

MINNESOTA Science

Agricultural Experiment Station
University of Minnesota
Fall, 1986

Plant Breeding Method Is High Tech

Crossing classic plant breeding methods with new technology can breed a golden opportunity. Take, for example, some new research on the lovely forage crop, birdsfoot trefoil.

In full bloom, birdsfoot trefoil is a field of yellow flowers. Agricultural Experiment Station scientists Robert McGraw and David Somers have been scrutinizing it at a much closer level, however. They have been manipulating individual plant cells trying to eliminate one negative characteristic of the crop—the tendency of its seed pods to shatter as they mature.

This can result in the loss of half the seed produced, a major problem for Minnesota seed growers, who harvested about 55,000 pounds of certified birdsfoot trefoil seed in 1985. If more seed could be harvested, the price of seed might decrease and seed growers could still profit.

"There are probably a lot of people that might grow birdsfoot trefoil if we could keep it from shattering," says agronomist McGraw.

Plant breeders must have a source of desired characteristics to develop improved varieties. Since all known varieties of birdsfoot trefoil have a strong



Birdsfoot trefoil is a useful pasture crop scientists would like to improve.

tendency to shatter, McGraw and plant geneticist Somers needed to find a source of shatter resistance elsewhere. A wild relative, *Lotus coimbrensis*, has nonshattering pods. However, it cannot be hybridized with birdsfoot trefoil through conventional plant breeding methods.

McGraw and Somers are attempting to overcome the problem by using a technique called "protoplast fusion" to create hybrids between the two species, and in so doing, introduce the genetic material needed to develop a nonshattering birdsfoot trefoil.

To understand protoplast fusion, one must know something of plant cells. Each cell is surrounded by a cell wall,

and everything inside a cell—including the genetic material which determines a plant's characteristics—is the protoplast. Plant protoplasts from most species, including birdsfoot trefoil, can be cultured to re-form whole plants.

This is how McGraw and Somers use protoplast fusion to get hybrids of birdsfoot trefoil and its wild relative: first, tissue of each species is digested using enzymes that remove the cell walls, releasing the protoplasts. The protoplasts (and the genetic material) of the two species are fused by treating them with other chemicals. From the 120 plants regenerated from fused protoplasts

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This Researcher Burns With a Purpose

Forester Frank Irving has been setting fires for almost 30 years. But this man with the incendiary occupation has the best of intentions—he's helping to improve forest and prairie areas with prescribed burns.

As a result of that 30 year experience, Irving and other Minnesota prescribed burners are developing a computer-based planning system to sift through all the variables involved in carrying out a controlled burn. "While fire has been increasingly used over the past 25 years as a forest management tool," Irving says, "resource managers still face many unknowns before they can safely and predictably burn a specific area."

Controlled burns are carried out throughout Minnesota to improve wildlife habitat, restore and preserve a certain prairie or forest type, or prepare an area for a new crop of trees. The Department of Natural Resources (DNR) uses fire to prepare seedbeds for tree regeneration and to improve deer, moose, grouse and waterfowl habitat. The U.S. Fish and Wildlife Service uses fire to rejuvenate waterfowl nesting areas. The Nature Conservancy, a natural area preservation group, carries out burns each year to maintain prairie and forest-prairie transition areas. And, the U.S. Forest Service prescribes burns for several purposes on national forests in Minnesota.

Irving has helped these groups to better predict the post-burn impact on plant and animal life, and to determine the best management approach. For example, he recently worked with the DNR in updating their burn guidelines to incorporate current research and experience related to prescribed burns. The

cedures and training required to carry out successful burns. He and DNR burn specialists spelled out how to develop a burning plan, what to use to conduct a burn, and how to report and evaluate the success of a fire. The official document also cites laws and regulations that must be followed.

"Managers now using prescribed burning techniques face three problems—when, how often, and how hot to burn," Irving says. The season chosen for burning favors certain plant species and inhibits others; the day or week chosen is determined by long and short term weather conditions. Often it takes more than one burn to get the desired result. Another factor is the burn's intensity, or how hot a fire is desired. Intensity determines the amount

of vegetation burned—from a low intensity burn which suppresses grass and small shrubs to burns that eliminate large trees or virtually everything.

For example, the Cedar Creek Natural History Area, near Bethel, Minnesota, has certain transition areas between the forest and prairie that must be burned early in the spring with a light fire (flame heights of one to two feet) from four to seven times every 10 years. This is necessary to maintain the area in its pre-settled state of the early 1800s.

The comprehensive computer system Irving and his colleagues are developing from field experiences and research will provide accurate, safe, reliable procedures for using fire as a management tool.

—Dave Hansen



Letters

While at a relative's, we saw a copy of the *Minnesota Science* summer edition which had some interesting articles. As we understand it these publications are free? We would like our name on the mailing list. Thank you.

Charles Bakker
Tyler, Minnesota

Editor replies: Subscription to Minnesota Science is free to any Minnesota citizen interested in the research of the Minnesota Agricultural Experiment Station. If you would like to be on our mailing list, just send me your name and address.

Referring to the article in the last issue introducing new crops: I have been disappointed that the wild hazelnut has not been introduced as they grow wild in the woods and at times are larger than the cultivated imported filberts.

I hope you will consider developing the hazelnut as our season is right, the land cheap, and (raising the hazelnut here) would save importation costs from California.

Lou Miller
Sebeka, Minnesota

Editor replies: I forwarded your letter to horticulturist Jim Luby who says the wild hazelnut does grow quite well in Minnesota. However, most of the nuts produced are quite small, he says, and therefore commercial production right now could not be competitive. The hazelnut is native to the Mediterranean. He says a breeding program would take

Saving Energy Means Matching Power to the Job

There is no conservation like innovation. Agricultural engineers at the University of Minnesota Experiment Station are taking a hard look at energy-wasteful tillage practices that increase plow and tractor energy requirements and fuel costs. "What we are finding out should help farmers, fuel suppliers, and farm machinery manufacturers develop more efficient tillage systems that are cost effective and use less energy than current practices," says agricultural engineer, Jonathan Chaplin.

The major use of energy in tillage operations is the resistance a tractor must overcome in pulling an implement through the soil. Chaplin says that the degree of resistance is affected both by the strength of the soil beneath the tractor, and the depth of implement operation.

Engineers refer to the resistance the implement imposes on the tractor as "draft" and the work the tractor performs in overcoming draft as "draft energy." High implement resistance transfers high loads to the drive wheels of the tractor. As the tractor moves forward, it must expend energy and fuel in transferring enough force to the drive wheels to overcome the high loads imposed by the implement.

An obvious solution would be to disturb the soil as little as possible. Studies conducted by Chaplin in sandy loam soil at Becker, Minnesota bear out this conclusion. Chaplin compared the energy efficiency of four commonly used tillage systems: mold board plowing and

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Latchkey Children Are Not Necessarily Deprived

One result of the changing shape of the American family has been the creation of some awkward hours in the afternoon. The time that has gone out of joint is the time between the end of school and the end of the business day—when the schedules of working parents and their school-age children are out of synch.

Latchkey children are those who are on their own, or in the company of their brothers or sisters, from the time that school is over till their parents come home from work. Their numbers have



A study shows that latchkey youths frequently enjoy their independence.

been increasing as more and more mothers take jobs outside the home, causing ominous warnings from some about the effect on children, and creating considerable guilt in parents faced with difficult choices.

However, a study of latchkey children by experiment station youth development researcher Diane Hedin has revealed some surprises. Surveying three Twin Cities communities, she found that, indeed, a high percentage of school-age children are latchkey children. But they don't necessarily dislike the experience. In fact, they frequently enjoy the time as the only time of the day they have to plan for themselves. The latchkey experience is positive or negative, Hedin concludes, depending on the child's environment.

Hedin found the size of the latchkey phenomenon in Minnesota higher than she expected, and higher than previously reported. The majority of children surveyed in kindergarten through eighth grade are in self or sibling care in part or most of each week after school during the school year. "That number is somewhat lower if we consider only the children who are home alone most of the time—three to five days a week. These latchkey children are 30 percent of the kindergarten through third grade children, and 40 percent of the fourth through sixth grade children surveyed," she says.

Hedin speculates that we have such a high percentage of latchkey children because we have one of the highest percentages of working mothers of any

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produce an apple variety—about 50 years. But he agrees that it could be done, and says others have expressed interest in this little researched Minnesota wild crop.

...We are interested in the blueberries that have been developed for northern Minnesota. The first edition (of *Minnesota Science*) was misplaced and so we were happy to see in the next edition an address to write to get the information.

Harry Brune
Bemidji, Minnesota

Editor replies: I still have some copies of the list of nurseries that are propagating Northblue, Northcountry and/or Northsky blueberry plants and I will send a copy of the list on request.

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so far, the researchers have identified two hybrids.

Now, Somers and McGraw must determine whether the hybrids are fertile and have nonshattering seed pods. If so, they will use conventional plant breeding methods to combine the nonshattering characteristic of the wild species with the desirable agronomic characteristics of birdsfoot trefoil. "We should know later this fall whether it is possible for us to introduce this nonshattering trait into birdsfoot trefoil using these methods or by using other tissue culture approaches," Somers says.

The scientists plan to produce more hybrids through protoplast fusion to increase the genetic diversity of the hybrids to isolate a variety of desirable plant traits. McGraw adds that this project is one of the first in which protoplast fusion has been used to improve a forage crop.

—Anne Gillespie Lewis

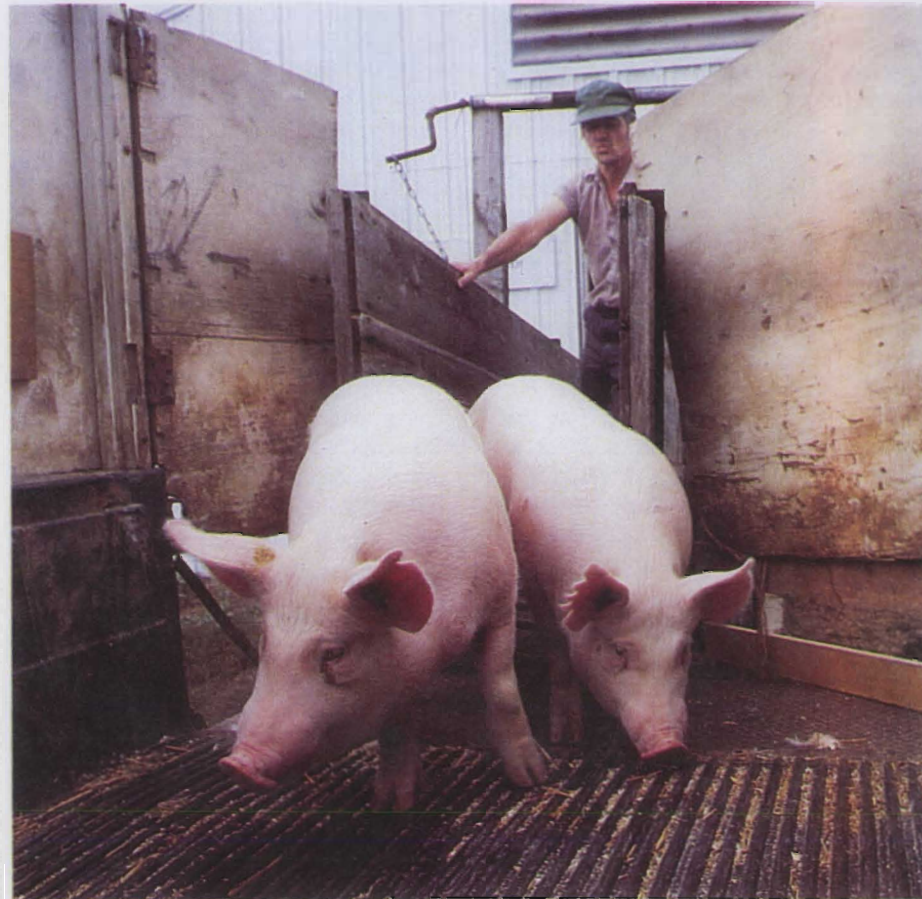
A Loading Issue: Scientists Study How to Move Pigs Gently

Raising pigs is a business and profit is necessary, but that doesn't mean that producers aren't concerned about raising pigs as humanely as possible. There are also economic reasons for this concern. Animals that are not over-stressed eat better and are less prone to disease problems.

Although the ways to handle animals have been deduced over centuries of raising them, the best methods are not always understood. Take, for example, the stress of moving pigs from barn to market. A team of experiment station researchers—animal scientists Dick Phillips, Bill Rempel and Marion Marshall-Nimis—recently completed a study of loading, an activity that is usually considered stressful for both pigs and producers. The results offer recommendations about how to move pigs gently.

Rempel, who has managed the swine breeding research of the experiment station for years, has been interested in animal welfare issues for a long time. He says he feels a responsibility to animal producers. "For the most part animal producers are following the recommendations that we have made—we meaning the entire scientific animal agriculture community—and if they are accused of mistreating their animals, who will defend them?"

"Loading is of increasing importance to producers," Marshall-Nimis adds, "and one of the reasons is public awareness of the welfare implications. Also there are costs to the livestock industry in terms of cut-out losses.



Pigs are contact animals, and tend to want to move together.

ing to consumers and has a shortened shelf life, or the dark, firm, dry meat (DFD), which also has less commercial appeal. DFD results from longer term stress, but PSE can result from short term stress, such as loading."

With a grant from Humane Information Services, the team decided to do a series of loading trials with three different breeds. "We wanted to see if there were breed response differences,

methods—a ramp and a hydraulic lift—as well as order out of the pen. The entire loading process was videotaped and the tapes were run and rerun for analysis. It's safe to say no group of pigs has ever had their every motion so carefully scrutinized.

The first surprise was that the light conditions did not seem to impact pig stress or comfort levels. Rempel suspects that the reason was due to the speed of loading. "If you sort the pigs before you

because Pietrain as a breed are amenable to good treatment. "Once they are used to being treated well, they are quite docile. Whereas the York is more active. In the barns the crew always say that the Minnesota No. 1 is the most stubborn pig we've got. Well, they may be under certain conditions, but they weren't under these conditions," he says.

To analyze the information on the videotapes, Marshall-Nimis developed a loading behavioral inventory, and then analyzed pig behavior frequency. She identified 28 categories of different behavior. Certain behavior was identified as implying a negative reaction, for example, backing up or trying to turn around.

"It became clear that the lift and the ramp were two completely different environments for the pigs, and created different responses. The ramp was solid-sided and about one and a half pigs wide. The lift was a big square open thing. In the lift, four animals could be alongside one another. Pigs are contact animals, and we found that they would be hesitant to enter either device until another animal came alongside, and then they would try to push through together. In both cases—the lift and the ramp—there wasn't enough room for two animals to go through together, so you would have a kind of traffic jam, until one animal would squeeze ahead. So one recommendation might be to make the ramp two pigs wide, or one pig wide, but not one and a half, which was a stressful width," she says.

The study showed that loading small groups at a time is an effective method of handling. "The ramp was actually faster than the hydraulic lift, though perhaps less humane," Marshall-Nimis says. "Once the animals had been load-

accused of mistreating their animals, who will defend them?"

Animals that are coerced often show bruising and marks on their skin and carcass. Also, stressed animals show changes in the quality of meat. The result can be either the pale, soft exudative type (PSE) which is less appeal-

Pietrain, which are highly stress susceptible, and the Minnesota No. 1, which is the breed developed by the Minnesota Agricultural Experiment Station," Rempel says.

"We loaded them in groups of five, from pens of 10 per breed, at each end of the barn," Marshall-Nimis explains. "One end of the barn was in almost total darkness, and the other was in very bright light."

The trials had a complicated design: the researchers were looking at three breeds, two light methods, two loading

roam around, then light and other factors may have more impact," he says.

The trials did reveal some breed differences. "The Yorkshire were significantly slower than the other two," Marshall-Nimis says. "They also showed an upward and apparently aggressive nudging behavior that the other breeds didn't exhibit." The Pietrain, surprisingly, handled well with no great signs of stress. "The Pietrains are susceptible to stress and I had thought that they might be the worst, but they really were quite placable," Rempel says. It could be

until the time they actually had to enter the truck," she says. However, Rempel adds, if the ramp is very steep the pigs run into difficulty. And the lifts are so high they are almost inaccessible for some trucks, causing difficulty at the other end.

There is much more to learn about the art of animal husbandry. But this careful look at just one small part of the complex job of raising pigs has potential benefits for handlers, producers and pigs.

—Jennifer Obst

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planting, chisel plowing and planting, no-till planting and ridge planting. No-till planting—depositing seeds directly into soil through the residue of the preceding harvest; and ridge tilling—planting seeds on top of previously formed ridge beds—resulted in fuel savings of as much as 70 percent over conventional mold board and chisel tillage. "The results show that the more soil disturbance brought about by any field operation, the more energy and fuel required," says Chaplin.

However, Chaplin says that many of the tractors in the fields today are oversized for the type of work being done. "Tractors and implements should be correctly matched in size so that the diesel fuel is used as efficiently as possible. Implements that do less soil disturbance will allow smaller tractors to be used." Using a large tractor with undersized implements wastes energy and reduces fuel efficiency in the same way that a large V-8 automobile loses miles-per-gallon in city driving. "Farmers may need to down size their tractors to gain the kinds of fuel savings we demonstrated at Becker," says Chaplin.

—Chris Ruttan

Water Quality Research Center Founded

A Center for Agricultural Impacts on Water Quality has been established by the University of Minnesota Agricultural Experiment Station with a special \$250,000 appropriation from the Minnesota Legislature. The center brings together a multi-disciplinary group of researchers to investigate the relationship between agricultural practices and ground water. The center will study both ground and surface water issues, help determine impacts of agriculture on water quality, and establish recommendations for agricultural practices, according to Jim Anderson, University of Minnesota soil scientist and newly named director of the center.

"If we're going to make decisions about certain agricultural practices, whether it be changing fertilization schedules or quantities, or changing tillage systems or whatever, we better know what the effects are. And by no means is that a clear picture," Anderson says. "We've conducted many agronomic studies on movement of nitrogen through soils to see whether or not we get yield responses by adding additional nitrogen, for example. What we don't have are

good field experiments that tell us what that amount of nitrogen moving through the soil profile means in relation to the ground water resources," says Anderson.

Although the research of the center will relate to agriculture across the state, the researchers are concentrating their initial efforts on two particular areas of the state: in the southeastern Minnesota silt loam soils over limestone bedrock and in the central sand plains area. "Those two areas of the state have been shown to be highly sensitive to impacts from intensive agriculture," Anderson says.

"We will be monitoring the soil water and the movement of agricultural chemicals through the soil profile to depth," he says. Right now they are extensively characterizing those sites to get a good idea of what chemicals are inherent in the soil and what's left over from past management practices. They are installing instrumentation at different depths to monitor the water quality during the growing season. "We will be setting up weather stations at both sites to automatically monitor precipitation. But this kind of research is labor

intensive—we need to have people out there sampling every time there is water moving through the soil," Anderson says. They plan to start studying crop rotations next spring, after spending this year minimizing the chemical inputs at both sites.



The new water quality research center will help determine sound agricultural practices.

A comprehensive educational program to inform the public about potential impacts of agricultural practices and ways to minimize those impacts is another important goal of the center.

—Jennifer Obst

Could Our Hardwood Forests Repel A Gypsy Moth Attack?

If the gypsy moth moves to the state in damaging numbers, how much resistance could hardwood forests manage?

Gypsy moths are destructive, leaf-eating insects that arrive in a new locale, often inconspicuously with the moving van, perhaps on the underside of lawn furniture shipped in from the east coast. They have been sighted by the Minnesota Department of Agriculture in the Twin Cities this year and in a small area near Sauk Center. "They are not here in sufficient numbers to study their biological effects," explains Herbert M. Kulman, entomologist and lead investigator of a new experiment station research project looking at the potential gypsy moth threat that will involve the entire northeastern region: including land grant eastern universities and midwestern universities in Minnesota,

Wisconsin, Illinois and Michigan.

The gypsy moths' favorite victims are red, burr and white oak. There are plenty of all three species in the hardwood forests of southeastern Minnesota, especially in Winona County, the site of the Minnesota research project.

"We want to find out if gypsy moths would be a problem if they arrive, and how much of a problem," explains Darren Georgeff, graduate student on the research project. The first step was to individually measure 5,000 to 6,000 trees.

The researchers will be looking at both the "risk" and "hazard" ratings of the trees. "Risk" is a mathematical equation which takes into account physical aspects of the trees such as density and the presence or absence of such characteristics as deep bark fissures and bark flaps (loose bark peels like

those found on paper birch). Such characteristics provide the gypsy moth winter protection. Small diameter trees have more tree surface area relative to leaf surface area, which means there is more habitat to provide refuge for gypsy moth larvae and pupae than there is food (leaf) source. Under these conditions the gypsy moth is more likely to run out of food and completely defoliate the small trees.

"Hazard" is a measurement of the tree's condition and a projection of whether or not it could survive the defoliation the gypsy moth can cause. If a tree has 50 percent of more dead branches, it will likely die if defoliated by the gypsy moth. "But not all trees defoliated by insects die. It would take two or three consecutive years of defoliation by the gypsy moth to kill a healthy tree," Georgeff points out. The "hazard" rating will be higher if trees have been affected by fire, weather or previous insect damage.

"The gypsy moth's favorite victims are red, bur, and white oak."

The researchers will plot on computer the information gathered onsite with geographic information. Geography can be destiny for the survival of a tree facing a gypsy moth threat. For example, on south facing slopes which are

IN PRINT

Fall topics for new publications show the range of work supported by the Agricultural Experiment Station: landscape values in the countryside, alternative ways to deliver vocational education to rural areas and the world food problem.

At a time when more and more farmers in Minnesota are being replaced by non-farmers escaping the cement and noise of the city, the beauty of rural landscapes can be easily diminished. *Caring for the Countryside: A Guide to Seeing and Maintaining Rural Landscape Quality* (AD-SB-3017) by Joan Nassauer, landscape architect with the Agricultural Experiment Station, gives rural residents and planners guidelines to manage development in a way that preserves the area's character. "People take for granted the qualitative aspects—the aesthetic and ecological aspects—of the rural countryside," says Nassauer. "Changes in the landscape should support its basic characteristics."

Nassauer suggests that two basic qualities define a rural landscape: meaning and composition. A farm pattern has a meaning, a reason for the lines and configurations it creates; it also offers a visual impression, conveys a feeling. The premise is thoughtful and, in combination with the publication's many photos and maps, helps the reader see landscapes with a new understanding.

Of interest to educators, policy makers and regional planners is *Access to Educational Opportunity in Rural Communities: Alternative Patterns of Delivering Vocational Education in Sparsely Populated Areas, Vols. 1-6*, by





Don DelGreco, of the Rochester office of the Minnesota Conservation Corps, measures trees in a study to track the health of the forest.

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place in the country. "And also we probably got higher response because we also asked kids to report, and parents tend to under-report," she says.

The study, the first of its kind to gather and compare responses from both parents and children, cut across income levels and focused on three school districts in the greater Minneapolis area: Burnsville, Edina and Minneapolis. Over 1,200 parents of students in kindergarten through eighth grade responded to a questionnaire, and about 40 parents participated in discussion groups. More than 1,250 students in fourth through eighth grade completed a questionnaire, and approximately 800 participated in discussion groups.

A strong majority of the fourth through eighth graders—80 percent—like being home alone. Most of the children enjoyed the time alone because it allowed them some independence. Some children who care for younger siblings reported that they like "being able to boss" them.

The only exception to this pattern was found among the lowest income, minority, urban elementary children from single-parent families. Fifty percent of them said they did not like being home alone at all. When students discussed worries in a group setting, their number one concern was a fear of

someone breaking into their home and robbing or hurting them.

"There have been studies that have shown that kids are frightened of being alone, and then that data was generalized to imply that all kids in a latchkey situa-

—
"We probably got higher response because we asked kids to report, and parents tend to under-report."
 —

tion are at risk. I think we have identified the environmental setting as critical," Hedin says.

Parents in all neighborhoods and income levels don't like the idea of self-care as much as their children. Thirty to 40 percent wished they could increase the amount of time they spent supervising their child.

The results of these findings, Hedin says, is a clearer picture of the latchkey phenomenon, and some suggestions on how to cope with it. "I think it would be better if we could get it clear that not every kid who's home alone is at risk. When you try to say to all these

drier and warmer than other slopes, or on low moisture soils, trees are usually smaller and in poorer condition.

Although Georgeff saw no gypsy moths in his sampling and no serious insect problems, this moth is very adaptable. That is why the Minnesota research project is attempting to keep steps ahead. With a mobile citizenry, the gypsy moth will be a continuous threat.

—Mary Kay O'Hearn

parents of latchkey children, 'your kids are really in terrible trouble and you should be ashamed of yourself,' their reality doesn't match up with that. The kids are happy; the parents supervise from afar; and it has been working out okay. So if we could target the kids who really want and need help, we would be using our resources more effectively," she says.

Hedin does not believe the trend will be reversed. "It's not the same here as it is in other countries, where children, as well as adults, are willing to participate in group activities much more extensively. Kids here just don't want to join things very much. Our culture prizes privacy and individualism, and the kids buy into that too," she says.

A sensible solution, Hedin believes, would be to bring work and school times back together. "The problem, after all, is only a problem because parents get home a lot later than kids, and I think both schools and employers need to do some thinking about how to get those schedules more in synch," she says.

Meanwhile, Hedin believes the best thing to do is give the latchkey child the skills to be even more comfortable taking care of him or herself. "Schools, or youth service agencies ought to provide that sort of education for kids. I think it is a basic survival issue," she says.

—Jennifer Obst

associate professor of home economics education and professor of agricultural education.

The six volumes report on in-depth case studies at five sites, three in Minnesota, one in South Dakota, and one in Illinois. Each site exemplified a different pattern of inter-school district cooperation, through pooling students and sharing costs, in providing vocational opportunities. Thomas says the findings will enable educational planners to evaluate alternative forms of inter-school district cooperation in rural areas.

Technology, Human Capital and the World Food Problem (Misc. Publication 37) is a colloquium of papers presented at the Alexander Von Humboldt award ceremony, of which Vernon Ruttan, University of Minnesota agricultural economist and recently elected Regents Professor, was the 1984 recipient. Topics include farming systems in Africa, technological cycles in Latin American agriculture, and Ruttan's own theory of induced institutional innovation, among others. Contributing authors read like a Who's Who of Economic Development: Hans Binswanger and Prabhu Pingali, T. Paul Schultz, R. Evenson.

For the price of these publications, contact your local county extension office or write to the Distribution Center, 3 Coffey Hall, University of Minnesota, 1420 Eckles Av., St. Paul, MN 55108.

—John Colmey



BRIEFS

ARMS Helps Farmers Manage Risks

A new computer program that helps farmers analyze the risks of growing cash crops is being developed by researchers with the University of Minnesota Agricultural Experiment Station.

The program, developed by agricultural economist Robert King and Fred Benson, is called Agricultural Risk Management Simulator (ARMS). It analyzes three variables: crop mix (up to four different crops); crop insurance levels; and forward contracting (based on various prices and amounts contracted).

"You enter your own farm information," King says. Up to 250 scenarios ranging from the worst to best possibilities all analyzed and summarized by the program.

"The program helps you learn the magnitude or risks involved," King says. "It makes it easier to see all the things that could go right or wrong and helps you explore planning options to reduce the risks."

MINNESOTA Science

Volume 41, Number 3

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Page 1, David Somers; page 2 top, Frank Irving; page 4, Darren Georgeff; all others, Dave Hansen.

Minnesota Science is published quarterly by the University of Minnesota Agricultural Experiment Station; Institute of Agriculture, Forestry, and Home Economics, St. Paul, Minnesota.

Address all correspondence and requests to Editor: *Minnesota Science*, 433 Coffey Hall, University of Minnesota, St. Paul, MN 55108.

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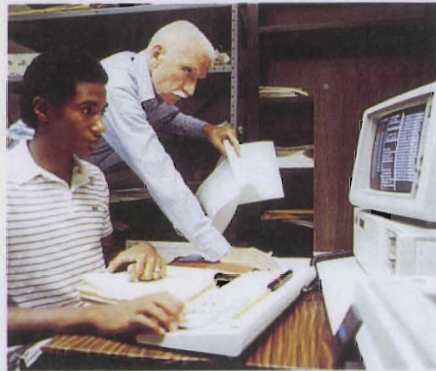
King says the program also helps one understand how risk management strategies can fit together. "Forward contracting a high percentage of the crop can look good if you lock in a favorable price," he says. "But bad weather and a short crop could really put you in trouble in that situation. The program will show you how crop insurance can reduce this risk and it helps evaluate the cost effectiveness of risk protection."

The ARMS program can also be used by both farmers and lenders as they discuss borrowing decisions, King adds.

The computer program is being evaluated and field tested and will be available at county offices of the Minnesota Extension Service by the beginning of 1987.

—Jack Sperbeck

High Schooler Gets Hands On Science Experience



Research apprentice David Thomas gets a taste of computerized climatology, with experiment station soil scientist Donald Baker's help. The goal of the USDA-CSRS sponsored research apprenticeship program for high school juniors and seniors is to stimulate interest among the minority communities in science related careers.

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Canola Meal Looks Promising for Feeding Growing Dairy Animals

Canola meal makes a satisfactory low-cost replacement for soybean meal as a protein supplement for growing dairy animals, according to a study done by George Marx, dairy scientist with the University of Minnesota Northwest Experiment Station at Crookston. "Canola meal has slightly lower protein content than soybean meal, but feeding trials showed little difference in feed efficiency between the two.

In the feeding trials, canola meal and soybean meal were used in separate calf starter rations and fed to 30 pre-weaned Holstein calves for four weeks and 28 weaned calves for 16 weeks. In another 16 week feeding trial, 20 growing Holstein steers were fed canola meal or soybean meal in a mixed ration containing corn silage and high moisture corn. "Similar average daily gains were experienced on both the soybean meal—and canola meal-fed calves. Average daily gain on the dairy steers fed either canola meal or soybean meal as a protein supplement was not significantly different," Marx says.

Canola was developed in 1979 from its parent stock known as rapeseed. Canola has many advantages over the old rapeseed including improved palatability and oil content, Marx says. This year, Minnesota is expected to grow 30,000 acres of canola.

—Jennifer Obst

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