

MINNESOTA *Science*

Agricultural Experiment Station
University of Minnesota
Spring, 1990

Low Inputs Work for Both Producers and Pigs

Getting into farming shouldn't require the resources of a multinational company, or a very rich relative. Unfortunately, these days it often seems that it does. That's why experiment station researchers Carlos Pijoan and Larry Jacobson designed one way to get started in farming without a key to Fort Knox.

Their design is for a low-input feeder pig operation. It's currently in a real-life test of its productivity, profitability, and implications for animal welfare, on the southeast Minnesota farm of Ardyce and David Olson.

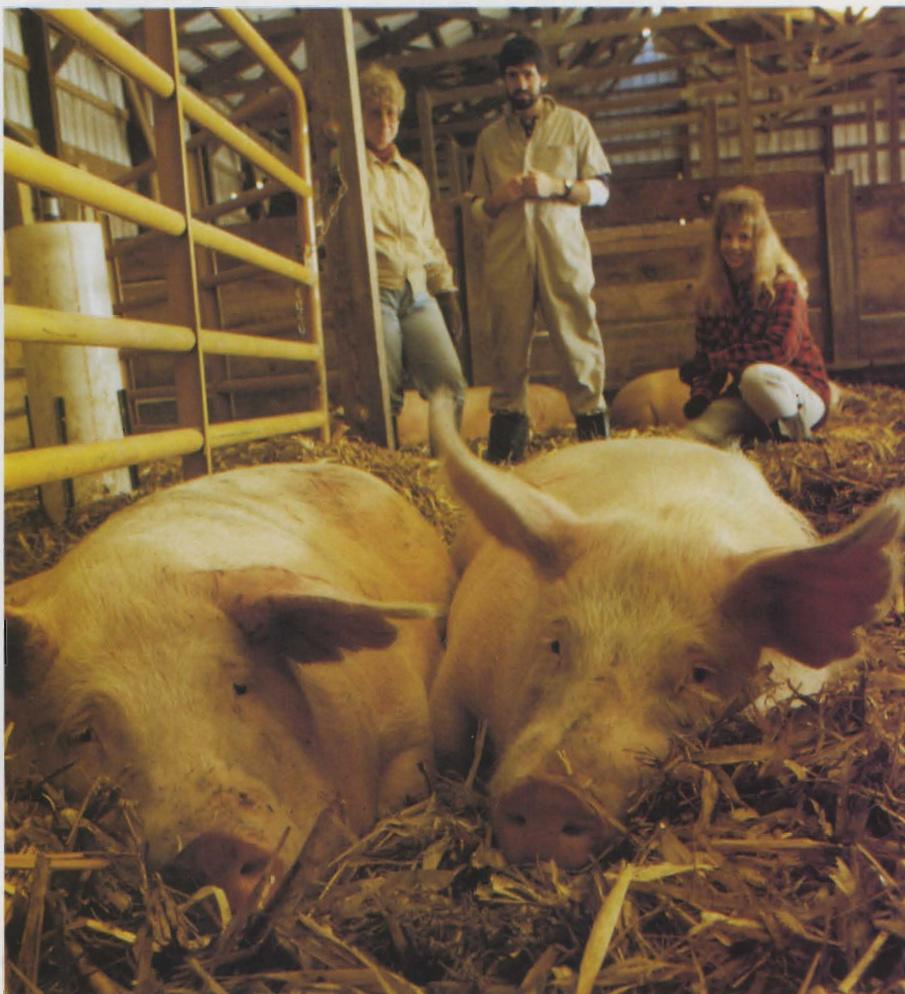
They are comparing their low-input system side-by-side with a conventional intensive one. The twenty animals in each are all the same age, have the same genetics and manager, and receive the same feed.

Some early results are interesting. Low inputs not only use less energy—the major input is lots of straw—but also require less labor. The low input system is also good for reducing pig aggression.

The system is in an old pole barn with an open south side and earthen floor. An open 32 by 40 foot heavily bedded pen is used for communal farrowing. No individual farrowing pens are provided. A large bale of straw lets sows build nests and farrow wherever they choose.

"We can build this system for about 25 percent of the cost of a conventional swine system. So even if the production is slightly less, which it probably will be, the return on the capitol investment is much better," says Pijoan.

Preliminary results already show that aggressive and abnormal behavior such as bar biting is less of a problem. Pijoan also notes that sow condition is



In a low input system, sows have the space and opportunity for social interaction. This farrowing pen on the farm of Ardyce Olson (background left) requires lots of straw but less labor than a confinement facility. Veterinarian Pablo Arellano and veterinary student Ann Langer visit the farm weekly to monitor the herd's health and behavior.

better, even though piglet weaning occurs about three weeks later than in an intensive system. He says he thinks this may be because the sows are more active and eat more in the low input system.

Besides looking for an economical and healthy system to raise pigs, they are also trying to minimize the use of chemicals. "We are trying very hard to

Low Inputs *continued on back page*

Realities of Divorce Push Children Into Poverty

Ramsey County Court Judge Margaret Marrinan sees the economic realities of divorce clearly from her seat on the bench in Family Court. "You can't expect to split up a whole pie and end up with a whole pie for everybody," she says.

Facing economic realities and achieving an equitable judgement isn't easy, especially with shifting laws and guidelines. It would help both judges and litigants, she says, to have some unbiased data on the actual economic effects of divorce on mothers, fathers and children.

The first stage of such a study has been completed by Kathryn Rettig, family social scientist with the University of Minnesota Agricultural Experiment Station. The Ramsey County Board of Commissioners and District Court helped with the investigation. The evidence is in and shows that divorce affects all parties negatively, but especially children and mothers.

The study looked at families of four, before divorce, with a median before-tax income of \$31,814, well above the poverty level of \$9,120. But after divorce, 81 percent of the children lived in sole custody of their mothers, who had to support them on a median gross income of \$9,648 plus inadequate help from court-ordered child support.

The study collected data from 1,153 court case records in ten Minnesota counties, representing all the state's judicial districts.

The results suggest that children of divorced families would be better off



Child support settlements are supposed to follow state guidelines. But an experiment station survey documents negative economic affects of even these divorce settlements on women and their children. Ramsey County Court Judge Margaret Marrinan says the research is needed to help modify the guidelines.

economically if the Minnesota Child Support Guidelines were strictly followed, says Rettig.

But even if the guidelines had been strictly followed, the income adequacy for children would have been questionable, she says. Actual court-ordered child support awards met only 56 percent of the children's minimum subsistence needs, as indicated by the poverty levels.

The majority of cases involved couples married about nine years, who

divorced in 1986 with one or two children. Courts ordered child support in three-fourths of the cases. But ordered support failed to meet guidelines established by the Minnesota Legislature. The average shortfall was \$175.20 a year.

Surprisingly, fathers with higher incomes were more likely to pay *less* support than suggested by the guidelines. "The more able the fathers would be to pay child support, the less judges are requiring it of them," says Rettig.

Minnesota's results are similar to data from other states. Minnesota differs, however, with fewer men receiving physical custody of their children. And alimony is given to fewer women in

A second stage of the research, now in progress, is mailing surveys to all parties of the 1,153 divorce case records originally examined. It will explore reasons why child support is or isn't paid, and the problems encountered in the child support system.

If funded, a third stage will include in-depth interviews with a sample of divorced families.

Judge Marrinan hopes that this kind of research will help everyone, especially couples considering divorce, better understand its potential economic consequences. "I hope also that the Legislature will look at the study. All the judges do is follow the law. On the other hand, it would be nice to have a law that is sufficient, and consistent."

Rettig also hopes the study will help legislators and judges come up with settlements and develop laws that better serve Minnesota's children.

—Jennifer Obst

Summer Branch Station Field Days Scheduled

Branch Minnesota Agricultural Experiment Stations host field days giving the public opportunities to see how experiment stations operate. Scientists are there presenting the most current findings of University plant and animal research.

Contact each station individually for more information. The 1990 schedule for summer field days is:

- Southern Station, Waseca, June 26;
- Southwest Station, Lamberton, June 27;



Water from a deep perimeter well at the Westport Water Quality Research Farm will be analyzed to evaluate chemical movement through the soil. Results will help researchers develop water quality recommendations.

Water Research Gets Specific

In making water quality agricultural recommendations, it doesn't help to think globally. In fact, just the opposite! A farmer's practices should be based on characteristics of individual fields.

That's a major recommendation of the University's Center for Agricultural Impacts on Water Quality. Three years of concentrated research on two sites, in groundwater sensitive central and southeast Minnesota, has yielded significant information about what happens to agricultural chemicals in the soil.

The Center's goal is to get research based information to farmers about management practices that are both profitable and environmentally safe, explains Center director Jim Anderson, an experiment station soil scientist.

The first research season was spent installing a complex maze of wells and soil moisture detection equipment for tracking even the smallest trickles of chemicals through the soil. The second year they waited for rains that never came.

It was Anderson's luck to begin a

water study in the 1988 drought. It was so dry, they even measured some chemicals moving *upward*, he says.

"We still learned some things from that season," says Anderson philosophically. "And, after all, this is the kind of thing producers live with. If we are trying to come up with recommendations, we need to do our research over the same spectrum farmers face."

Research is suggesting some specific recommendations to impact sensitive areas. For example, at the Lawler Farm in southeast Minnesota, it seems the best treatment of fertilizer nitrogen may be a more precisely measured spring pre-plant application. "Fall application resulted in nitrate concentrations twice as high as spring applications," Anderson says, "and the amount of nitrates in the percolating water increased as the rate of nitrogen application increased."

Farming by soil type will become common, Anderson says. "We'll apply chemical rates according to soil types

Water *continued on back page*

Minnesota than nationally. "We found alimony was awarded in only 10 percent of the cases, the duration was short, and the amount was low," Rettig says.

- West Central Station, Morris, July 12;
- Northwest Station, Crookston, July 18;
- North Central Station, Grand Rapids, July 19.

"How Bad Without Chemicals?" Ask Researchers of Corn Pest

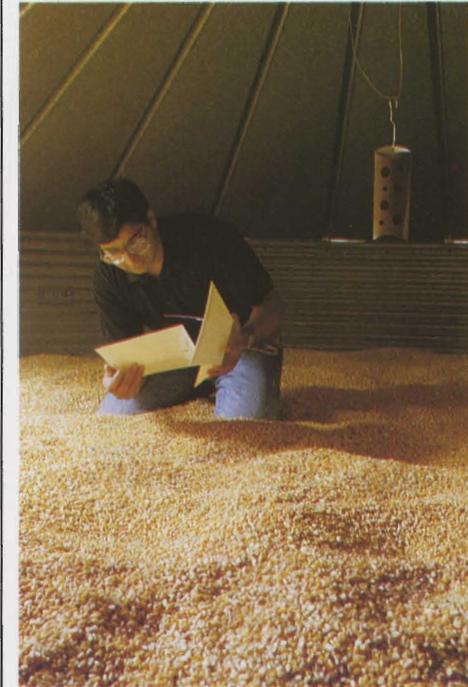
Minnesota's annual stored grain losses from insect activity are an estimated \$82 million. For feeding on corn stored in bins, Indianmeal moths and their larvae are thought to be Minnesota's third most common insect pests. Unfortunately, neither the amount of damage larvae cause nor the effectiveness of adult control measures has ever been precisely known.

Stored-grain entomologists Phil Harein and Bh. Subramanyam are trying to change that. It's practical research of the Minnesota Agricultural Experiment Station because the only current control for Indianmeal moths, though simple, is seldom used. It's a resin strip in the bin space above the corn. The strip slowly releases dichlorvos vapors that kill moths before they mate and reproduce.

One major project objective is to develop a model that will predict changes in Indianmeal moth populations as influenced by grain and ambient temperatures. That's why the researchers are sampling corn stored on farms for moth larvae and adults.

"This survey will show how serious a pest the Indianmeal moth is," says Subramanyam. "The model will enable farmers to predict when control is needed." Subramanyam has spent the past four years investigating stored grain insect problems in Minnesota.

The researchers will also study whether moths have developed resistance to dichlorvos. Laboratory tests with moths collected from different locations will show whether the resin strips are



Entomologist Bh. Subramanyam's work takes him inside grain bins. In this corn bin he's checking a trap for evidence of Indianmeal moths. A dichlorvos resin strip hangs from the roof.

losing their effectiveness.

The researchers do not suspect that the adult moths have developed resistance to dichlorvos, because less than 10 percent of Minnesota's farmers use it. Other chemical alternatives, such as malathion and pirimiphos-methyl, and a nonchemical alternative, *Bacillus thuringiensis* (a bacterium) are not effective against this pest because of resistance.

—Dave Hansen

Soviet's Own System Sabotages Agricultural Reforms

Americans enjoy inexpensive, plentiful and dependable food. By contrast, the Soviet Union's state ideologies and production, processing and marketing inefficiencies cripple food supplies.

"Soviet farms get one-half to two-thirds as much output per unit of input as farms in North America," says agricultural economist Karen Brooks. Brooks studies economic reform in Soviet agriculture for the Minnesota Agricultural Experiment Station.

Brooks is no mere outsider looking in. She has traveled to the Soviet Union several times, most recently to Lithuania. And she works with economists from the Soviet Agricultural Academy of Sciences.

"The Soviets have a tremendous opportunity," Brooks says. "If their agriculture were chronically unproductive because they have a poor natural resource base, they wouldn't be able to do much about it."

Changes initiated by Soviet President Mikhail Gorbachev may improve things, says Brooks. For example, newly legalized lease contracts exploit personal initiative and promise the benefits of

private management without ideologically unacceptable private ownership. Lease contracts permit farm workers to lease land from the state-owned farms where they were formerly employed.

Yet, relatively few strike out on their own, despite the allure of more freedom and money making opportunities. Brooks says that's because the system has not yet changed enough.

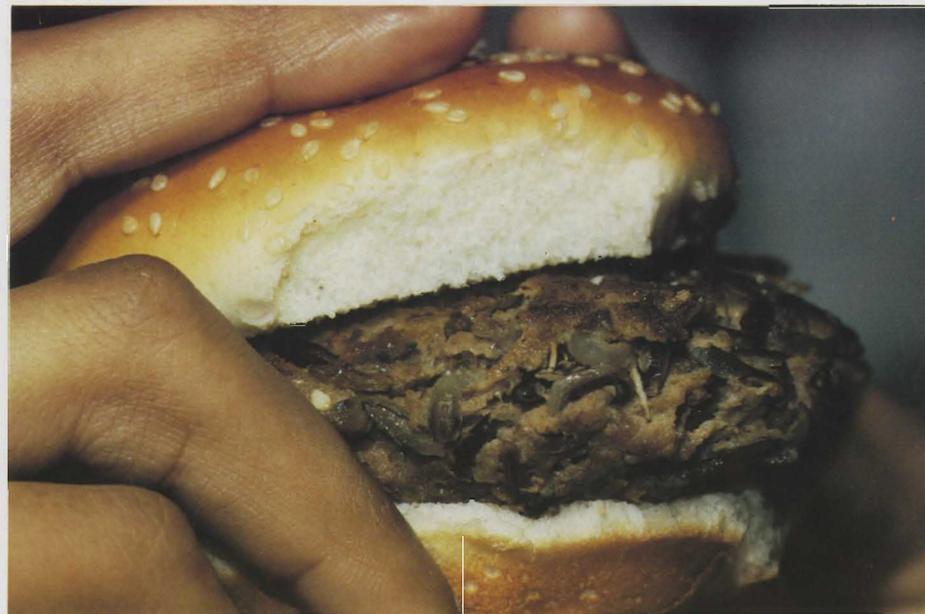
For example, leaseholders can only obtain machinery, fuel, fertilizers and chemicals from the state farms from which they rent. Those farms often try to cover losses by inflating prices to the entrepreneurs. Leaseholders who clash with the farm chairman may even find essential inputs totally cut off.

Eliminating the middle-man role of state and collective farms wouldn't solve the problem, Brooks says, because all inputs come from state monopolies. The lack of competition does little to encourage service, quality, timely delivery or lower price.

"They need to break up the state monopoly in the input supply business," she says.

"The Soviets have tried to approach agricultural reform simply by restructuring the relationship between the people who do the work and the farms. They haven't put the same effort into changing the economic environment so that people can work effectively.

"They need to increase people's confidence that these changes are here to stay. Longer leases would help, or if people had ownership deeds in their hands. And, if they could feel that the economic environment is changing so they could make a go of it, they might



Ground beef mixed with wild rice makes a tasty burger with less fat. The combination was cooked up by experiment station researchers who also found that wild rice retards rancidity in frozen uncooked meat.

Wild Rice Plus Beef Equals Better Burgers

A trendy restaurant might tout it as *un Hamburger au riz sauvage*. But you needn't patronize such a place to enjoy what Paul Addis and Richard Epley say is a tasty and healthful way to prepare a burger: mix cooked wild rice with the meat before shaping the patty.

Research directed by food scientist Addis and animal scientist Epley, has also found that adding cooked wild rice to ground beef results in a burger with less fat, and that is also less likely to turn rancid when frozen uncooked.

Graduate student Phil Minerich conducted the research, funded by beef and wild rice producers. It may provide an alternative to beef loving consumers concerned about calories from fats.

properties, and some processors are already adding wild rice to the sausages they make."

Addis and Epley are especially excited about their discovery that wild rice retards rancidity in uncooked ground beef. That could be a very important finding for both the beef and food service industries.

"It might explain why our taste panel consistently preferred the hamburgers that contained wild rice over the ones that did not," says Addis. "The patties had been frozen, uncooked, about a month and a half, and they preferred the wild rice burgers whether we had added 15 or 30 percent wild rice by weight and whether the ground beef





St. Cloud blueberry.

New Blueberry Extends Harvest Season

St. Cloud, a new blueberry cultivar from the Minnesota Agricultural Experiment Station, is good news both for Minnesota's fledgling blueberry industry and for home gardeners. It's especially suited to colder regions of the U.S. and Canada.

St. Cloud grows tall, up to four feet. "Although its greater height allows for more convenient harvesting," says horticultural scientist Jim Luby, "it may predispose the plants to more winter injury in extremely cold regions or during seasons with inadequate snow cover." Nevertheless, over the past six years yields of mature plants at Becker averaged seven pounds. That's a good indication that St. Cloud has considerable hardiness.

"St. Cloud will be a great companion for Northblue. That it ripens several days earlier is a definite plus," says David Wildung, horticultural scientist at the North Central Experiment Station, Grand Rapids. "St. Cloud will extend the length of the picking season for cultivated blueberries in Minnesota to about one month.

"I also think the quality of St. Cloud is better than any of the other cultivars we've released," he says.

According to a survey conducted about a year ago, half-high cultivars developed at the University account for nearly all the 100 acres of U-pick blueberries in Minnesota.

—Sam Brungardt

be much more enthusiastic about striking out on their own."

Brooks says, "there are many problems they need to work on in order for agricultural reform to work: supplying inputs, marketing both inputs and outputs, breaking up the state monopolies, and changing pricing policy. Soviet agriculture is moving in the direction of private ownership although it won't get there soon."

—Sam Brungardt

"If you want low-fat ground beef, you have to reduce the overall fat content," Addis explains. "In this case, we added hydrated wild rice and came up with a low-calorie, low-fat and, to some extent, low-cholesterol product that also contains starch, which is probably the best source of energy for the human body."

"Some of the compounds in [wild rice] are the same ones released when meat is smoked. These have antioxidant

contained 10, 20 or 30 percent fat to begin with."

Their findings could lead to improved low-fat frankfurters and sausages. The water bound to wild rice may be able to replace some of the fat that gives these processed meats the "bite" consumers like.

Further research on the natural antioxidant properties of wild rice might also improve the quality of many other food products. —Sam Brungardt

It Takes a Lot to Keep Things Natural



Most visitors to the Boundary Waters Canoe Area Wilderness expect solitude. But with increased use of the BWCA, conflicting demands require wilderness management decisions.

"Wilderness management is controversial," says David Lime, recreation researcher with the College of Natural Resources. "Some people think that wilderness areas and national parks don't need to be managed—just leave them alone and they'll take care of themselves."

That's not the answer, Lime says, because humans impact wilderness

areas, whether they want to or not. Every visitor to a wilderness such as the Boundary Waters Canoe Area Wilderness (BWCA), changes it with each visit.

Human activity outside the area also has consequences. Acid rain for example! Even letting natural fires burn is a human impact on a wilderness, a management decision.

"Many people accept wilderness

management; of the natural resources, forests and lakes. But they often don't think of people management," Lime says. "You need to 'manage' people. Some people love wilderness to death. Just look at many of our national parks."

Park and wilderness use increased rapidly in the 1970s. And Minnesota's BWCA became the most heavily used wilderness in the nation. Lime says it's precisely that popularity which led the Forest Service to regulate use.

The leading complaint of the more than 5,000 BWCA visitors Lime has surveyed is that they are "meeting too many other groups" in the wilderness. They say it diminishes the wilderness they come to the BWCA to experience.

Other comments also reflect people's impact on the area. "Finding an unoccupied campsite," and "airplanes flying overhead," are mentioned by over a third of those surveyed.

"A surprise to us was the magnitude of the response to visitor caused damage to vegetation," Lime says. Because of the high numbers of complaints, he is preparing to study crowding at specific

Wilderness continued on back page

It's Okay for Us to Like Oatmeal Again

Oats! As a kid the word conjured up extreme views, positive or negative, of a hot morning cereal. But oats became one of the most promoted and popular foods of the past decade. Despite some questioning nutritional studies, that status may well continue in the '90s.

It's almost all positive for Minnesota Agricultural Experiment Station researchers. As oat breeder Deon Stuthman says, "It's out of the category of a forgotten crop. It's getting us some attention now. There's more discussion and more research money available than there was five years ago. And it's now okay, if not more than that, to admit that you had oatmeal for breakfast."

But getting farmers growing it requires making money doing so. It is moving in that direction, says Joe Warthesen, a University cereal chemist in Food Science and Nutrition, and member of the American Association of Cereal Chemists oat bran committee.

"Some of our Minnesota commodities have suffered due to consumption patterns," says Warthesen. "This one is going in the right direction." Minnesota is the second largest U.S. producer of oats.

Experiment Station Releases Two New Chrysanthemums

Two new Minnesota maris will be at garden centers this spring. Snowsota and Maroon Pride, culminate a 39 year career of recently retired experiment sta-

It's going that way because of the reported cholesterol lowering properties of its soluble fiber, and the fact that food processors heavily promote that presumed benefit on behalf of a growing array of products.

"Oats is in an enviable position," says nationally known University food scientist Joanne Slavin. "It's the thing to have right now, so if you can associate anything about you or your product with oats, you are in!"

Slavin has done nutritional studies on fiber from many crops. "When peo-

ple say they want to do a human nutrition study on fiber, what they really want to do is run themselves off against oat bran," she says. "It's the standard right now. Rather than find out what their fiber can do in a human, they want to know how it compares to oat bran."

The only problem possibly facing oats could be the sheen wearing off its current fad. "I don't think any other fiber will lower cholesterol more than oats. Maybe some are comparable, but it's probably got as good a composition to lower cholesterol as any," she says.



Protecting Research Goes Low Tech. Balloons colored with hawk and owl like eyes, anchored just above a crop canopy, provide some Minnesota Agricultural Experiment Station oat fields with "low tech" protection from scavenging birds. They are part of an effective arsenal of non-lethal anti-avian techniques that in-

But she tempers her enthusiasm with a caution. "What could knock it down and really effect sales would just be people recognizing that the literature on cholesterol lowering is maybe not as strong as they thought it was."

Also facing the industry is protecting the nutritional image of oats from being diluted by promotional zeal. "What's happening to the oats market lately, is it has been fueled by the nutritional implications of putting more oat bran into a variety of foods," says Warthesen.

"Oat bran is not an item of commerce easy to define," he says. "In the milling process it could be diluted with oat flour, or oat hulls. Those are probably not going to have the same nutritional impact as oat bran itself. There's some concern that if it's oat bran it ought to be the most nutritionally significant oat bran."

The quality of oats can also be diluted with weed seeds and field residues, though Minnesota's is some of the cleanest, according to Ray Lottie, a manager of cereal grain operations for General Mills. "By and large, Minnesota farmers do a pretty good job of harvesting oats so they come off pretty clean of foreign material such as wheat seeds and chaff and straw," he says.

Filling our growing domestic needs with Minnesota and U.S. oats production may, however, be difficult under current federal farm policy. Stuthman and Slavin represent the views of many when they say they think it's economically too difficult for many farmers to risk reducing their base acreage in price supported crops to speculatively plant alternatives such as oats.

But even that may change. With Congress considering ways to promote "sustainable agriculture," Minnesota, which once grew a substantial amount of

tion horticulturist Richard Widmer.

Widmer bred many of the 79 chrysanthemums released by the Minnesota Agricultural Experiment Station since 1934. Minnwhite, Minngopher, Mellow Moon, Centerpiece and Autumn Fire are some of the more recent, widely grown introductions.

"When Louis Longley started breeding mums, only primitive types would bloom here unless the growing season was very long, which was very unusual," recalls Widmer. "Over the years, we've strengthened the stems, improved growth habits, made them more disease resistant and enlarged the size of the blooms."

The new releases are good examples. Snowsota produces an informally mounded plant topped by 1½-inch, long-lasting, white flowers with light yellow centers. The plants are 15 inches high and 24 inches wide.

Maroon Pride displays 3-inch to 3½-inch, fully-double, dark red blooms. Its plants grow 18 inches high and 28 inches wide.

Both Snowsota and Maroon Pride usually begin to bloom the last week of August in the Twin Cities.

—Sam Brungardt



Snowsota chrysanthemum.

clude perimeter strips of noisy wind-flapping ribbons, using falcons to disburse birds, providing alternate feeding sites, and even trapping and relocating some. Agronomist Deon Stuthman says it's an effort to avoid offending people. "Our preference would be that the birds would just leave us alone, but in urban areas especially, that preference isn't honored by the birds." Since the second world war, 20 oat varieties have been released by the experiment station.

oats to feed people and livestock on farms, may someday again count oats among its more important crops.

—Larry Etkin

Possible Clue Found to Rotation Effect

Crop rotation is an idea whose time has come *again*. During the 1960s and '70s, many farmers abandoned this "sustainable" practice. Chemicals, it appeared, allowed them to grow the same crops in their fields year after year.

Many are reevaluating the wisdom of continuous monoculture.

"Benefits from rotation include better weed, insect and disease control, plus improved soils structure and nutrient levels," says agronomic scientist R. Kent Crookston. "But even under management designed to eliminate pest and soil problems, rotations provide a yield boost that we've been unable to fully explain."

Trying to find that explanation has kept Crookston busy for more than a decade. And some recent studies by graduate students Philip Copeland, agronomy, and Nancy Johnson, ecology, may finally have provided an important clue to why corn and soybean produce higher yields in rotation.

In 1988, Copeland took shoot tissue samples to determine differences in the nutrient content of corn and soybean seedlings in Crookston's plots at the Lamberton and Waseca experiment stations. And working with plant physiologist Steve Simons, Johnson sampled the plants' roots and rhizosphere, the soil around them.

Johnson was studying a symbiosis, a mutually beneficial relationship between plant roots and certain soil fungi known collectively as vesicular-arbuscular mycorrhizae (VAM).

When corn or soybeans sprout,

VAM hyphae (threadlike body structures) invade the seedling's roots. They act like pipelines bringing the plant water and nutrients that hyphae outside the roots take from the soil. They help plants obtain elements, such as phosphorus, zinc and copper, that they can't readily get

on their own.

Johnson studied the corn and soybean roots and determined the extent to which they'd been infected by VAM. With plant pathologist Frank Pflieger, she identified the VAM species in the soil samples from Waseca and Lamberton, and their relative abundance, by examining and counting their spores. Each species' spores has distinguishing characteristics.

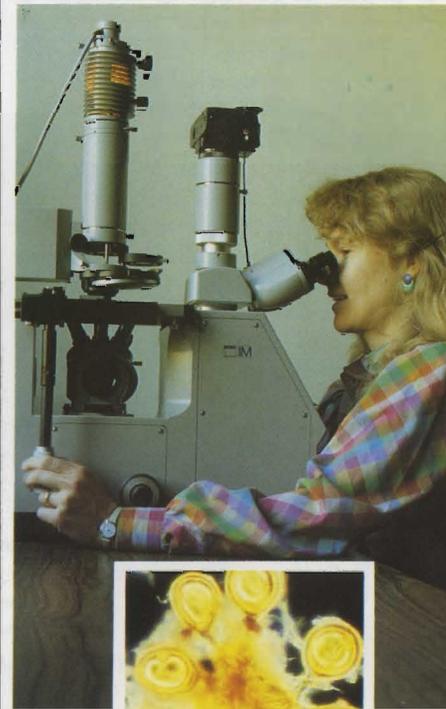
Johnson concluded that some VAM species proliferate when corn is grown while others flourish with soybeans. Then, looking at Copeland's data, she found associations between three things: the phosphorus and copper content, ultimate yield of the seedlings in a plot, and the most abundant VAM species (in terms of number of spores) in the previous crop grown in the plot.

For example, in first-year soybeans, she found that the VAM species whose spores were most numerous (having flourished in the previous years' corn) matched up with high phosphorus and copper in the leaves of young soybean plants. These same VAM species were also associated with the higher yields of soybeans following corn.

The same held where corn followed soybeans. Certain VAM species predominated, and were associated with the higher first-year corn yields.

The reverse was also true. Corn that followed corn had lower phosphorus and copper levels, yields, and VAM counts of the associated species. Ditto for

Rotation continued on back page



Using an "inverted" microscope, with the light source on top and lenses below, ecology graduate student Nancy Johnson counts mycorrhizae spores (Inset) in a soil sample.

Water *continued from page 2*

across the field. That means developing some real-time measuring devices in the equipment that we use to apply fertilizers, herbicides and pesticides, as well as soil tests to adjust the rates of application during the growing season."

The research pointing toward site specific recommendations started with a corn crop. Last summer the researchers rotated part of one field into soybeans. Eventually Anderson wants to investigate the impact of legumes and alfalfa.

Meanwhile, current projects keep generating ideas for more research. "Scientists want to study not just cover crops and rotations and tillage systems," Anderson says, "but sprayer technology, and public policy implications, and economics. . ."

Three years into this complex study that has such important implications to Minnesota's economy and environment, the researchers know the more closely they look, the more there is to learn.

—Jennifer Obst

Rotation *continued from page 4*

continuous soybeans.

Johnson and the other researchers agree that her observations need to be verified by at least another year of field studies. And, she concedes making one big assumption: that the VAM species most numerous as spores are the ones that invade seedling roots.

Verifying that assumption requires growing the VAM species on roots in laboratory cultures. That will let them see whether their effect on growth and yield is beneficial or detrimental. Crookston and Pflieger are planning to do that.

Pflieger is cautious about believing certain VAM species to be detrimental. "We need more information," he says. "An adversarial relationship between a plant and a VAM species is not at all common."

Much more needs to be learned before anything certain can be said about soil microflora's impact on the rotation effect. But the hypothesis has opened a new line of research that may contribute to a more sustainable agriculture.

—Sam Brungardt

the visitors themselves, Lime says. "The Forest Service has had to do a lot of regulating. People create biological as well as social impacts."

The effects of those impacts may become clearer with results from other University research. A computer simulation showing how a campsite can deteriorate over time is to be used by landscape architecture researchers David Pitt and Joan Nassauer to evaluate reactions of users of recreation areas. It should help show at what point people notice changes, and what level of deterioration people find unacceptable.

These studies are part of preparations for the Forest Service's 1992 update of its BWCA management plan. Entry permits to the BWCA have been required since 1966, and access has been limited since 1976.

Lime's study is sponsored by the Forest Service and the private Wilderness Research Center foundation.

—Dave Hansen

Low Inputs *continued from front page*

use zero antibiotics," Pijoan says. "If the pigs get sick, of course, we will treat them with antibiotics, but we don't give them in the feed. We feel there is a market for chemical-free pork."

The study has gone through one farrowing, and will go through four before final economic analysis. Funds from the Greater Minnesota Corporation will expand the study to the Rosemount Experiment Station.

—Jennifer Obst

MINNESOTA *Science*

Volume 45, Number 1

EDITOR

David L. Hansen

PRODUCTION EDITOR

Larry A. Etkin

DESIGNER

Nancy H. Teufert

PHOTO EDITOR

David L. Hansen

PHOTO CREDITS

Page 4 top, Larry A. Etkin; page 4 bottom, Nancy Johnson; all others David L. Hansen.

Minnesota Science is published quarterly by Educational Development System for 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*, Educational Development System, 405 Coffey Hall, 1420 Eckles Ave., University of Minnesota, St. Paul, MN 55108.

Contents of this tabloid become public property upon publication. The written material may be reprinted if no endorsement of a commercial product is stated or implied. Please credit the University of Minnesota Agricultural Experiment Station. Trade names or products occasionally are printed. No endorsement of products or firms is intended, nor is criticism implied of those not mentioned.

The University of Minnesota, including the Agricultural Experiment Station, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, veteran status or sexual orientation.

Wilderness *continued from page 3*

lakes or groups of lakes. "Tolerances vary from the periphery to the back country," he says.

Visitors are also concerned about the quality and condition of portages, the survey shows. And, "too many rules and regulations" is a frequent complaint.

Those rules are a direct response to

Agricultural Experiment Station
University of Minnesota
220 Coffey Hall
1420 Eckles Avenue
St. Paul, Minnesota 55108

ADDRESS CORRECTION REQUESTED

Non-Profit Org.
U.S. Postage
PAID
Mpls, MN
Permit No. 155