to replace the banned granular pesticide Furadan, which had been used to control chinch bugs.

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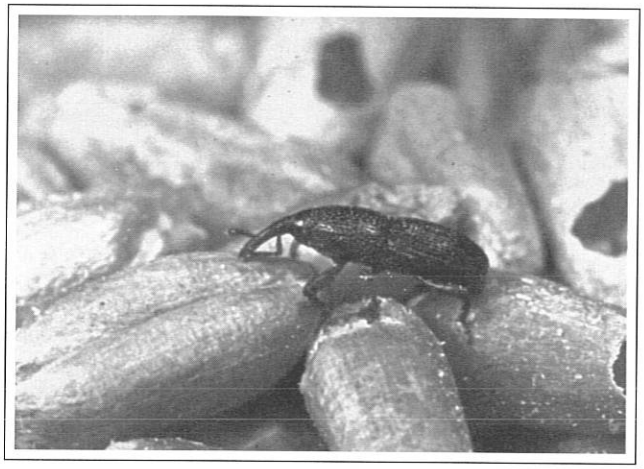

## Reducing Pesticide Residues in Stored Wheat

For years, Cooperative Extension Service personnel have stressed a chemical-based management system for preserving the quality of farm-stored wheat. However, research performed by Kansas Ag Experiment Station scientists has documented that it is highly effective to use aeration as the basis of an integrated pest management (IPM) strategy for controlling insects in farm-stored wheat. Public concern about the presence of pesticide residues in the food supply and a commitment by the U.S. government for 75 percent adoption of IPM by the year 2000 heightens the need for Kansas farmers to adopt this technology.

K-State Extension personnel and cooperating farmers demonstrated how the use of aeration controllers facilitated grain cooling and reduced insect pests in farm-stored wheat at 16 locations across Kansas. The IPM strategy was approximately 40 percent less expensive compared to traditional storage pest management practices. Personnel from commercial grain elevators, Kansas Farm Service Agency, Kansas Wheat Commission, and the American White Wheat Producers Association were involved in the project and are assisting producers in their decision to adopt this technology.

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## Genetic Engineering of Cereal Grains for Enhanced Resistance

Chitinases are induced in plants as defense mechanisms in response to pathogen infection. Using genetic engineering, scientists can develop crop plants that can produce chitinases and other defense proteins prior to infection. Such efforts are attempts to enhance the plants' resistance to fungal infection and attack by insects. At K-State, transgenic rice, tobacco, wheat, and sorghum plants have been developed that express a plant or insect chitinase gene constitutively. Testing against fungi or insects has demonstrated that, in some cases, the transgenic plants are able to withstand fungal infection or insect attack much better than control plants. This strategy of enhancing host defense is far more preferable than the use of insecticides or fungicides—both from an economic and an environmental point of view.

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## Naturally Controlling Squash Bugs

The squash bug is a major pest nationwide of squash and pumpkins. Pesticides are the only controls currently available, and they only marginally control this major pest. In addition, they may be harmful to the environment. A K-State entomologist is studying a parasitic wasp called Gyron that is a natural enemy of the squash bug. It attacks the eggs of the squash bug and could be an excellent biocontrol.

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## A New Way to Get Rid of Fleas

U.S. consumers spend about $1.1 billion each year in attempts to control fleas on their dogs and cats. A new trap for collecting fleas in homes has been developed by KSU entomologists and patented by Kansas State University. This trap is more effective than other existing traps in removing newly emerged fleas that have developed in homes (or other premises) infested with fleas. Its operation is based on the behavior of newly emerged fleas seeking a host. Fleas poised to jump on a passing host orient toward a light source or a window, and when this light source is interrupted by a host passing in front of the light the flea jumps toward the suddenly created shadow. The main feature of the trap is a green light with an on/off cycle. The short cycle simulates the shadow of a passing potential host. Fleas jump when the light goes off and are then trapped on an adhesive board placed in front of the light source. The patent for this trap has been licensed to S.C. Johnson and Son, Inc. The commercial version will provide pest control companies with a better tool to determine the extent of flea infestation in homes. Its use can lead to reduced use of insecticides in homes.

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## Decreasing Chemical Control of Sunflower Head Moth

Research by Kansas Ag Experiment Station entomologists has shown that pheromone traps can be used to monitor populations of sunflower head moth. The traps are in expensive and help growers know when chemical control of the sunflower head moth is needed. The result is that growers can protect sunflower yield potential when needed and yet not waste their money on unnecessary chemical control. A Kansas farmer who has 200 acres of sunflowers can save up to $15 an acre or a total of $3,000 if he or she doesn't need to treat.

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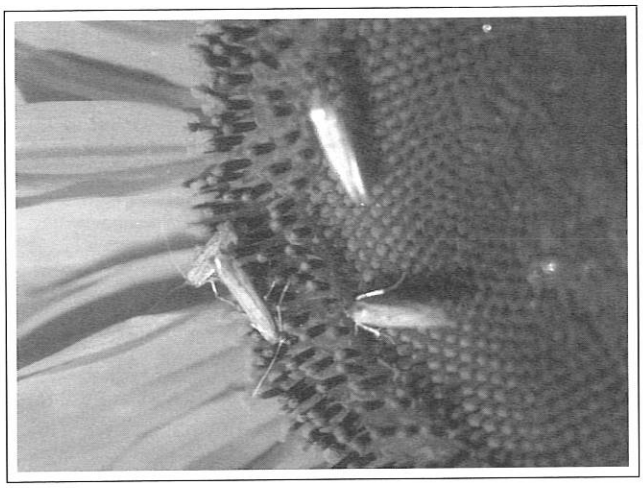

## Extension Entomology Diagnostic Lab

The Extension Entomology Diagnostic Laboratory provides county extension personnel and the general public with quick, accurate identification of insects found in homes, yards, on people and animals, and in agriculture. In addition to identification, the laboratory provides information on biology of the insect, its status as a pest or nonpest, and control measures. Most insect questions are not of economic importance and are handled without use of insecticides. Alternative control tactics are often suggested for insects that are considered harmful, decreasing chemical use as much as possible. The laboratory diagnoses about 600 samples annually submitted by county agents, companies, and the general public. In addition, a number of insect questions are handled over the telephone and by direct contact with individuals who come to the laboratory. Over 40 percent of the samples submitted come from horticultural settings, followed by households (40 percent), agriculture (15 percent), and animal/medical (2 percent). Response to a submittal occurs within three days after receiving it. Educational information on insects is provided by the Diagnostic Laboratory through Cooperative Extension Service publications and reports.

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## Eliminating Termites with Fewer Chemicals

New technology is emerging in the marketplace for the control of termites. Termite-baiting technology has been the subject of research by private industries such as DowElanco, FMC, and American Cyanamid in recent years. The first commercialization of this technology in Kansas was in 1995 on a very limited basis by DowElanco. Extension representatives are evaluating this technology as it evolves in the marketplace.

Other termite baiting systems are under development by other companies and will enter the marketplace soon. As they emerge, they will be similarly evaluated. Through this process, Extension can continue its role of providing unbiased information by comparing competing technology, products, and services, regardless of who developed them.

Termite-baiting technology utilizing an insect growth regulator can reduce the amount of insecticide applied. For example, the label rate for a conventional termite barrier treatment of a 1,900-square-foot house with a full basement and attached garage requires 500 to 600 gallons of termiticide containing 40 to 48 pounds of insecticide. The new termite-baiting technology requires an average range of 0.0012 to 0.012 ounces of dry insect growth regulator to protect the same house.

Specially designed bait stations in DowElanco's Sentricon system are installed at a maximum of 20 feet apart in the soil around the house. The stations are monitored by a pest control technician on a regularly scheduled basis. When termites are found in the bait stations, the monitoring device is replaced by a tube containing an insect growth regulating (IGR) chemical that is spread by the feeding termites throughout the colony. When termites are no longer found in the tubes for a period of two months, the colony is considered to be eliminated. The total number of IGR-containing tubes used will vary with colony size and other factors but normally ranges from 1 to 10. Each tube contains 0.0012 ounce of IGR. Furthermore, the IGR is not applied to the soil, which virtually eliminates any chance for soil, water, or structural contamination.

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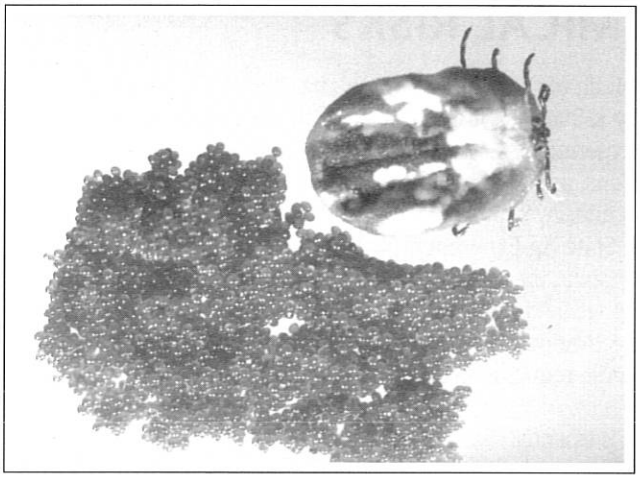

## Informing the Public About Potentially Dangerous Insects

Prior to 1989, when Extension agents were inundated by questions about ticks and Lyme disease, there was no Kansas Extension program in medical entomology. A bootstrap program was launched through which thousands of clients received information on ticks and tick-borne disease. As a spin-off from this program, a research collection of 1,150 lots of ticks has been established and continues to grow. Thus, K-State has a research base, representing Kansas species, from which to draw further knowledge. Utilizing public educational meetings, news releases, printed material, and the entire Extension organization, this program has become a primary source of information for Kansas doctors, pest control operators, county and school nurses, regional installations of the U.S. Army, the Kansas Department of Health and Environment, and the general public.

A user-friendly identification key to Kansas ticks was written and made available to county agents and personnel of other agencies and businesses. This has facilitated more rapid and accessible identification of ticks—an essential step in determining individual risk of disease. Public consciousness has been raised, and the nature of questions received reveals a generally greater level of public knowledge.

Ten years ago people thought Kansas was free of Lyme disease, but now 20 to 40 cases per year are diagnosed and treated for this potentially debilitating disease. During the same time period, the incidence of two sometimes deadly tick-borne diseases, Rocky Mountain spotted fever and tularemia, has declined from 35 to 40 cases per year in Kansas to only 5 to 10. This reduction may be at least partially the result of Kansas State University's multifaceted educational program.

Through serving other types of requests from these clientele, a broader program in medical entomology has evolved. Now the program addresses all biting and stinging arthropods, disease vectors, and dermatological and respiratory manifestations of allergy to insects.

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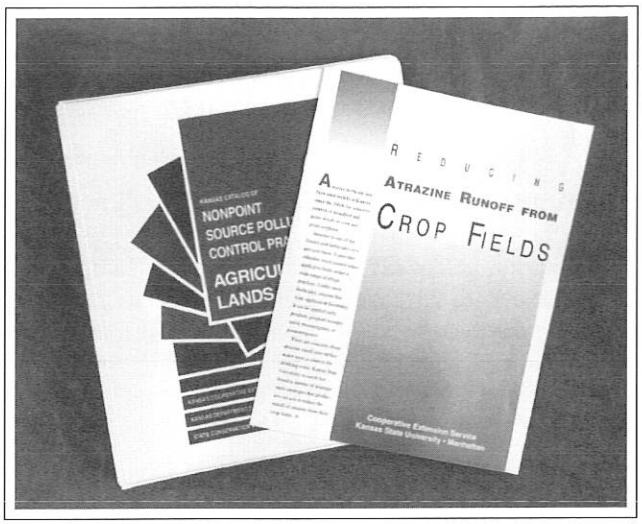
# REDUCING CHEMICAL RISKS




## Kansas Catalog of Nonpoint Source Pollution Control Practices

K-State Extension provided the leadership, in cooperation with the Kansas Department of Health and Environment and the State Conservation Commission, in compiling a catalog on the principles of nonpoint source pollution. It also lists 31 pollution control practices for agriculture. Each practice is evaluated for its effectiveness in reducing pollutants and for its cost to install and maintain. The catalog is intended to be used by county extension agents, county nonpoint source pollution coordinators, conservation districts, natural resource conservation service personnel, and other professionals. The information in the catalog will be used to help farmers and ranchers develop better environmental and economic management strategies.

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## New Publication Focuses on Reducing Atrazine Runoff

A colorful new KSU Agriculture publication will help producers reduce atrazine levels in Kansas surface water supplies. The eight-page publication, titled "Reducing Atrazine Runoff from Crop Fields," lists 10 specific best management practices (BMPs) that farmers and chemical applicators can use to reduce the potential for atrazine runoff from crop fields. There are one or more practices to fit every tillage practice or field situation. These practices involve little extra expense and result in better weed control than the traditional use of atrazine that is surface applied at planting time.

Much of the information on atrazine BMPs was generated by K-State research funded by the Kansas Agricultural Experiment Station, the Kansas Corn and Sorghum commissions, and agribusinesses. Field research on atrazine runoff is underway at several northeastern Kansas sites, including K-State Ag Experiment Station fields at Powhattan and Ottawa, the Foster Farm near Rossville, and elsewhere. Other field research focuses on atrazine formulations and application timings to maintain weed control objectives while reducing field runoff potential.

It is essential that these research results are communicated to farmers and chemical applicators. Adoption of these practices should reduce atrazine runoff. This will help maintain good water quality and could help keep the product commercially available. Atrazine remains an immensely effective and economical herbicide for broadleaf weed control and grass suppression in Kansas corn and sorghum fields. It is applied to over 75 percent of Kansas corn and sorghum acreage. As new herbicides are developed for these crops, most are used in combination with atrazine.

Some of the atrazine applied to fields is inevitably lost in surface water runoff. But by using the BMPs explained in this new K-State publication, runoff losses can be reduced.

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## Reducing Chemical Use in Farming Through Biotechnology

Rice and tobacco plants have been genetically engineered at K-State to express a plant or insect chitinase gene. The expression of this gene alone or in combination with other defense proteins confers upon the host plant greater resistance to fungal and insect pests, which could result in reduced use of chemicals used in growing these plants. Similar work is now being done in the genetically more complicated wheat and sorghum.

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## Reducing the Use of Nitrogen Fertilizer

Many of the soils in Kansas have relatively high levels of soil organic matter, which can be a valuable source of nitrogen for plants. Accurate determination of these organic sources of nitrogen can reduce nitrogen fertilizer needed for crop growth. Reducing the amount of nitrogen fertilizer lowers production costs and also reduces nitrogen contamination of surface water and groundwater. Nitrogen released from the soil represents 20 percent of applied fertilizer. Nitrogen released from manure, soybeans, and soil is being studied in several experiments. For example, it is estimated that in one year approximately 20 pounds of nitrogen per acre were available to corn and grain sorghum following soybean under dryland conditions. Previous research estimated a contribution of 30 pounds of nitrogen per acre under irrigated conditions. Another finding was that manure applications can maintain the nitrogen supply capability of the soil, thus reducing the need for nitrogen fertilizer. Tillage and crop rotation also can affect the timing of nitrogen released. The economic benefit to Kansas farmers is difficult to determine, but if nitrogen fertilizer use could be reduced by approximately 22 pounds per acre on 2 million acres of the state's corn and grain sorghum acreage, then economic savings of $8.9 million would be realized (assuming nitrogen cost at 20 cents a pound). Additional savings could be realized through reduced contamination of groundwater resources.

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## Making Cakes without a Dangerous Chemical

Flours used to make the most common cakes in the United States are bleached with chlorine gas. This bleaching not only whitens the flour and the cakes made from the flour but also alters the cake-baking properties of the flour. Flours that have been treated with chlorine can be used with formulas containing much higher levels of sugar. This is considered a more desirable cake in the United States. The use of chlorine gas, a highly poisonous and corrosive chemical, is considered to be an environmental and safety hazard. The use of chlorine also has been questioned from a food safety perspective; however, to date, no actual problems have been documented. Research in the K-State Grain Science and Industry Department has shown that, by heating the flour and slightly modifying the cake formula, cakes of equal or better quality can be made compared to those made from flours treated with chlorine.

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## Kansas Farmers at Greater Risk of Cancer

A Kansas Ag Experiment Station researcher found that Kansas farmers experienced an inflated risk of cancer morbidity from 1980 to 1990. Farmers were found to be at an increased risk of morbidity for non-Hodgkins lymphoma; Hodgkin's disease; multiple myeloma; leukemia; and cancers of the lip, bone and connective tissue, prostate, brain, and skin. The cost of excessive cancer morbidity to the Kansas economy is currently unknown.

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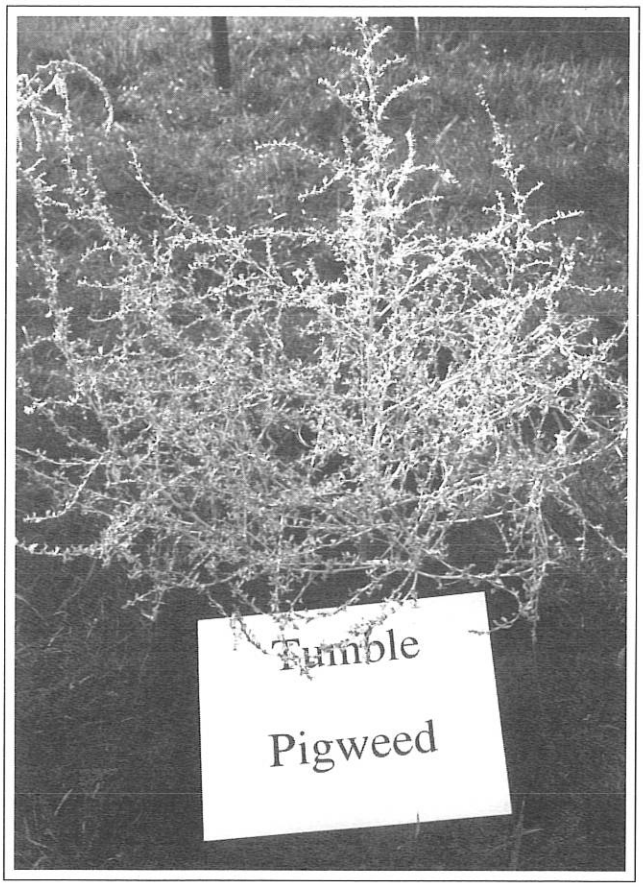
3-9

# WEED CONTROL




## A Machine That Can Identify Weeds

It can be difficult for equipment operators to locate weeds and control a sprayer at the same time when applying herbicides. A researcher at K-State is investigating a machine that can identify weeds common to Kansas wheat fields. The vision device would be able to distinguish between weeds, crops, and soils. This new equipment would allow selective application of herbicides, help farmers save on expenses, and protect the environment.

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## Biological Control of Annual Grass Weeds

Because of the widespread adoption of conservation tillage systems and a shift to semidwarf wheats, there has been a dramatic increase and spread of winter annual grass weeds that compete with wheat. At the same time, an increased awareness exists of environmental and health risks from intensive use of herbicides and increased soil erosion from tillage methods used for weed control. Scientists at K-State are evaluating native bacteria from soils and roots of plants to see if they can effectively control weeds in winter wheat. In one study, the researchers found that several isolates of bacteria reduced downy brome and Japanese brome by more than 50 percent.

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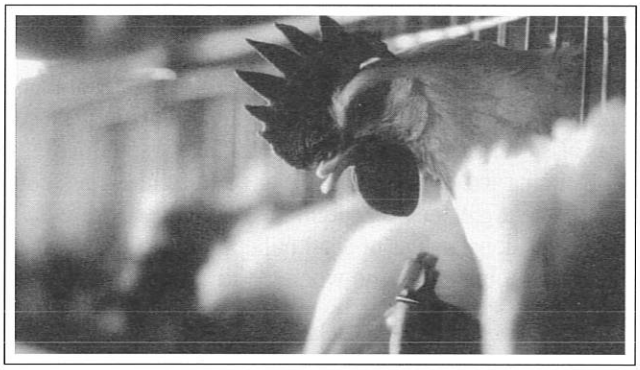
3-10

# LIVESTOCK



## Chicken By-Products

An estimated 282 million to 284 million laying hens were at some stage of egg production in 1994. Under normal practices the retired hens (or spent fowl) are processed for meat, and the remaining carcasses are rendered into value-added by-products. However, processing costs of laying fowl have increased while yield and quality have decreased due to continued selection for reduced body weight of the hens to produce a more efficient layer. The lack of demand for spent fowl has depressed prices and increased the need for finding alternative methods of disposal or rendering into value-added products. Methods to dispose of spent fowl and farm mortalities include burying, incineration, composting, or rendering, raising concerns about water and air quality, costs, and intensive management requirements. A new method for continuous flow roasting and drying of high-moisture products has been developed at K-State. Whole, ground, spent hens can be processed and dried to 6 percent moisture at low cost. An inexpensive method for rendering whole fowl into a digestible meal would increase the utilization of spent fowl. Rendering spent fowl and mortalities into a value-added by-product for the feed industry would be a preferred alternative to composting, burial, or incineration. The effectiveness of this method for producing a pathogen-free protein meal for use as a feed component is being investigated.

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## Improved Livestock Waste Handling Systems

The Herington Reservoir was polluted with livestock waste runoff several years ago, but now the quality of water is greatly improved because of the cooperative work of several livestock producers in the area, Kansas State University researchers and Extension specialists, and many other government support agencies. The Herington Reservoir serves as the source of drinking water for the communities of Herington and Hope. Extension specialists worked directly with 11 livestock feeding operations in the watershed, helping the producers design new, effective animal waste facilities to meet Kansas Department of Health and Environment (KDHE) approval. The Extension team set up demonstration projects and held field days for area producers. The team also developed long-range plans for each operation, taking costs and profits into account. The changes made in the livestock operations were expensive and took several years to complete. But the results have been positive. Levels of nearly all pollutants in the reservoir from livestock wastes are now below the safe drinking target level set by KDHE. Because of the design and location improvements made in the feeding operations, producers were able to greatly expand their cattle numbers while still reducing livestock waste pollution.

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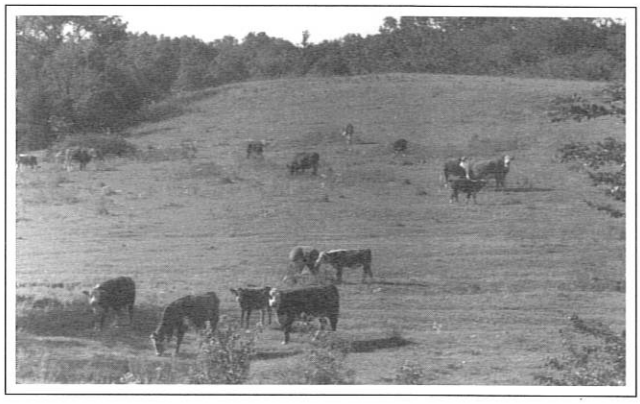

## Water Quality Publication Focuses on Grazing Lands

Livestock grazing has the potential to produce waste materials that can pollute water, but pollution from grazing lands can be controlled by proper management. Pollution control and water quality is the subject of a publication, "Managing Kansas Grazing Lands for Water Quality," by the Kansas Cooperative Extension Service and the Kansas Department of Health and Environment. The 16-page publication outlines the most important management principles that can be used to address potential pollution. It then focuses on some specific practices producers can use to improve their grazing lands.

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# CROPPING PRACTICES

## Grain Sorghum Production without Atrazine

Research is being done at KSU Agricultural Research Center–Hays to find alternatives for atrazine. Dryland plots in west-central Kansas treated with a tank mix of halosulfuron plus bromoxynil, about five weeks after sorghum emergence, produced yields equivalent to plots treated before sorghum emergence with metalachlor plus atrazine. Plots where weeds were not controlled produced 1,600 pounds of grain per acre. Halosulfuron plus bromoxynil-treated plots yielded 2,000 pounds of grain per acre even during the driest June-to-September period on record. Under current economic conditions, expected additional net income from timely weed control would be $9 per acre.

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## Importance of Crop Rotations

Even in adverse seasons, wheat grown in a wheat-sorghum-fallow cropping system produced nearly 34 bushels per acre or 72 percent more than continuous wheat at the KSU Ag Research Center—Hays. If 1995 continuous wheat acres within a 75 mile radius of Hays had been grown under the wheat-sorghum-fallow, a yield increase of almost 10 bushels per acre would have been expected. Estimated additional economic impact is $32 million, which is derived by projecting this yield increase at $4 per bushel across 800,000 acres. This clearly demonstrates the importance of choosing an optimum cropping rotation in the drier regions of Kansas.

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## An Alternate Crop for Low-Rainfall Areas in Kansas

The development of pearl millet as an alternative grain crop continues to show promise for production in low-rainfall areas of Kansas. Superior experimental hybrids produce yields similar to sorghum on silt loams and from 10 percent to 50 percent greater than sorghum when grown on sandy soils. Nutritional values of pearl millet grain are comparable to corn for human food and when fed to several classes of livestock and poultry.

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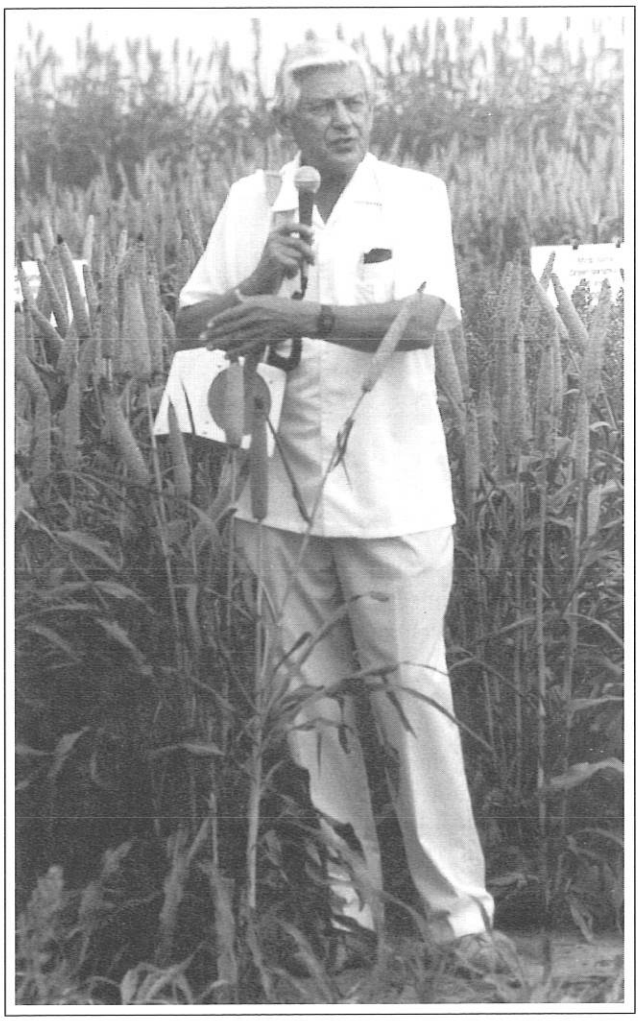



3-12

## Adapting Sunflower to Kansas

You wouldn't think that the Kansas flower would need any help, but it does when being grown as a cash crop. Research at the KSU Northwest Research-Extension Center in Colby is showing that oilseed and confectionery yields, seed quality, and crop residue for controlling wind erosion can be improved substantially by proper selection of planting date, row spacing, and plant population.

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# SOIL CONSERVATION


## Research on Soil Quality

Soil samples from several KSU experiment fields, centers, and farmers' fields are being collected and analyzed for organic matter, water-holding capacity, infiltration rate, and water-stable aggregates (contributors to soil structure or tilth) to determine which farming practices contribute most to soil quality improvement in Kansas. Farming practices that improve soil quality include cover crops; using manures and composts; crop rotations that include hay-type legumes (alfalfa and clovers); reduced tillage; and planting perennial grasses. If soil quality degrades, soil erodes more quickly, holds less water, and can compact and restrict root growth, which makes plants more susceptible to other stress factors.

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## Helping Return CRP Land to Crop Production

A KSU research and Extension project involves determining the best management practices for returning Conservation Reserve Program land to crop production while also maintaining good soil conservation practices. The Conservation Reserve Program has been a very successful program at reducing soil erosion from wind and water. It has benefited the environment, reduced production of surplus commodities, benefited wildlife, and provided income for producers. Kansans have enrolled 2.9 million acres into the Conservation Reserve Program. However, in previous set aside programs like "Soil Bank," 75 percent to 80 percent of the acres were returned to crop production with the close of the program. If history repeats itself, it is very likely that greater than 75 percent of the Conservation Reserve Program land will be returned to crop production. K-State is cooperating with private industry and other government agencies on the project.

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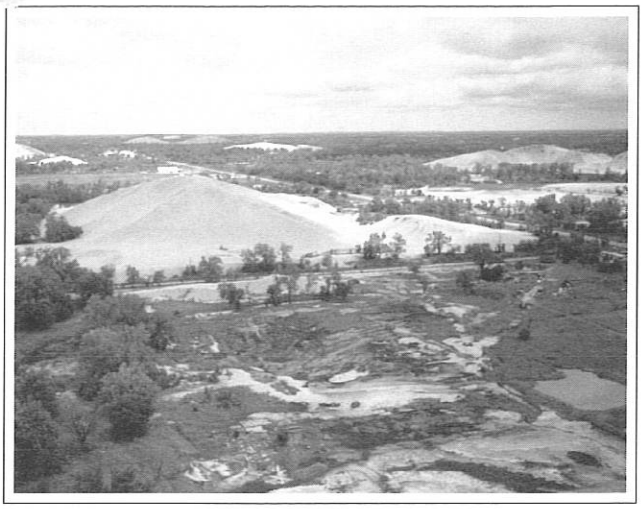

## Remediation of Contaminated Soils Using Vegetation

Several departments at K-State have combined their expertise to explore the use of vegetation to clean up soils that are contaminated with heavy metals or petroleum products. Researchers from Agronomy, Civil Engineering, Biochemistry, Geology, and Chemical Engineering are investigating the impacts of establishing vegetation on sites that have concentrations of contaminants that are a threat to the environment.

### Removing Heavy Metals

The mining and smelting areas of southeast Kansas were subjected to a century of exposure to waste materials with very high contents of lead, zinc, and cadmium. Huge piles of mine tailings and decades of emissions from smelters have left a large portion of Cherokee County with heavily polluted soils, groundwater, and surface water. Significant progress has been made in stabilizing the contamination by planting vegetation in the mine tailings. The U.S. Bureau of Mines and KSU cooperatively developed a revegetation technique of seeding directly into the mine tailings in the presence of a small percentage of composted material. With just a few exceptions, the reclamation has been highly successful. Mixtures of native and introduced prairie species are well established, and several sites are beginning to resemble the original landscape. The vegetation established on the soils will prevent further contamination of soils, air, and surface water. The plants will greatly reduce blowing dust as well as curtail surface erosion. This alone will improve the environment and living conditions for people in and around these areas. The monetary savings directly resulting from this research is considerable. The normal technique of covering mine tailings with up to five feet of topsoil would have cost millions of dollars for the area that has been revegetated.

Another alternative that is being explored is the use of phosphorous to reduce heavy metal bioavailability. Soils are amended with large amounts of phosphorous, and the chemical forms of metals are altered. Work at KSU has focused on assessing the changes in heavy metal chemistry brought about by various phosphorous sources and rates and what influence those changes might have. Other scientists have demonstrated that children who consumed lead contaminated soil treated with phosphorous adsorbed less lead than if they consumed soil that had not been treated with phosphorous. Adapting this remediation alternative would eliminate the need for excavating lead contaminated soil from residential yards.

### Cleaning Petroleum Contaminated Soils

Petroleum contamination is one of the most prevalent forms of pollution in the United States. Groundwater, surface water, and soils have been contaminated in every state through leaking underground storage tanks, large spills, pipeline breaks, and industrial processing. Although there are many technologies available for the cleanup of these sites, most alternatives are very expensive. Bioremediation of organic contaminants (the use of microorganisms to degrade pollutants) was developed many years ago as an inexpensive and more natural approach. For some contaminant compounds in soil, this is a viable method. However, some contaminants are tightly held by the soil and resist attack by microorganisms; even after years of bioremediation, some soils still are not acceptably clean.

A large, interdisciplinary research group at K-State has been studying the feasibility of phytoremediation, a special variation of bioremediation that includes the use of vegetation. The roots of plants actively explore the soil and promote very high levels of microbial activity. As a result, the small volume of soil immediately surrounding the roots has excellent potential for degrading contaminants.

The potential monetary benefits from this technology are enormous. Traditional engineering solutions to petroleum contamination can cost up to $2 million per acre. Phytoremediation is about one-half the cost of the least expensive

form of bioremediation (about $15,000 per acre compared to $30,000 per acre or more).

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## Conservation Reserve Program Economic Research

Conservation Reserve Program research has been conducted from 1994 to 1996 on nine field sites in eight counties in Kansas. Research objectives are to determine the productivity of hay production and grazing on Conservation Reserve Program land and to determine the economic feasibility of haying and grazing Conserve Reserve Program land. Five of the sites involve hay production and four involve grazing (either stocker or cow-calf). An economic analysis of hay production and grazing performance on each site showed the cost of producing hay on a per-pound basis of crude protein was lower than the cost of alfalfa on two of five hay sites. Spring burning was cost effective on all of the grazing sites. The economic analysis of grazing suggests that stocker grazing is a potentially feasible option on one-third of the Conservation Reserve Program land in western Kansas. A conceptual framework has been developed so that Conservation Reserve Program contract holders can compare net returns per acre for several alternatives.

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## Woodland's Contribute to Conservation

Kansas has more than 1.4 million acres of natural woodland, mostly under private ownership. These woodlands help control soil erosion and filter the sediment that washes into streams and rivers. They help lower home heating bills and improve livestock performance. They are important wildlife habitat. And they are utilized in wood products made and sold in Kansas. A KSU and state-federal program is helping to further expand Kansas' conservation plantings. The program sells more than 1 million low-cost tree and shrub seedlings yearly through county Extension and conservation district offices. The available species stand up well under the state's diverse growing conditions.

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## Economic Evaluation of Topsoil Loss in Spring Wheat Production

Relationships among topsoil removal treatments and additions of nitrogen and phosphorus fertilizer on dryland spring wheat yields in a Northern Plains wheat-fallow rotation were used to determine the on-site effects of topsoil loss and fertilizer applications on net returns and to estimate the value of soil. Yields were estimated from a production function, and corresponding net returns were examined for spring wheat under alternative soil loss levels and fertilization rates. The most efficient levels of fertilizer applications for farm managers at various levels of soil loss also were examined. The first centimeter of loss reduced yield from 1,719 kg/ha to 1,709 kg/ha, whereas the last centimeter of loss reduced yield from 1,362 kg/ha to 1,331 kg/ha. Each additional centimeter of loss increased the yield loss. The KSU economic analysis indicates that the optimum amount of nitrogen and phosphorus that should be applied increases with each increment of soil loss. Fertilizer reduces yield loss to some extent, but net returns continue to decline as soil loss increases. This result confirms that nitrogen and phosphorus fertilizers are imperfect economic substitutes for soil.

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## Soil-Specific Production Strategies and Agricultural Contamination Levels

The intense application of chemicals to the land surface has created concern about nonpoint-source contamination of surface water and groundwater resources. Potential economic profitability and environmental impacts of five cropping systems, including one conventional and four alternative systems were examined for northeast Kansas. Erosion/Productivity Impact Calculator (EPIC) was used to estimate potential crop yields and nitrate loadings from five cropping systems. To calculate annual net returns from each system, price and cost information from enterprise budgets was combined with the crop yields simulated by EPIC.

The Conventional System is representative of commercial farms in northeast Kansas. The Conventional System includes four major crops: wheat, grain sorghum, soybean, and corn on 640 acres. These crops are components in the five crop rotations common in northeast Kansas. Alternative System 1 has 213 acres each planted to wheat, sorghum, and soybeans. The total land in production in Alternative System 2 is divided equally between sorghum and wheat—320 acres each. In Alternative System 3, alfalfa accounts for 372 acres, with the rest used for wheat and soybeans. Alfalfa was harvested three times in the second year and once in the third year. Alternative system 4 consists of corn, soybeans, and alfalfa with a 7-year rotation. Harvesting alfalfa occurs three times in years 2 and 3. The Conventional System uses the most fertilizer of all the systems. Alternative systems 1, 2, and 3 use several chemicals; however, the amounts applied are smaller than those in the Conventional System.

System 3 has the highest net return but also the highest nitrate leachate. System 2 has the lowest level of nitrate leachate but has the lowest net return. The Conventional System has the third highest net return, second highest nitrate runoff, and second highest nitrate leachate. There is no unique system that maximizes contaminant loadings. System 2 has the lowest combined nitrate leachate and runoff but also has the lowest net return. System 3 has the highest net return and has the highest combined contaminate loading. However, System 3 has the lowest contaminated loading per dollar of net return. System 2 has the highest.

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# WASTE MANAGEMENT

## Utilizing Municipal Solid Waste Compost

Solid waste disposal is one of the most pressing environmental issues facing Kansas communities. With diminishing capacity of existing landfills and the reluctance of the general populace to create new landfills, other alternatives to straight landfilling of municipal solid waste (MSW) need to be explored. Incineration may reduce waste volume but raises as many environmental concerns as landfilling. However, composting of MSW may be more environmentally acceptable and should substantially reduce waste volume. Landfill longevity could be extended further by finding alternatives to landfilling the composted MSW. Application to agricultural land is one of the largest potential uses for MSW compost.

A study was done to determine the effect of application rate of composted municipal solid waste—with or without cow manure and with or without commercial fertilizer—on growth, composition, and yield of grain sorghum. Increases in yields of grain sorghum due to MSW compost applications were small and inconsistent. Few differences in plant uptake of nitrogen, phosphorous, and potassium due to compost were found, especially at later growth stages. Both cattle manure and fertilizer additions increased yield and nutrient uptake. Therefore, the availability of macronutrients from MSW compost may be less than from cattle manure and fertilizer. Trace metal accumulation from MSW compost in plant tissue and soil was minimal and did not appear to pose a problem.

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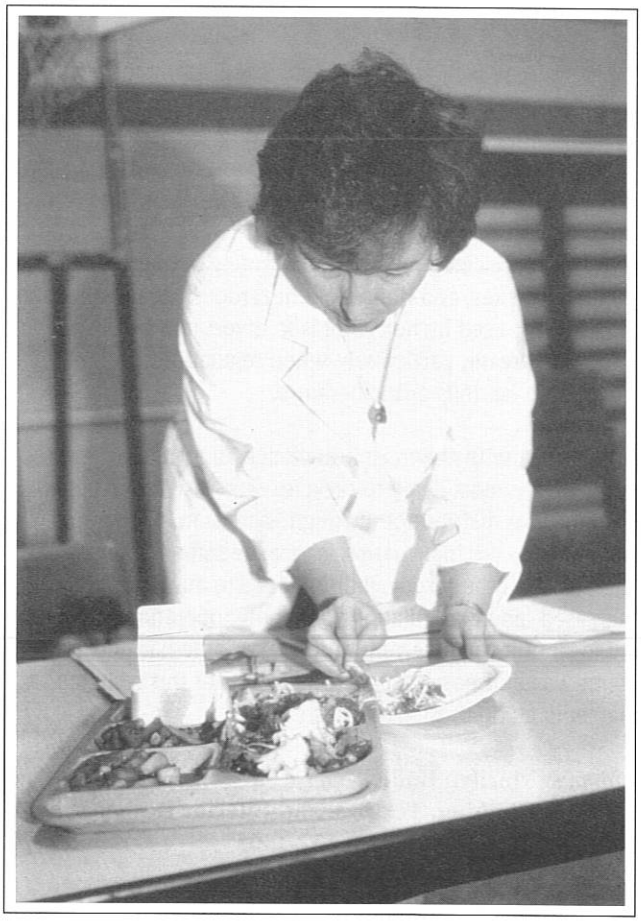
## Environmental Issues Impacting Foodservice Operations

A waste stream analysis completed in a residential care facility found that an average of nearly 1 pound and almost 1½ gallons of total waste was discarded per meal served. Packaging waste accounted for 87.7 percent of total volume of waste. Cardboard, plastic, and paperboard were the materials that could be recycled. Food waste accounted for 69.9 percent of total weight of waste discarded, which was mainly done by a garbage disposal requiring significant amounts of water and energy. If alternatives to disposal of food waste were identified, foodservice operations could save several thousand dollars annually. An infrastructure within the state that supported recycling would not only save money but would divert waste from landfills.

An "Environmental Issues Impacting Foodservice Operations" manual was developed and evaluated by content specialists and representatives of noncommercial foodservice operations, including schools, colleges and universities, and health-care facilities in Kansas, Nebraska, Iowa, and Missouri. The manual is available for a minimum fee from the KSU Department of Hotel, Restaurant, Institution Management, and Dietetics. It is designed to assist foodservice directors and managers in enhancing their knowledge of





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diverse environmental issues, including the Clean Air Act, refrigerants, water and energy conservation, hazard communication standards, and solid waste management. General resources are identified that all operations could utilize. Specific resources for the states of Kansas, Nebraska, Iowa, and Missouri are included in the manual. The manual is a valuable resource for noncommercial foodservice operators desiring to establish environmental progams.

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## A Comparison of Household Waste Management Practices

A random sample of residents in five states was surveyed by mail about their household waste management practices. Nearly 1,000 responses were received from households in Kansas (125), Iowa (182), Minnesota (312), Missouri (227), and Nebraska (120). The reported practices for disposing of household waste were compared with the programs and regulatory policies for disposing of waste in each state. The implications from this research are that governmental units desiring to reduce the amount of household waste going to landfills can learn from successful programs and policies that include:

- Curbside pick up of recyclables is a strong motivator for recycling because it reduces the effort needed by households to divert items from the waste stream.
- Beverage container deposit programs motivate consumers to recycle to recover deposits made at the time of purchase.
- Well-publicized public programs (e.g., compost sites, used oil sites, and household hazardous waste collection sites) are used by households to divert items from the waste stream, particularly when regulations prohibit disposal in landfills or incinerators.

Households with the most knowledge about the programs available are most likely to recycle. The results are being produced for distribution through Extension. The target audience for the information is local decision-makers charged with the responsibility for waste management. Increased federal regulations on landfill operations are causing local units of government to make some hard decisions about waste disposal issues. The results of this research may help guide those decisions.

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## Better Forecasting of Food Production

Foodservice in the United States is a huge industry, totaling more than $300 billion annually. Any improvements in the industry can result in substantial savings for businesses and consumers and in better utilization of resources. Ag Experiment Station scientists in the Department of Hotel, Restaurant, Institution Management, and Dietetics have demonstrated that food production can be improved by using Expert Systems, Neural Networks, and Quantitative Models, a computerized forecasting program developed by Ag Experiment Station researchers. Because consumers spend 44 percent of each food dollar away from home, better forecasting of food production, which this program can provide, means better use of raw agricultural products and labor in the hospitality industry, cost savings, more efficient operations, less waste (both food and packaging) into the waste stream, and more satisfied customers.

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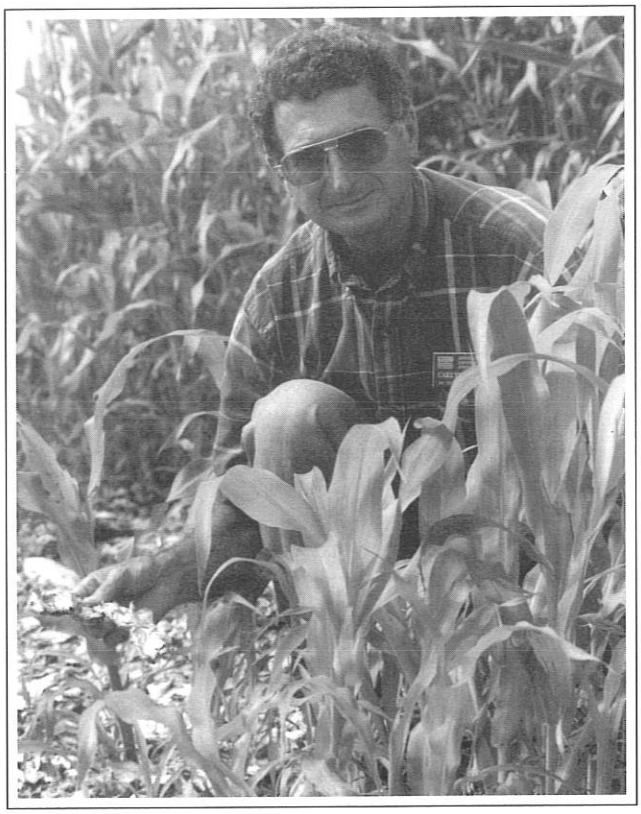

## Extending the Life of Landfills

Disposal of municipal solid waste is a problem both economically and environmentally. Nearly 60 percent of an average community's solid waste stream currently deposited in landfills is biodegradable. Over 80 percent of these



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organic materials are paper products and yard waste (primarily grass). An alternate method of disposing of these biogradable materials would significantly extend the life of landfills. Research at the KSU Agricultural Research Center–Hays showed that biodegradable materials like newspaper and grass, when applied in the raw form to agricultural soils, were decomposed by soil microoganisms. To ensure rapid decomposition, early application after fall harvest and monthly tillage of the soil were critical. Also, rate of application and blending of high (grass) and low (paper) nitrogen sources were important. Under irrigation and continuous cropping, rates up to 45 tons per acre of grass and newspaper mixture decomposed sufficiently during the period from harvest to planting of a forage sorghum. The performance of the newly planted crop was not affected. On dryland fields, lower rates of solid wastes may be necessary. Also, a crop-fallow rotation would allow more time to decompose the organic materials. To accomplish the above, city- or county-owned land and equipment could be used to facilitate the program. In addition, private landowners could submit bids to apply the material on their own land providing they do not object to foreign materials contained in the waste. In either case, trench silos would be necessary (to allow material to be wetted down and packed to keep from blowing) to store the shredded newspaper and grass until application could be made after the fall harvest. The economic and environmental implications for land applications versus deposits in Title D landfills are enormous.

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# UTILIZING BIODEGRADABLE MATERIALS

## Increasing Degradability of Plastics by Using Soybeans

A K-State textile scientist has developed polyethylene films containing 40 percent saturated soybean fatty acid fillers to enhance biodegradability. Polyethylene is used in making a wide variety of consumer products, so this project has considerable commercial potential. For example, plastics used in packaging are produced from polyethylene. In addition to being biodegradable, one new polyethylene film also is resistant to microorganisms.

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## Thermoplastics Technology Using Corn

Industry uses flexible foamed plastic sheets made from petroleum-based polymers to cushion delicate instruments during shipment. Grain scientists at K-State are investigating ways to produce similar packaging material that contains high levels of cornstarch. One formulation developed by the researchers contained 45 percent starch and gave low density foams with a uniform cell structure and good elastic properties. The product is estimated to be 60 percent biodegradable.

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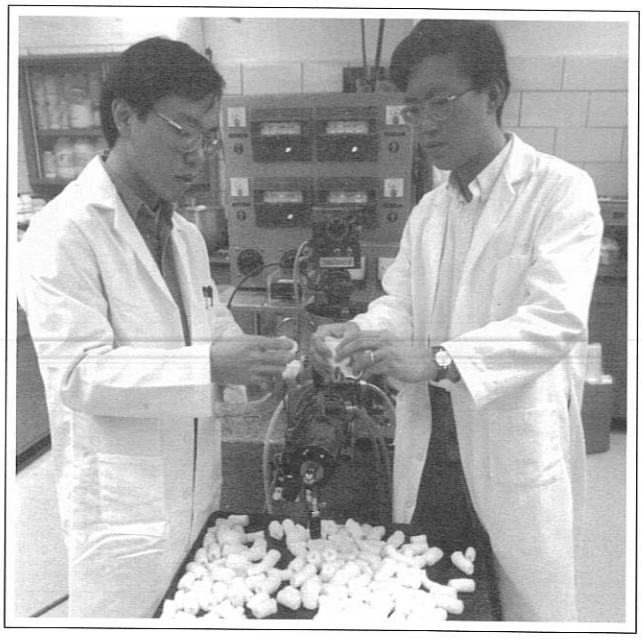



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## Harnessing Microbes to Clean Up the Environment

KSU scientists are enlisting microbes—or bacteria and fungi—to break down pollutants created by humans in a process known as bioremediation of toxins. The researchers have been finding that microbes are capable of breaking down pesticide residues and other synthesized toxic chemicals. A few years ago, this was thought to be an impossibility. Bioremediation technology has the potential to clean up excessive levels of pesticides caused by spills at distribution points and to prevent agricultural and industrial chemical spills from percolating through the soil into groundwater sources. Currently, the primary clean-up targets for bioremediation are wastewater from pesticide manufacturing plants, accidental spills, and soil polluted by industrial and military activities. The new twist to bioremediation at K-State as well as at other major universities is to modify the organisms through genetic engineering. The process might include taking a single gene out of an organism that can degrade a toxin and putting it into bacteria better suited to survive in the field. Another example might be to use bacteria that can detoxify a pollutant down to a point and then employing another better suited to carry out the process to completion.

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# WATER MANAGEMENT

## Subsurface Drip Irrigation

Research at the KSU Northwest Research-Extension Center at Colby shows that subsurface drip irrigation is a highly efficient delivery system. One study demonstrated that careful management of Subsurface Drip Irrigation systems could reduce net irrigation needs by nearly 25 percent while maintaining top corn yields of more than 200 bushels per acre. Another study showed that Subsurface Drip Irrigation for corn production reduced water use by 46 percent while reducing yields by only 15 bushels per acre. Also, Subsurface Drip Irrigation helps protect water quality through reduced drainage to the water table.

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## Irrigation Practices that Conserve Water

Research at KSU is evaluating the potential for water conservation through the use of high-frequency, deficit, subsurface drip irrigation for corn production. Conservation of irrigation water is easily attained by practicing deficit irrigation, but yields often are drastically reduced. Subsurface drip irrigation offers the irrigator a "win-win" situation by maintaining high corn yields while still saving water. Irrigation water savings of 46 percent were obtained with only an 8 percent reduction in yield. Researchers hope to further reduce yield reductions through combined management of high frequency deficit subsurface drip irrigation and in-season fertigation. Subsurface drip irrigation also can help to protect water quality through reduced drainage to the water table.

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## Providing Urban Areas with Water Quality Information

A new series of colorful brochures from the Kansas Cooperative Extension Service will help urban residents protect water quality. The brochures address the proper use of fertilizers and lawn and garden chemicals. The fertilizer brochure explains how to evaluate the various fertilizers on the market and how to use them safely so that nitrogen and phosphorous do not enter water sources. The lawn and garden chemical brochure discusses environmental safety as well as safety considerations for people and pets. The brochure also includes information on product selection, application, storage, and disposal. Plans call for the brochures to be stocked in commercial garden centers where county extension agents will be stationed. The brochures will be used in a pilot program in several urban counties.

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## Developing Models to Study Water and Crops

Simulation models are being used to observe and understand the interrelationships among soil water supply, drainage, evapotranspiration (ET), and crop yield. Researchers developed a water balance model and then a microcomputer software package. The model estimates drainage, crop evapotranspiration, and crop yield. Weather records and field research results from Tribune were used to adapt the model to western Kansas. Based on the model, a Windows compatible microcomputer software package was developed for corn, grain sorghum, sunflower, and winter wheat. The software allows users to study the effects of irrigation system efficiency, water application timing and amount, and water conservation under dryland conditions. The software can be used as an educational tool for illustration of water's influence on crop production in western Kansas.

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## Irrigation and Water Management Demonstration Project

K-State Extension and Water PACK (Water Protection Association of Central Kansas) have teamed to develop a five-year cooperative irrigation and water-management demonstration project. The goal of the project is to improve irrigation application and water-use efficiency for sustainable, irrigated crop production in south-central Kansas by increasing irrigation scheduling procedures. This project involves the use of the most current technology with climatic forecasting and field feedback of soil moisture, applied irrigation, and rainfall. A total of 13 fields irrigated by center pivot are included in this project (one field in each of the 13 Water PACK counties). In 1996, the project included eight fields and will add five more sites in 1997.

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## Limited Irrigation Increases Profits

In a three-year study at the KSU Southwest Research-Extension Center near Garden City, corn yields were increased an average of 24 bushels per acre (26 percent) with a single application of 4 inches of irrigation water. At a corn price of $2.50 per bushel and a cost of irrigation water of $2.25 per inch, income would increase $51 per acre over that of an all dryland system.

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## The Economic Impacts of Water Supply Reductions on the Upper Arkansas River

Changes in agricultural production, water availability, and the implementation of conservation policies in the Arkansas River Basin of Kansas are occurring because of dwindling stream flows, groundwater deficits, and changing agricultural policy. Researchers evaluated economically optimal crop production mixes related to the new agricultural policy environment and the condition of declining water availability for a representative southwest Kansas farm. The results indicate that at lower levels of water the amount of corn is reduced, with no corn produced at or below 12 inches per acre of water availability. Alfalfa is grown in place of corn



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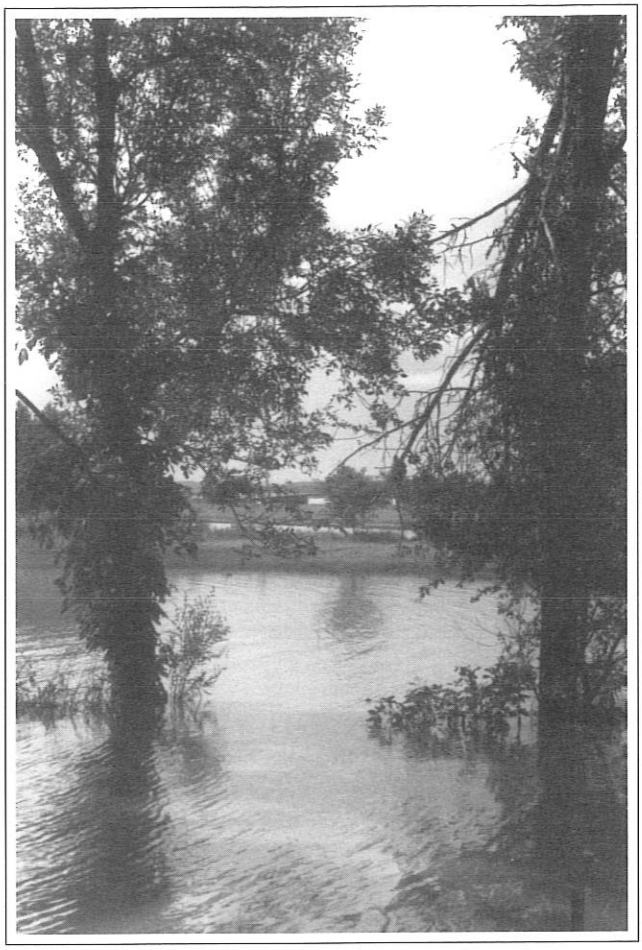

as water availability declines. Irrigated grain sorghum is not produced at any level of water use. Net returns are higher under the Federal Agriculture Improvement and Reform (FAIR) Act or 1996 Farm Bill compared to the policy restrictions of the previous farm bill. However, if a haying restriction, which limits alfalfa production to 15 percent of base acres, is imposed, then net returns decrease, and the crop mix switches away from alfalfa to sunflowers and soybeans. Corn is not produced at 12 inches of water or less. At very low water levels, irrigated land switches to dryland production. The highest net returns under all water availability scenarios are found under the FAIR program with no grazing restriction, given long-term average prices and the 1996 government payments. In each mode, net returns decline as water availability declines, but the decline when water application levels are relatively high is small, generally showing a decrease of less than 1 percent when water availability declines from 24 inches to 20 inches per acre. This suggests that some reductions in water use could possibly be made with relatively small annual losses in net income.

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## Irrigation Economics Evaluation System

K-State researchers have found that the microcomputer model, Irrigation Economics Evaluation System (IEES), can be used to estimate costs under a variety of operating conditions and to evaluate irrigation systems for economical water use. IEES is designed to utilize user-supplied data to calculate the operating costs of Medium Pressure Center Pivot, Low Pressure Center Pivot, Low Energy Precision Application Center Pivot, Low Drift Nozzle Center Pivot, Furrow Flood Gated Pipe, Surge Furrow Flood Gated Pipe, and Sub-Surface Drip irrigation systems that use either natural gas, propane (LP) gas, diesel fuel, or electricity. IEES is designed to calculate operating costs for 11 items associated with operating irrigation systems and the total annual operating costs on a per acre, per hour, and per acre-inch basis. The program also calculates the net returns for the crop grown with the irrigation system. In addition to calculating annual operating costs, the mode has six options that can be used to economically evaluate improvements in the pumping plant or the way the irrigation system is used for crop production. These options are evaluation of pump repair or replacement; evaluation of switching power units from one power source to another; estimates of operating cost changes caused by a falling water table and/or a pump efficiency decline; estimates of operating costs for different levels of water application; estimates of operating costs under selected fuel inflation rates; and the economic feasibility of switching distribution systems.

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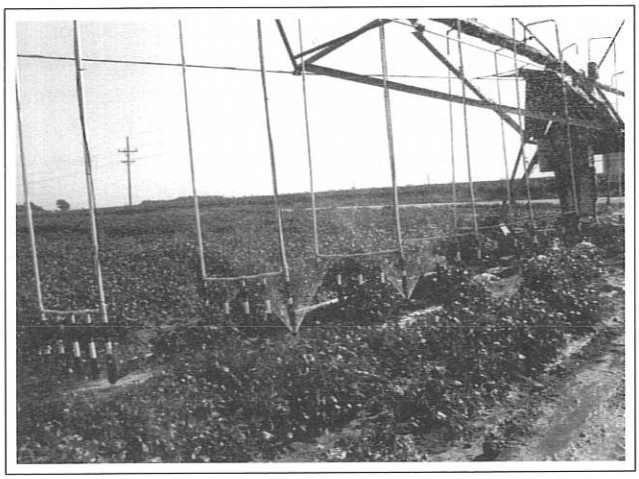



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## Phosphorous Losses in Runoff Water

Despite recent media attention on nitrates and pesticides in groundwater, phosphorous represents a significant threat to surface water quality. Phosphorous accelerates the eutrophication process, producing water that has undesirable odor and taste and greatly reduced recreational potential. Surface waters in Kansas that are impacted by phosphorous receive phosphorous from a variety of sources, including animal production facilities, agricultural lands, wastewater treatment facilities, industrial inputs, and septic systems. KSU scientists have focused on the effect of tillage and fertilization practices on phosphorous losses in runoff water from areas used for grain sorghum production.
A field experiment is being conducted at the East Central Experiment Field in Ottawa. Total phosphorous and soluble phosphorous losses have been highest for surface broadcast applications of phosphorous with no-till practices. Phosphorous losses have been lowest for treatments not receiving phosphorous or for phosphorous placed below the soil surface under conventional or no-till practices. Soluble phosphorous, a form which has a high bioavailability, is highest for the surface broadcast applications of phosphorous under no-till or ridge-till systems. Generally, switching from conventional tillage to no-till practices will reduce phosphorous losses as well as reduce soil erosion. Experiments suggest that this change must also be accompanied by practices that place phosphorous fertilizers below the soil surface; otherwise, losses may actually increase compared to losses experienced with conventional tillage.

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## Reducing Atrazine Runoff in the Upper Delaware River Basin

If atrazine cannot be kept below safe drinking water standards by voluntary practices among farmers, the product could be taken off the market or severe limitations could be placed on how atrazine is used. This could have significant economic consequences to Kansas farmers. Atrazine is used on about 3.4 million acres of corn and grain sorghum in Kansas every year. Without atrazine, more expensive herbicides would have to be used in corn and grain sorghum crops. At an average increase of $5 to $10 per acre for alternative herbicides, the added costs could total $17 million to $34 million annually in additional herbicide costs.

Recent monitoring of water has indicated higher-than-desired atrazine concentrations in Perry Reservoir in the Delaware River Basin. Three sub-basins, located in parts of Atchison, Brown, Jackson, and Nemaha counties, have been found to contribute approximately 80% of the total atrazine runoff occurring in the Delaware River Basin.

Keeping atrazine herbicide out of water supplies ranks high on the Kansas public's "wish list" for agriculture. Kansas Agricultural Experiment Station researchers have discovered best management practices (BMPs) for using atrazine that can help reduce runoff of the herbicide. It is essential that farmers and pesticide dealers adopt these atrazine BMPs. Starting in the fall of 1995, a team of Kansas Cooperative Extension Service (CES) specialists and agents developed an innovative educational program to achieve adoption of the atrazine BMPs. The program targets producers and chemical dealers through one-on-one contacts, surveys, publications, news releases, and demonstrations. An intensive, one-on-one educational approach such as this has rarely been used over such a large area to address an environmental problem.

Also, in response to Governor Graves' Water Quality Initiative for the Kansas-Lower Republican River Basin, a pilot cost-share incentive program was initiated in the Mission Creek Watershed in Brown County in cooperation with the State Conservation Commission. The SCC provides the cost-share incentive monies and administration, and the CES provides the educational support by explaining the program requirements and helping farmers develop qualifying management plans.

The overall goals of the Atrazine Runoff Reduction Program are:

1. To have 15 percent of producers adopt at least one best management practice in 1996 that they did not use in 1995.
2. To reduce atrazine runoff in the targeted area by 10 percent.
3. To maintain average concentrations in Perry Reservoir below the EPA's minimum safety level of three parts per billion.

A survey of farmers in the program area indicated that a majority were going to add at least one BMP for atrazine in 1996 that they had not used in 1995. Therefore, it is expected that atrazine runoff will decline significantly in the future in the Delaware River Basin. This Extension effort will benefit both the public and farmers. The public will have reduced anxiety over the safety of drinking water, and farmers will be able to keep using atrazine to control weeds in corn and grain sorghum without endangering water quality.

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## A Training Program on Wastewater Treatment

For nearly a decade, the Kansas Cooperative Extension Service has been working closely with the Kansas Association of Sanitarians and Kansas Department of Health and Environment to educate and train sanitarians, contractors, and homeowners about on-site wastewater treatment. As part of the program, Extension faculty have edited, printed, and distributed the Environmental Health Handbook. Also, Extension has organized and conducted training with the help of sanitarians and Kansas Department of Health and Environment. As a result, sanitarians are better prepared than ever before to evaluate site conditions and to specify workable and environmentally sound on-site systems, and contractors have a greatly improved understanding of conventional septic systems, individual lagoons, and suitable alternatives for problem sites.

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## Reducing Sewage Discharge and Protecting Groundwater

Cooperative Extension Service specialists are providing leadership for on-site wastewater treatment system design, evaluation, maintenance, and improvement. K-State encourages continued evaluation of alternatives to conventional septic tank soil absorption lateral systems for problem sites and adoption of proven methods where they are technically, practically, and economically feasible. This program is improving the Kansas environment by reducing discharge of sewage to the surface and protection of groundwater. Several publications have been developed to inform people about on-site wastewater, including

- A Blueprint for Rural Communities and Small Town Wastewater Treatment Alternatives.
- Get to Know Your Septic System.
- Septic Tank Maintenance.
- Septic Tank-Soil Absorption System.
- Sewage Sludge Use on Agricultural Land.
- Soil Evaluation for Home Septic Systems.
- Why Do Septic Systems Fail?
- Your Wastewater System Owner/Operator Manual.
- Safe Domestic Wells.

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## New Satellite Technology Can Help Protect Groundwater Quality

To help prevent fertilizer nitrogen from causing groundwater pollution, K-State researchers are bringing the latest satellite technology down to the farm. The goal is to develop an advanced level of nitrogen management that is based on data so precise that it could revolutionize the way farmers apply fertilizers and chemicals.

Currently, nitrogen fertilizer recommendations to farmers are based on average soil nitrogen levels and average yield goals for an entire field. But this approach can cause problems. When the farmer puts 200 pounds of nitrogen onto the entire field based on average needs, some areas end up with too much and some too little. Wherever too much was applied, some of that nitrogen could move down through the soil and eventually into groundwater.

Variable-Rate Nitrogen Management uses the latest in satellite technology to fine-tune nitrogen applications and eliminate overapplication. Global Positioning Systems (GPS) play a key role in Variable-Rate Nitrogen Management, allowing researchers to pinpoint the location of sampling points within a field. This permits the construction of detailed maps that show yield potential and the status of soil nutrients. The researchers use this information to create a fertilizer recommendation map that calls for varying levels of nitrogen across the field. The computer on the fertilizer application equipment then uses the variable-rate recommendation map to adjust fertilizer rates "on the go," with the assistance of computer-driven controllers and GPS guidance.

Research on two large irrigated corn fields in Barton and Stafford counties indicates that the new technology is starting to show benefits. After two years of field work, researchers have found they've been able to match nitrogen applications more closely with crop needs. They've also been able to get more bushels of grain per pound of nitrogen applied. This reduces the chances of polluting groundwater and increases farmers' net income at the same time.

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## Plugging Abandoned Wells

Many Kansans, particularly rural residents, depend on private groundwater wells for their domestic water supply. Recent surveys and studies indicate that water from about half of private wells would not meet public water supply standards. Because of the importance of groundwater to rural Kansas residents, the Kansas Cooperative Extension Service in cooperation with Kansas Farm Bureau developed an educational program on plugging abandoned wells.

The program, "Safe Water for Kansas," featured information on water testing, well construction, well site selection, and disposal of abandoned wells. The plugging of the abandoned well, however, was the high-interest feature of the program. Participants learned about the hazards and liabilities associated with abandoned wells and the correct procedure for plugging abandoned wells.

Over 175 well-plugging demonstrations were conducted with almost 100 percent participation by the 105 Kansas counties during the initial two years of the program. Nearly 200 wells were plugged, with approximately 6,000 persons attending. The program focused initially on farms but expanded to include rural residents and small communities. The impact of the demonstration also was magnified with coverage by the local newspapers, radio stations, and, to a lesser extent, by television.


Well-plugging demonstrations are still being conducted but most now are without direct specialist involvement. County Extension agents and other agency personal have continued to schedule events and promote plugging at farms shows, county fairs, agent update training, and other events. State support continues with publications and the production of a video: "Plugging Abandoned Wells." The program's success is probably due to a number of factors, including 1) the increasing concern and awareness of the public regarding the environment; 2) the establishment of local environmental planning groups in Kansas that corresponded with the initiation of the program; 3) the multiple organizational sponsorship of the events; and 4) the hands-on or active nature of the event. In almost every instance, some degree of participation by those in attendance occurred. Every event accomplished a positive action: the proper plugging of at least one abandoned well.

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## Students Tackle Environmental Projects

The capstone course for the Natural Resources and Environmental Science secondary major utilizes environmental case studies as the basis for its semester-long projects completed by students enrolled in the course. Topics for the projects have included the proposed sand dredging from the Kansas River; an alternative wastewater treatment system (wetlands) for Clinton State Park and an accompanying education plan; and the Governor's Water Quality Initiative, with one group emphasizing each area of interest—for example, herbicides or sediment or coliform bacteria. The course is team taught with instructors from such disciplines as agronomy, civil engineering, geography, and communications.

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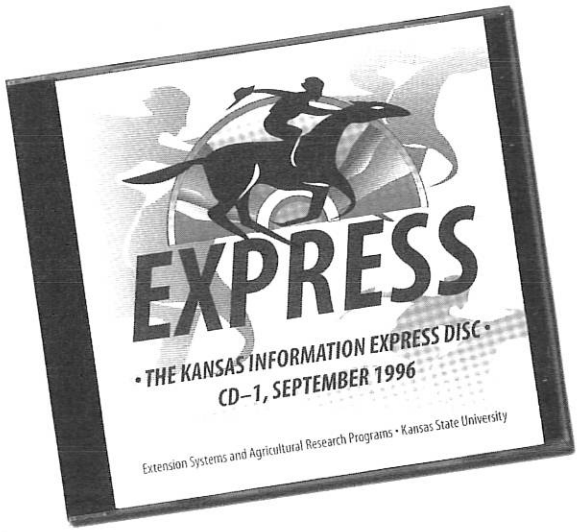
3-25

# GOING ELECTRONIC




## Electronic Publications Save Paper and Help the Environment

The recently developed EXPRESS CD-ROM and Web pages of the Agricultural Experiment Station and the Cooperative Extension Service are benefiting the environment because they provide a wealth of information that is accessible without being printed on paper. Electronic publications allow users to be selective and print only what they need. The Web pages contain approximately 500 documents. The CD-ROM contains 863 documents from Kansas, plus approximately 1,400 from other states. Many of the publications relate to environmental issues. Four of the Web pages contain environmental topics, including 95 publications available as Solid Waste Management Fact Sheets and as the Water Quality Library; the Crops and Soils Library; and the Agricultural Economics Library. These publications benefit the people of Kansas by offering practical, environmentally sound advice on farm, garden, and home topics.

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## 4-H'ers Use the Web Instead of Transportation

The Internet/World Wide Web has been described as one of the most equalizing forces society has experienced. Whether one lives in a village of 200 or a metropolis of 2 million, information accessed through the Web is the same. In the past, those living in urban communities had easier access to educational information than those who lived in rural communities. Comprehensive libraries and universities were more likely to be located in urban centers. Now much of the information found in libraries and at universities is available through the Web. With the growth of local Internet providers and special phone opportunities for rural families, using the Internet is becoming practical for everyone. If it isn't available now, it will be soon. Such usage helps the environment by reducing travel and all the resources that go into travel.

Using one lesson in the new curriculum, 4-H'ers in Geary County developed a questionnaire and then delivered that questionnaire via the Internet to 4-H'ers in other countries. They collected data that became a part of their local 4-H project work. The 4-H'ers reached beyond the boundaries of their own county, state, and country and incorporated a global interchange with youth in other countries. They were able to do this with no travel expense, with one project leader investing a minimal amount of time, and using a current resource, the Internet, to enrich the global perspective of 4-H'ers, many of whom did not have the means to travel beyond their state, let alone national boundaries. What they accessed via the Internet was the same in this rural Kansas town as it would have been had they used a computer on the Internet in Kansas City, Topeka, or Wichita. This is one example of how the delivery methods in the new 4-H clothing/textiles curriculum have been successfully used to expand the opportunities for all Kansas 4-H'ers.

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3-26

K-STATE RESEARCH AND EXTENSION

# WATER QUALITY

## 1996 Program Updates and Highlights


## ABSTRACT

Water is a precious natural resource. In Kansas, we depend on water for drinking, household use, agriculture, industry, and recreation. Concerns exist in Kansas about the quality of surface water and groundwater. A 1994 Kansas Department of Health and Environment report indicated that 97 percent of streams and 82 percent of lakes in Kansas would not fully support all uses as designated by state statute. Other studies suggest serious water-quality problems with private drinking water wells . Surface water contaminants include bacteria, sediments, nutrients, and pesticides. Major private well contaminants include bacteria and nitrate.

Most current Kansas water quality problems originate from nonpoint source pollution. Nonpoint source pollution generally occurs over a large area, over an intermittent period, and from such diverse sources as farms, ranches, transportation corridors, and urban areas. Nonpoint source pollution is not monitored easily at the point of origin and generally is not traceable to an exact source. Most future improvements in Kansas water quality will be made by reducing nonpoint source pollution.

The diverse nature of nonpoint source pollution makes it difficult to control with regulations. Kansas State University has developed and delivered several educational programs to assist Kansans in reducing its impact on surface water and groundwater quality.

K-State research and Extension have joined forces with numerous federal and state agencies, organizations, and Kansas citizens to reduce the risk of contamination of Kansas water resources. Movement of such chemicals as atrazine into surface waters is being controlled by applying principles of best management practices. Soil testing, timing of application and use of computer simulation models reduce application rates of nutrients. Improved livestock facility design and management of waste-handling systems reduce surface water and groundwater contamination threats. Private wells are better managed, and abandoned wells have been plugged. All of this adds up to higher quality and safer water for Kansans to use and enjoy.


House Environment
1-28-97
Attachment 4

# WATER QUALITY

## PESTICIDE MANAGEMENT

In Kansas, atrazine herbicide has been used widely since the 1960s for selective weed control in corn and grain sorghum. Atrazine is one of the lowest cost per-acre herbicides that provides effective weed control. A 1990 survey indicated that atrazine was applied to 76 percent of the corn acres and 88 percent of the grain sorghum acres in eastern Kansas. In the mid-1980s, concerns arose about atrazine concentrations running off fields and entering streams, rivers, and lakes, especially in eastern Kansas. These surface waters are the major drinking water sources for many local communities.

Atrazine has become an even more important issue since the United States Environmental Protection Agency established a maximum contaminant level of 3 parts per billion (ppb) for atrazine in drinking water. Several rivers and lakes in central and eastern Kansas routinely contain atrazine concentrations more than 3 ppb, particularly in the summer months following application. In some cases, atrazine concentrations average more than 3 ppb for the entire year. Because of these concerns, Kansas established a Pesticide Management Area in 1992 for atrazine in the Delaware River Basin. It is imperative that atrazine concentrations in rivers and lakes be brought below 3 ppb. But, if atrazine were banned in Kansas because of water quality concerns, it is estimated that alternative herbicides would increase crop production costs by $5 per acre to $20 per acre. Because the economic importance of atrazine for Kansas crop producers and the concerns about atrazine concentrations in surface waters, K-State initiated a research and Extension program in the late 1980s to reduce atrazine runoff to surface waters.

### Research Programs:

A research program was initiated in the late 1980s to determine how atrazine is lost from cropland and to develop best management practices (BMP) for using atrazine and reducing its impact on surface water. Some of the work done included:

- A nationally recognized research and demonstration field, The Foster Farms Water Quality Demonstration Program, was established near Rossville. This site is used to train farmers, government agency personnel, legislators, and private industry personnel about atrazine and water quality. This site also was used to develop BMPs for atrazine.
- A research project evaluated the effects of different tillage systems on atrazine runoff. Contrary to previous beliefs, it was found that greater atrazine runoff occurred from no-tillage fields than from conventionally tilled fields.
- A research project at the Cornbelt Experiment Field near Powhattan found that soil incorporation of atrazine could reduce atrazine runoff by 60 percent to 75 percent. Vegetative buffer strips were found to be only slightly effective at reducing atrazine runoff from crop fields.
- Other studies examined the effects of atrazine application timing, reduced atrazine rates, and different application methods on weed control in corn and grain sorghum.

### Research Impact:

The conclusions of KSU research indicated that with proper management atrazine could be used to provide economically acceptable weed control with few adverse effects on water quality.

### Extension Programs:

An Extension program initiated in 1991 assisted farmers and pesticide dealers in adopting management practices to reduce atrazine runoff from crop fields. The program has used news releases, surveys, newsletters, publications, farmer and dealer schools, field demonstrations, radio, and one-on-one visits, including the following:

- KSU research and Extension personnel reviewed research results and determined the effective-

ness of various BMPs for reducing atrazine runoff. Two publications have been printed and distributed explaining atrazine BMPs to farmers. An atrazine BMP slide set also was developed.

- A 73-page publication, Kansas Catalog of Nonpoint Source Pollution Control Practices: Agricultural Lands, was produced. This publication explains the principles of nutrient and pesticide movement in water and lists 31 BMPs. The publication was distributed to county Extension agents and other agency personnel and is being used to help farmers develop production systems that minimize agriculture's effects on water quality.
- 3,000 farmers were taught atrazine BMPs at 15 KSU Agronomy Field Days.
- 1,500 farmers learned about atrazine BMPs at tours of county field demonstration sites.
- 650 pesticide dealers attended two-day educational trainings about atrazine and water quality.
- 3,500 farmers learned about BMPs for atrazine at KSU county Extension meetings.
- A survey of atrazine use practices was conducted in the Delaware River Basin.
- KSU helped to develop a water-monitoring system in the Delaware River Basin for atrazine.
- KSU helped the State Conservation Commission develop and implement the first-of-its-kind incentive program for atrazine BMP adoption in the Mission Creek Watershed.

### Extension Impact:

- Increased farmer and pesticide dealer awareness and knowledge of atrazine contamination of surface water.
- A significant number of farmers have adopted atrazine BMPs. In a survey of farmers in selected Delaware River sub-basins, 81 percent indicated they were using at least one of KSU's recommended BMPs for atrazine. Also, because of the educational program, 31 percent of the farmers surveyed said they were going to add additional atrazine BMPs in 1996.
- Since the initiation of the educational effort in 1991, atrazine concentrations in Perry Lake (PMA targeted watershed) have remained below the 3 ppb maximum contaminant level for drinking water.
- The demonstration incentive program in Mission Creek Watershed had 95 percent farmer participation. The incentive program will be expanded to a larger area in 1997.

## NUTRIENT MANAGEMENT

Groundwater and surface water are important Kansas natural resources. Groundwater supplies 85 percent of the drinking water for Kansans and is a valuable source of irrigation water. The principle environmental concerns with nutrient management in Kansas are nitrate and phosphorus (P) for groundwater and surface water, respectively. Sources of nitrate include fertilizer, livestock wastes, septic tanks, and soil organic matter. A Kansas survey of farmstead wells found 28 percent of private wells contained nitrate levels above health advisory levels.

No large geographical areas in Kansas have serious nitrate contamination problems, but local areas with shallow groundwater, sandy soils, extensive concentrations of livestock, and intensive crop systems are vulnerable. A goal of the nitrogen (N) management program is pollution prevention. Management factors, including different N sources and rates, tillage systems, and crop rotations, affect the movement and fate of nitrogen. Studies are being done on those management factors.

Phosphorus is the greatest nutrient threat to surface water quality in Kansas. Excess P produces water that has undesirable odor and taste and greatly reduced recreation potential. High P concentrations in surface water can lead to excessive aquatic plant growth that is associated with oxygen depletion in the water, fish kills, and undesirable odor and taste. Adversely affected surface water bodies in Kansas receive P from a variety of sources, including animal manure, agricultural lands, wastewater treatment facilities, industrial inputs, and septic systems.

## Research Programs:

- Research has begun on fields to apply variable-rate technology for N management. To improve fertilizer use and reduce environmental risks, studies are focusing on matching fertilizer rates to specific nutrient needs by accounting for residual soil nitrate, N mineralization, and crop demand. Variable-rate nutrient management also is known as precision farming, farming by soil, and site-specific management. These approaches are supported by Global Positioning Systems (GPS), yield monitors for grain combines, Geographic Information Systems (GIS), and low-cost computer power. Detailed GIS information can create maps of prescribed fertilizer rates applied by modified spreader equipment with computer driven controllers and GPS guidance.

  The research used two irrigated corn fields with loamy fine sand. Yields measured in 1993 and 1995 were used to create yield goal maps for each site. From 1994 to 1996, pre-planting nitrate-nitrogen levels were measured in soil samples. Researchers used the yield goal maps and soil nitrate-nitrogen maps to make variable fertilizer nitrogen recommendations. Two nitrogen fertilizer treatments, uniform and variable, were applied on the sites. Yield maps for both sites showed variability from year to year and from field to field, mostly caused by weather. Excellent weather in 1994 led to record high grain production at both sites; excessive precipitation and unusually low temperatures during growing season led to lower yields at both sites in 1993 and 1995. The research results indicate the most critical period for significant movement of N is when crops are not growing on the land.

- An aggressive demonstration and applied research program on profile nitrogen soil testing began in 1991, followed by three demonstration-research studies in 1995. The results demonstrated the nitrogen soil test can be used to adjust application rates for residual nitrogen. A study comparing soil test recommendations, conducted in southeast Kansas, showed that KSU recommendations resulted in equal yields to those from private labs, which, in some cases, recommended considerably more N input. Most research and demonstration sites were located on farmers' fields and KSU Agronomy experiment fields.

## Extension:

- Extension encourages use of the residual soil nitrate test through farmer and dealer schools, demonstrations, publications, news releases, radio, and television. Its use is particularly important where high residual soil nitrate levels are expected, such as following fallow or following low rainfall years with lower than anticipated yields. The agrichemical use survey for corn (1990) and grain sorghum (1991) indicated that N was applied at a rate of 177 lbs and 70 lbs N per acre, respectively. The results indicated that Kansas producers are not over applying commercial nitrogen fertilizer. In 1996, with above normal rainfall, soil nitrate levels will likely decrease.

- Extension has developed a nutrient recommendations computer program that contains updated nitrogen fertility recommendations. The program is used by KSU county Extension agents for making soil fertility recommendations.

- The Kansas Fertilizer Research Report of Progress, compiled annually by Extension specialists, is distributed to KSU county Extension agents and agribusiness chemical dealers. The 1995 report contains the latest research information on how to minimize the effects of nutrient management on water quality.

- The Field Research Report of Progress, compiled by Extension specialists annually, is distributed to approximately 1,700 KSU county Extension agents, farmers, and agribusiness dealers. The report contains information on nutrient management and conservation practices.

# PHOSPHORUS

## Research:

- Research focuses on tillage and fertilization practices for grain sorghum production and their affect on P losses in runoff water. An experiment at the East Central Experiment Field in Ottawa showed soluble P losses were highest for surface broadcast applications used with no-till practices. Total P losses were the lowest for treatments not receiving P or with P placed below the soil surface under either conventional or no-till practices. Soluble P, a form that has a high bioavailability, is highest for the surface broadcast applications of P under no-till or ridge-till systems.

  Generally, the best way to reduce P losses, as well as reduce soil erosion, is to use no-till practices that place P fertilizers below the soil surface. Surface P application in no-till actually may increase P losses compared to conventional tillage. These research results are being communicated to the agricultural community through field days, county and state meetings, and KSU Agricultural Experiment Station research progress reports.

## Extension:

- The KSU soil testing laboratory tested 4,818 soil samples for P in 1992 and 1993. Results indicate a marked decrease in soil test phosphorus levels from 1991 to 1992. Extension has a computer program for nutrient recommendations that is being used by most county Extension agricultural agents.
- Soil erosion and sedimentation continues to be a source of the P entering Kansas surface waters. An aggressive demonstration program using a rainfall simulator showed the effectiveness of conservation tillage in controlling soil erosion. More than 1,100 attended the 23 demonstrations that were conducted across Kansas. Many Kansas farmers have adopted no-till practices. In Washington County, as a result of the Extension program, no-till acreage increased 25 percent in 1995.
- A major focus of the Extension program was to increase KSU county Extension agents' knowledge of soil fertility. Sixty agents attended a two-day training school in soils, soil fertility, and environmental management. Agent training sessions also were held on diagnosis of crop nutrient deficiencies, and one-day agent updates were held in each of the five Extension areas.
- In-depth soils schools cover information ranging from the basics to soils to nutrient recommendations, and they provide in-depth material on nutrient management recommendations. Fifty farmers and dealers attended the two schools conducted in 1995.
- One hundred thirty dealers were trained by the Extension Service at numerous meetings, including two-day sessions offered in cooperation with the Kansas Fertilizer and Chemical Association and with Farmland Industries. One hundred forty dealers were trained at two field diagnostic trainings (wheat and row crops) conducted by Extension specialists.
- Soil fertility schools and demonstrations were major parts of the program in 1995, including 115 KSU county Extension meetings and demonstrations that emphasized nutrient efficiency and environmental quality enhancement. The program has been very effective. For example, in Harvey County, education on such techniques as soil testing, proper fertilizer rates, and application techniques influenced 133 farmers to improve their fertilizer efficiency.
- Numerous counties have active nutrient-management or soil-testing plans in their Nonpoint Source Management Plan (NPS). Extension nutrient recommendations are used and are often made by the KSU county Extension agent. In Geary County, the Extension agent helped nine producers develop nutrient and pest-management plans.

# LIVESTOCK WASTE MANAGEMENT

The KSU Cooperative Extension Service has made livestock waste management a priority. Program accomplishments have been cooperative efforts between state specialists and county Extension agents.

Extension has been a successful partner in Kansas Department of Health and Environment, EPA-319, demonstration projects. These projects are a multiagency cooperative effort with cooperation from the KDHE, State Conservation Commission, county conservation districts, Natural Resources Conservation Service, and the Environmental Protection Agency. Extension Agricultural Engineering has been responsible for designing innovative livestock waste system demonstrations.

The Herington watershed project was completed in 1996. Livestock producers, after four years, installed four total containment structures and two grass filters. Two producers relocated feeding sites; one installed a stream bank water point; and one installed a pasture feeding pen. Only one producer chose not to participate in the voluntary program.

1996 also saw the completion of two demonstration projects in the Hillsdale watershed in Johnson and Miami counties. A triple sediment basin/grass filter was installed at a replacement heifer feedlot, and a total containment system was constructed at a dairy. Several groups have toured these projects, including legislators, EPA/KDHE representatives, dairy cooperatives, and local citizens. More than 200 people have toured the sites since construction was completed in early fall 1995.

KSU Extension also has been heavily involved in educational meetings on corporate farming issues and livestock waste regulations related to Kansas Senate Bill 800. More than 1,000 people attended the educational meeting on management and control of livestock waste. Managers responsible for raising 20 percent of the swine in Kansas attended an environmental assurance meeting coordinated with the Kansas Pork Producers Association. During 1995, Extension Agricultural Engineers made 100 farm visits related to livestock waste control.

In 1994, a demonstration project coordinated by the KSU Nemaha County Extension agent with Heartland Jerseys was toured by more than 100 people. In Nemaha County, five manure storage basins have been installed with a capacity of 2,400 tons of manure. A similar system is being installed in Minnesota as a result of a dairy producer touring the Nemaha project. Several dairies in Nemaha County are working with KSU Extension Agricultural Engineers on new concepts or modified designs. Extension faculty are completing the design of a wetland demonstration in Anderson County for a 200-cow dairy. This work is in conjunction with KDHE and other state agencies.

# PRIVATE WATER WELLS

Good quality, safe drinking water is important for everyone. Households on a public water system benefit from drinking water standards, a regulatory program, trained operators, and regular water tests. The protection and assurance of a reliable, high-quality supply are the reasons nearly 90 percent of Kansas households are connected to public water supplies.

Those 110,000 households with private water supplies almost always use a private well. A large private well survey was done in 1994 (phase I) and 1995 (phase II) in Kansas and the other eight states affected by the 1993 flood. Samples collected from 825 private Kansas wells showed:

- More than 51 percent with high total coliform bacteria (the indicator of bacteria problems used for public water supplies. It indicates the well is or has been exposed to the environment).
- More than 18 percent with E. coli bacteria (an indicator that water is contaminated by bacteria in sewage or livestock waste).

- Fewer than one-half percent with high atrazine (above the safe drinking water standard of 0.003 milligrams per liter).
- 24 percent with high nitrate (above the public drinking water standard of 10 mg/L).
- 6 percent with high lead (above the public drinking water target level of 0.015 mg/L).

## Research:

Data collected in the 1986 survey of farmstead wells used for drinking water showed that since 1975 more than 80 percent did not fully meet construction standards established for new wells. This below-standard well construction is believed to be the major contributor to total coliform and E. coli or fecal coliform contamination.

In 1986, the Farmstead Well Study, Phase I, assessed inorganic chemicals, volatile organic chemicals (voc), and pesticide contamination of farmstead wells. K-State researchers cooperated with the Kansas Department of Health and Environment to assess the impact of manmade contaminate sources on private wells. The results of this research are found in Fig. 1.

The study's conclusions suggest that although modern agricultural activities on farmsteads have impacted well water quality, their impacts are probably not a serious threat to the health of people depending on those wells for drinking water. The 29 percent of wells with nitrate above the maximum contaminant level is a serious concern for infants, successful pregnancy, breeding livestock, and small animals. Sources of high nitrate include active livestock confinement facilities, abandoned livestock confinement facilities, livestock manure, household wastewater (septic system), lawn and garden fertilizing, field fertilizing, and accumulation and disposal of other organic wastes.

The 1987 Farmstead Well Study, Phase II, attempted to relate well construction factors, including well location from contamination sources, and farmstead characteristics of mixing, storage, handling, and clean up of fertilizer, with increased chances of finding contaminants. KSU researchers found chances of high nitrate closely linked to distance from organic waste sources as shown in Fig. 2. A strong link between nitrate level and per-

**Figure 1.**

| | Detectable/Above Background (percent) | Above MCL (percent) |
|---|---|---|
| Pesticides (Total) | 8 | 3 |
| Atrazine | 4 | 3 |
| Chlordane | 1 | - |
| 2, 4-D | 1 | - |
| 2,4,5-T | 1 | - |
| Tordon | 1 | - |
| Volatile Organic Chemicals | 3 | 0 |
| Inorganic Chemicals | | |
| Nitrate | 56 | 29 |
| Lead | 7 | 4 |
| Selenium | - | 1 |
| Cadmium | - | 5 |

**Figure 2.**

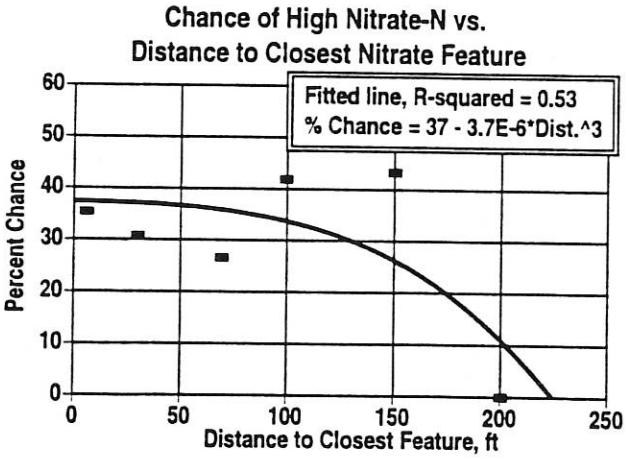
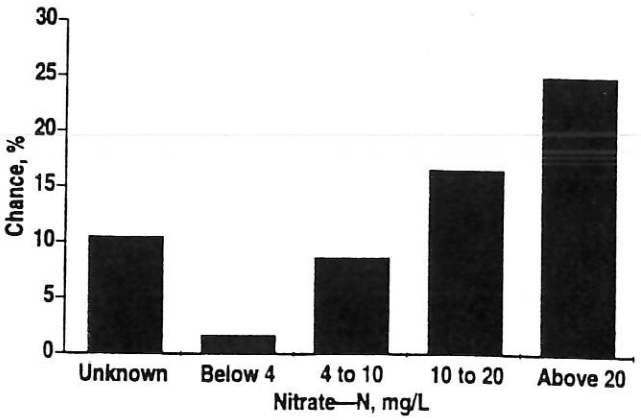



**Figure 3.**






4-7

cent of chance of detectable pesticides also was found as shown in Fig. 3.

The 1994 Private Well Survey of 825 Kansas wells is the largest sampling of private wells. This study of the nine 1993 flood-affected states showed some similar characteristics across broad geographic areas. Unlike the previous farmstead well study, bacteria contamination was a major emphasis for this test. The study found a high percentage of wells (51 percent) with total coliform bacteria and many wells (18 percent) with E. coli. High nitrate was evident in 24 percent of the wells.

## Extension:

KSU Extension initiated its educational program on private drinking water in 1986.

Leader Training—KSU county Extension agents who work most closely with homemaker leaders and home managers were trained on overall water quality, drinking water standards, health and water, water nuisance, water treatment, and water testing. More than 200 persons have been trained to assist others with understanding drinking water concerns, nuisance problems, health risks, water test interpretation, obtaining water tests, and water treatment. More 300 copies of the Household Water Quality Handbook were provided to trained persons. More than 30 Extension bulletins were prepared to assist users and assistance providers with problem-solving information.

Water Testing/Drinking Water Clinic—A series of water testing/drinking water clinics were held in over 80 counties. More than 3,000 drinking water tests were conducted. The participants attended follow-up public meetings to learn how to interpret test results, identify safe well construction, discern between water nuisance and health concerns, protect valuable groundwater resources, and treat water effectively.

Abandoned Well Plugging—Beginning in 1990, KSU Extension demonstrations of the proper procedure to plug abandoned wells have been held in almost all counties. Kansas Farm Bureau has been helpful in promoting and assisting with this very effective effort. Farm Bureau provided complimentary water nitrate screening tests at these events. More than 240 wells have been plugged during these demonstrations. More than 5,000 participants witnessed the correct plugging procedures and were instructed on the importance of plugging wells, correct plugging procedure, groundwater protection, and wellhead protection. Twenty-five thousand copies of Extension bulletin Plugging Abandoned Wells have been distributed through county Extension offices, county conservation districts, and local environment or health officers. Reports to KDHE of plugged wells have increased since demonstrations began in 1990.

Farm*A*Syst—Farmstead Assessment System is a wellhead protection evaluation and production program for private wells. The program has been adapted for Kansas from a program developed in Wisconsin and Minnesota. It helps the owner identify potential risks to wells and groundwater and to prioritize those risks for an action plan. Seven fact sheets have been produced that describe how potential contamination sources can adversely affect wells and groundwater and what actions can help minimize those risks. More than 20 training sessions have reached people in more than half of the counties in Kansas.

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WATER PACK

Water Protection Association of Central Kansas

# A REPORT TO THE KANSAS HOUSE ENVIRONMENT COMMITTEE

# IN SUPPORT OF KANSAS STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE

BY

WATER PROTECTION ASSOCIATION OF CENTRAL KANSAS

JANUARY 1997

Phone & Fax (316) 792-5095 • 6024 Birchwood Drive • Great Bend, Kansas 67530

House Environment
1-28-97
Attachment 5

# Overview

Water Protection Association of Central Kansas, formed in 1990, is an organization of about 500 agricultural producers and businesses. Our founding principle is activism. The need for a pro-active voice for irrigated agriculture was the catalyst for the formation of the organization.

## Mission:

To promote, foster, and encourage the beneficial, economical and sustainable use of quality water.

## Objectives:

- educate our members and the general public about the management of sustainable irrigated agriculture and the long term benefits to our society
- develop and maintain relationships with government and non-government organizations at all levels to promote the wise use and conservation of our water resource
- develop our membership to enhance our pro-active approach and maintain an effective organization in Kansas and the nation
- develop and implement projects that complement our mission

Water Protection Association of Central Kansas is a pro-active voice for irrigated agriculture and takes an active role in water issues and works with other groups and government agencies to develop water policy. We are a partner with the Division of Water Resources, Groundwater

Management District #5 and US Fish and Wildlife Service in the Quivira/ Rattlesnake Basin Partnership. The Partnership's goal is to address water resource concerns and develop management strategies for the Rattlesnake basin.

The Quivira Coalition, of which our organization is a lead member, consists of other agricultural organizations, municipalities and environmental groups. The Coalition was successful in obtaining federal funds for Quivira National Wildlife Refuge. The funds will be used by US Fish and Wildlife Service to study ways to improve water management on the refuge.

## Economic Impact

In South Central Kansas there are more than 758,800 acres of irrigated crops. These crops use $159,830,000 worth of inputs and create $280,659,000 worth of income from production. In addition to crops, this area has $367,815,000 in livestock production. As you can see, this area has a substantial impact on the economy of Kansas.

## South Central Kansas Irrigation Scheduling and Water Management Demonstration Project

The Project is a five year cooperative effort between Kansas State University (K-State) Research and Extension and Water Protection Association of Central Kansas. The goal of this project is to

increase the understanding, adoption, and use of improved irrigation management and scheduling procedures by using current technology and climatic forecasting with field feedback of crop growth, soil moisture, applied water, and rainfall. The research is on target for this specific area of Kansas. We are intermediate in rainfall with wetter conditions to the east and dryer conditions to the west. Unique in Kansas, this area has predominately sandy soils with high infiltration rates. With proper management, our water resource is totally renewable.

## Outreach

K-State Research and Extension professionals will direct and conduct field demonstrations and applied research of irrigation scheduling and water management practices in cooperation with land holders on demonstration farm sites located in South Central Kansas. Farm demonstration sites, selected in each of the 13 representative Water Protection Association of Central Kansas counties, will be used for the duration of the project. Each site is located near a paved road and is identified with a large sign that lists the project title, the cooperators, the project sponsors and current irrigation scheduling information. Each demonstration site will receive an overall system evaluation and weekly visits for system and field/crop measurements. The fields will be open to peripheral visits throughout the summer with more detailed field tours and project updates scheduled each August. Annual winter seminars of education programs and project updates will also be held throughout the project region.

## Results

By the end of the project, substantial numbers of South Central Kansas farmers and crop consultants will be aware of the benefits of irrigation scheduling and field water management including: water and energy conservation, sustainability of water resources, reduced chemical usage, reduced equipment maintenance and wear, and enhanced crop growth and development. It is also expected that these individuals will know how to access and use the regional weather station network to obtain real-time weather data for irrigation scheduling purposes. This project should also result in a greater public awareness of resource stewardship by area farmers. The cooperative effort between K-State providing technical support and Water Protection Association of Central Kansas providing funding which will total about $600,000 during the next five years, most of which will come from the private sector.

## Conclusion

Thank you for your support of K-State Research and Extension. This project is a totally cooperative effort between K-State, Water Protection Association of Central Kansas and other public and private organizations with comprehensive water conservation and economic growth objectives. As producers of crops and livestock, we thank you and appreciate Kansas legislative funding of Kansas State University's Agricultural Experiment Station and Cooperative Extension Service programs.

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"When the well's dry, we know the worth of water."

-- Benjamin Franklin