

MINNESOTA Science

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Artificial Stomachs Transplant Research to Lab

Finding the right balance of foods to keep you healthy, energetic and slim may often seem complicated. But your diet is simple compared to the complex requirements of the cow. Its four stomachs quadruple the challenge of finding a perfect diet.

Minnesota Experiment Station animal scientist Marshall Stern has tackled this problem with an unusual research tool. For six years he has used eight "artificial digestors" in his lab to simulate dairy and beef cattle digestion.

To study the rumen, the first division of a cow's stomach, the digestors duplicate fermentation that occurs naturally. Fermentation is started with an inoculation of actual rumen contents.

The digestors are kept at about 100° F, the same temperature as the rumen. The system provides a continuous addition of artificial saliva along with pellets of mixed diets being studied.

Stern especially studies efficient use of protein—the most expensive part of a ration. Nutritionists know that cow rations should include readily degraded



Marshall Stern's laboratory simulates the digestive process of cows with banks of glass "digestors" processing different feeds. Monitors record the process of protein breakdown within the artificial stomachs.

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proteins to aid rumen microbes, along with slowly degraded proteins to provide amino acids for absorption from the intestines. "Before anything ever reaches the cow's intestines, it undergoes a lot of degradation, fermentation and synthesis by rumen microbes," explains Stern. "If a protein is too degradable, not enough will reach the small intestine."

Soybean meal, a major protein supplement fed to dairy and beef cows in the midwest, is highly degradable. About 70 percent of its protein breaks down in the rumen.

Many strategies have been devised to protect soybean meal protein from

microbial degradation in the rumen, including treating the meal with heat, sodium hydroxide, or alcohol. Using the fermenters has proved to be an efficient way to compare the effectiveness of these treatments.

Protein in a ration can also be naturally protected and contain less degradable protein, such as the protein in byproduct feeds like blood meal and feather meal.

These studies attempt to wring every molecule of usable protein out of a ration. For example, one study is

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Visions of Alternative Agriculture Drive Center

Luther Waters has a vision, and hopes Minnesota's Legislature will help make it reality.

Waters directs the University of Minnesota Center for Alternative Plant and Animal Products (formerly the Center for Alternative Crops and Products). He hopes legislators will support the Center this spring by increasing the recurring appropriations of the Minnesota Agricultural Experiment Station and Minnesota Extension Service.

The Center, which is an integral part of the experiment station, the College of Agriculture, and the extension service, was established in 1986 to generate, receive, and evaluate ideas for new crops and agricultural products; to facilitate research and development; and to disseminate information on alternative crops and products.

The Center's main accomplishments so far? Waters points to its lupine and

grain amaranth feasibility studies.

And, he's proud of the Center's symposia. "Their purpose," he says, "is to be an outreach effort, to also create awareness, and help to identify industry needs and potential research.

"Because of last year's soybean utilization alternatives symposium, task forces will be working over the next couple of years to generate white papers on where research ought to be directed in the areas of human food, animal feed, industrial uses, and plant composition. Experiment station administrators in the 12-state North Central Region are already discussing possible industrial uses for soybeans, and this could result in a regional research effort."

The Center has also published bulletins for farmers on growing and using crops such as triticale, lupines, and grain amaranth.

But Waters thinks two new computer

data bases are the most essential elements of the Center's success. One is a directory of expertise; the other compiles information about alternative crops. Waters hopes the data base will eventually access the expertise of the facilities of most universities in the North Central Region. This would help the Center quickly assemble knowledgeable teams for problem-solving and extension efforts.

"We're collecting publications from all over North America on some 90 crops," says Waters.

"The problem is, much information is published and distributed at the state level that never gets included in a national data base. Or, the summaries of scientists' research on minor crops may never get published. We have single copies of many titles that are out of print. If those were lost, the information in them would be lost.

"The money we're asking for," says Waters, "would be used to further develop the data bases; conduct comprehensive research on lupines, amaranth, and other agricultural enterprises; carry out feasibility analyses of new crop and product opportunities; and to establish interdisciplinary research teams to solve problems related to commercialization limitations."

Neither Waters nor C. Eugene Allen, acting vice president for agriculture, forestry and home economics and acting director of the Agricultural Experiment Station, deny that working on alternative agricultural enterprises is a gamble. "Developing alternative plant and animal products is risky," Allen says. "But if we're to find niches that Minnesota farmers can fill, we've got to take that risk."

—Sam Brungardt



Lupines Potential Home-Grown Protein Source

About a fourth of Minnesota's dairy cows and other cattle are in the 14-county area covered by the Central Minnesota Initiative Fund. Altogether, central Minnesota farmers spend about \$14 million a year for protein supplements, most of which are produced outside the area.

Since protein can account for as much as one-fourth of a dairy farmer's expenditures, an economical, home-grown source could increase profits and reduce vulnerability to the commodity

prices. The Minnesota Extension Service has personnel with expertise in agronomy, soils, animal science, plant pathology, entomology and agricultural engineering. The Staples Irrigation Center is playing a major role, as are extension agents and farmers in several counties.

Despite last summer's drought, Putnam says some valuable knowledge was garnered from last year's trials:

- Vernalization—exposing lupine plants to cold early in the seedling stage creates shorter plants with fewer nodes



Dried flowers are an alternative agricultural enterprise gaining popularity. Minnesota Everlastings, a grower cooperative in Henning, ships to retailers and floral arrangers across the country.

Flower Sales Blooming in Northeastern Minnesota

Growing flowers outdoors may blossom in the United States as growers cash in on a trend: Americans are buying flowers as never before—not just for special occasions, but for every day as well.

So, it was no surprise that a symposium on the commercial field production of cut and dried flowers, sponsored by the Center for Alternative Plant and Animal Products, attracted more than 200 participants in December.

For Joe Seals of Crivitz, Wisconsin, it was an opportunity to recruit members for the new Association of Specialty Cut Flower Growers. “Because this is a fledgling industry and so many people are new to it, just about everything that was presented was new and useful material,” he noted. “But the really good thing that came out of the symposium was the proceedings, which will prove to be a valuable reference. Also important was the effort to identify the research needs of our industry.”

For Mary Bahr of Henning, the symposium was an opportunity to do business. Bahr, an instructor at Detroit Lakes Technical Institute, is production manager for the nine-month old Minnesota Everlastings Cooperative. Largely through the efforts of Dell Christianson, who also teaches at the Institute, some

30 families from the Detroit Lakes area were trained to grow flowers for the co-op. It sold about \$30,000 worth of flowers, mostly statice and globe amaranth, its first year.

“A lot of basic—and for us, new—information was presented,” Bahr says, “particularly on using herbicides on ornamentals. I made a lot of contacts with whom I’m now doing business, and I made some sales.”

Carlton County extension director Lee Raeth and his counterpart in St. Louis County, Eugene Bromenshenkel, obtained a \$25,000 grant from the Northeast Minnesota Initiative Fund to contract with Detroit Lakes Technical Institute, which also contributes staff time to the project, to train 30 families from around the area to grow flowers outdoors.

This summer, Raeth and Bromenshenkel will work with horticulturists at the North Central Experiment Station, Grand Rapids, to identify floral species that are especially suited to northeastern Minnesota. The grant will also fund training a person in marketing so Minnesota Everlastings can expand its sales, and fund a quality control person to work with the northeastern Minnesota growers.

—Sam Brungardt

markets. Lupines could fill the need, if lupine production proves feasible. Swine and poultry producers might benefit from growing lupines too.

That was the rationale the Center for Alternative Plant and Animal Products put forth last year, when it successfully sought Initiative Fund and Bremer Foundation support for a three-year assessment of the risks and opportunities in growing white lupines on dairy farms in central Minnesota.

Experiment station agronomist Dan Putnam coordinates the research. He notes that lupines have high protein content, fix their own nitrogen, and generally do well on the acidic, sandy soils of central and east-central Minnesota.

“The main obstacle to expansion of this crop is consistency of yield, not market development,” Putnam says.

The project is an example of the interdisciplinary clout the Center can muster. It involves University of Min-

and branches, and lower yield.

- Lupine plants that grow from Rhizobium bacteria inoculated seed produce better yields and seed that is higher in protein.

- Animal scientist Steve Cornelius found that growing pigs aren’t overly fond of lupine meal; they decreased their feed intake two percent from normal for every one percent of lupine meal that was added to their ration.

- Dairy scientist Don Otterby is exploring the possibility of replacing soybean meal protein with lupine protein in the diets of dairy cows. He found that cows sometimes do not perform as well as they should when fed lupines, but thinks partial substitution may be possible.

Says Putnam, “What is exciting about this research is that we’re looking at the crop as it fits into an agricultural system, from planting to use.”

—Sam Brungardt



Lupines could become a locally produced protein source for dairy cows and other livestock. The Center for Alternative Plant and Animal Products is coordinating research by agronomists, animal scientists, plant pathologists and others.

Tags May Help Track Food Shelf Life

When you check the date on a carton of milk before taking it from the grocery shelf, you are demonstrating your understanding of kinetics. In plain language, kinetics explains what happens to refrigerated products if subjected to temperature change.

Food scientists Ted Labuza and Petros Taukis, Minnesota Agricultural Experiment Station researchers, study kinetic theory and its practical application to food quality. Their recent research may help you reach for that carton of milk, and many other foods, with much more confidence in its quality.

They have been researching the use of time-temperature indicators (TTI)—small tags affixed to a food or food package which may give a clear reading of the remaining shelf life of the food.

Food product quality and useful shelf life depend on its temperature history, from production to consumption, including distribution and storage, Labuza says.

Minnesota law requires a date stamp on every food product with a shelf life of less than 90 days. It's an attempt to give the consumer a guide to food freshness. But it's not necessarily accurate, Labuza says, because "the date does not tell you whether or not the product has been abused."

A better approach is to monitor the time-temperature exposure each food package has gone through from plant to home. "There's been over 150 different kinds of time-temperature indicators designed to do this, but very few have ever made it to market," Labuza says.

Three different types are in use, mainly on temperature sensitive products such as photographic film, frozen blood,



Station research aims to assure consumers that the refrigerated and frozen foods they select are high quality. Scientists are investigating food tags that monitor storage time and temperature.

right indicator to a particular food.

Taukis has removed one block to this. He has developed a mathematical formula to correlate the response of a TTI to the change in quality of a food product that has undergone the same time-temperature exposure.

Knowing this, a TTI response can be predicted for any constant or variable

to different temperatures," Labuza says. "One of our goals has been to use accelerated shelf life tests which put products at higher temperatures and then use that information to mathematically project what would occur at lower temperatures."

Once the "kinetic characteristics" of both the TTI and the food are known,

Generation Gap Isn't, Says Youth Poll

Odds are your teenager thinks you do a pretty good job as a parent, knows that they don't always make the job of parenting easy, and has deep ties to the family.

So concludes the most recent Minnesota Youth Poll. The polls have tracked views of adolescents for more than a decade. They are conducted by the Center for Youth Development and Research, supported by the Minnesota Agricultural Experiment Station.

"Youth polls provide a snapshot of the state of youth in Minnesota," says acting Center director Irl Carter. "Over time these snapshots are useful to assess the development of youth in general, and to spotlight specific problems."

Contrary to the often noted "generation gap," the poll found the majority of young Minnesotans living in families with "harmony, not strife; affection, not alienation; and commitment to, not rejection of family life."

"It's a great myth of life, that teenagers are in tremendous conflict with their parents," says poll author Diane Hedin.

But, "normal" adolescent development makes some conflict nearly inevitable as overprotectiveness crashes squarely into desires for increasing freedom and responsibility.

The youth polls will be incorporated into a data base the Center is developing, to give a broad picture of Minnesota youth. Few states attempt seriously to maintain such a data base on youth.

—Larry Etkin

and vaccines. Each has a slightly different monitoring device. One reason these tags are not in general use is cost—about 25 cents apiece. “The food industry would like them to cost about a half cent,” Labuza says. He thinks they could become popular enough for the price to come down if a way can be found to easily match the

temperature, Taoukis explains. Thus, the food industry can select the most appropriate TTI without doing extensive side by side tests of the food and the indicator.

The challenge to the food manufacturer is to do appropriate shelf life studies for the food. “To use these tags, you have to know how the food responds

one can calculate the amount of food quality left in a product at any time. This information can be used to improve and tightly control food distribution, and optimize food product rotation on the grocery shelf, Labuza says.

That would be good for both producers and consumers.

—Jennifer Obst

Minnesota Youth Poll: Youth's Views of the Family is available for \$3 from the Distribution Center, 3 Coffey Hall, University of Minnesota, 1420 Eckles Ave., St. Paul, MN 55108 (Minnesota residents add 6% sales tax). Request item AD-MR-3540. Make checks payable to the University of Minnesota.

Lake Superior Fish High in Oils that Prevent Heart Disease

Some Lake Superior fish have high levels of fatty acids that help prevent heart disease, according to experiment station food scientist Paul Addis.

In Minnesota Sea Grant sponsored research, he found that siscowet lake trout have higher levels of Omega-3 fatty acids than even most saltwater fish.

Before Addis' discovery, it was assumed that only saltwater fish were high in Omega-3's.

Omega-3 fatty acids make blood platelets slippery and prevent them from sticking together. This reduces the chance of blood clots and hardening of the arteries, the major causes of heart disease. Researchers have found that Omega-3 fatty acids help reduce cholesterol and blood pressure, and may alleviate arthritis pain.

Addis studied the fat and Omega-3 fatty acid content of eight species of Lake Superior fish: lake herring, deep water chub, sucker, smelt, whitefish, lean lake trout, and siscowet (fat) lake trout. Siscowet trout contain the most Omega-3's, as well as being high in other beneficial fatty acids. The siscowet are almost 26 percent fat, compared to 11 percent fat in lean lake trout, 10 percent in chinook salmon, 11 percent in sardines, and 4 percent in tuna.

—Annette Larson

Farm Families and Stress: One Year Later

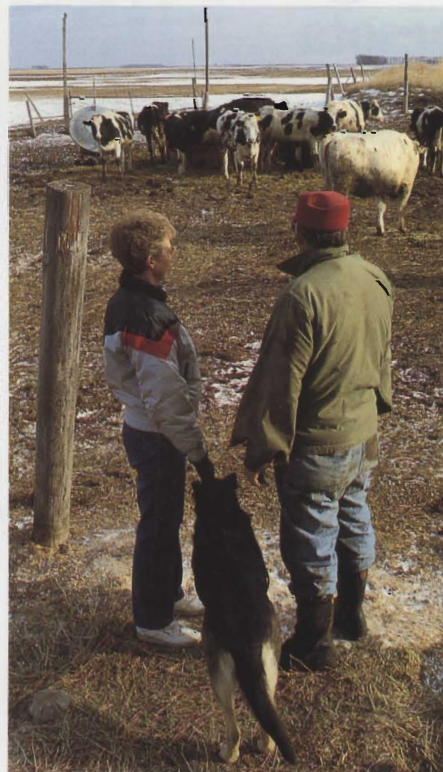
The strength and resiliency of the farm family is basic rural mythology. A recent study by Agricultural Experiment Station, Department of Family Social Science researchers reveals that the myth is borne out by reality in times of economic stress. In crisis, Minnesota farm families find strategies to cope. And, even if forced to leave farming, they want to stay in the rural community.

Researchers Kathryn Rettig, Jean Bauer, and Sharon Danes have completed the second year of a study of families who had gone through Farm Credit Mediation. Seventy-five percent of nearly 600 first year participants also replied to the second-year survey. That survey was designed to examine the recovery processes of the families in the original sample.

One year after mediation, 72 percent are still farming, but over half also have off-farm jobs. Many of those who have left farming still hope to return.

“On the first study, the bitterness and the anger shouted at you. The level of intensity of the feelings had diminished in the second study,” Rettig says.

The farm families had mixed feelings about the services provided by their communities during their crisis. “They wanted further job training, more job opportunities, counseling, and formal and informal education on how to manage their resources,” says Bauer.



Farm families that went through mediation affirmed their commitment to their land and community.

The respondents' distrust of lenders was reaffirmed in year two. Respect for attorneys has also not returned,” says Bauer. The study also revealed a continuing negative attitude toward government agricultural policies.

The second year after the crisis, the

families reported reduced levels of stress, and increased satisfaction with life in general. They also reported improved economic well-being, even though their economic condition had improved only slightly. “The second survey showed the farm families' denial had begun to decrease and their expectations have become more realistic,” says Danes.

The survey shows that the family unit has been sorely tested, but is still strong. There were very few divorces. “They seem to be receiving a lot of support and positive feelings from their family, which was the raft in the storm,” Rettig says.

The second year survey showed increasing satisfaction about the family's willingness to talk about sensitive issues. “The people who left farming were the ones that were most satisfied with their family's willingness to discuss sensitive issues, because they were even willing to talk about that least wanted option,” Rettig says.

The survey revealed positive growth in value clarification and family communication over the two years. “Often studies of families under stress focus mainly on the difficulties stress creates. These studies fail to emphasize the real strength that people draw upon from within themselves and with each other, to deal with crisis,” says Rettig.

—Jennifer Obst

Neem May Be Potato Beetle's Nemesis

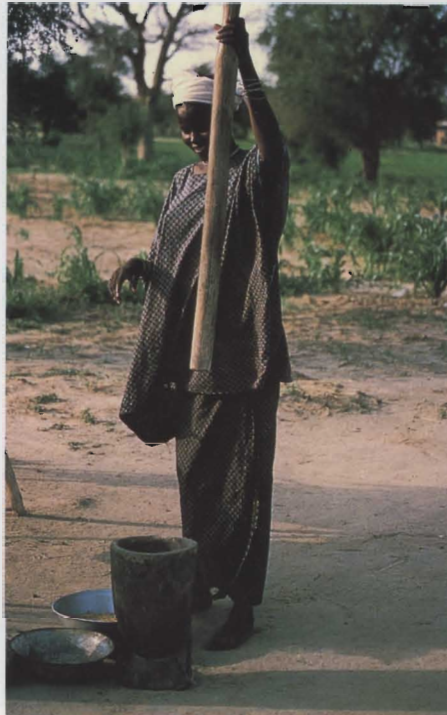
What do grasshoppers in West African millet fields and beetles in Minnesota potato fields have in common? Both are big trouble. And both may have met their match in a natural remedy extracted from a subtropical tree long known for its medicinal properties.

The neem tree is "truly admirable," says experiment station entomologist Ted Radcliffe. He has studied its use in Africa, and sees its potential benefit in tackling a North American problem. Extract from the neem tree may be an effective weapon against pesticide resistance.

Neem, one of the few trees that grows in the arid subtropics, has been widely planted in West Africa as a strategy to stave off the encroaching desert. Neem's insecticidal and medicinal properties have long been known in folk tradition. In West Africa, stored food and household goods such as woolens are covered with neem leaves for protection, Radcliffe says. "It's used commercially to make soaps and toothpaste," he adds. "In Africa, people chew the twigs for the bactericidal effect."

Radcliffe and colleagues Dave Ragsdale, Dave Noetzel and Florence Dunkel, have been studying the use of neem as a natural repellent of pests of millet, a staple of the West African diet. Their research began at the request of Peter Strzok, President of AFGRO, a Minnesota private volunteer organization involved in international rural development. The project is funded by USAID.

Their research has shown neem is effective, primarily as a feeding deterrent, against 11 species of grasshoppers, including all of the major economic pests of millet and sorghum.



A villager in the West African country of Niger grinds up kernels from a neem tree (upper right) for use as a natural insecticide.

sprayed plant, they may become sterile," Radcliffe says.

The researchers are testing neem in West Africa on millet seedlings. But Radcliffe thinks the real future for neem in Africa is as a readily available, easily

prepared natural protectant for vegetable crops of local subsistence farmers.

Radcliffe suspected this natural product might also be useful in Minnesota against the Colorado potato beetle, a pest with growing resistance to modern chemical insecticides. "The Colorado potato beetle's pesticide resistance has been growing at least three-fold a year," Radcliffe says. Some have developed a 500-fold resistance in six years.

But Radcliffe's first match of neem against the Colorado potato beetle did not indicate they were perfect enemies. "Last summer we sprayed single row crops with different rates of neem, and got only 30 to 40 percent control, which is not adequate."

So he changed tactics. "This time we put it on big plots. And, before applying it, we used a conventional insecticide to take off the adults and big larvae. But there were millions of eggs left, which were exposed to neem from the time they hatched. Well, we never found a Colorado potato beetle in that field for a month. And adjacent check plots averaged about 25 beetles a plant. So this was not trivial control," he says. Neem was more effective than all the most current conventional insecticides.

Radcliffe suspects the first trials

Neem continued on back page

IN BRIEF

National Wind Erosion Project Begins at Crookston

The Northwest Experiment Station at Crookston has been chosen as one of seven locations across the United States for a two-year study estimating soil loss from wind and water erosion.

The Crookston station, in cooperation with scientists with the USDA-Agricultural Research Service at Morris, will be taking samples before and after each tillage operation and after each rain greater than one inch. The data they accumulate will give scientists a better understanding of soil properties that influence susceptibility to wind erosion. Superintendent Larry Smith explains, "This will give us an opportunity not only to qualify the amount of soil moving because of wind erosion, but also its chemical composition such as nutrients and herbicides."

The field data will be used as a basis to develop computer modeling techniques for conservation recommendations specific to a location.

—Jennifer Obst

Minnesota Moose Share Forest Habitat



which is extremely important to many forest animals."

If conifers are to be planted, the site is prepared by pulling out roots of the sprouting hardwoods. After spruce or pine are planted, broadleaf plants are controlled, usually with chemical

The insecticidal properties of the neem tree are most concentrated in the kernels of its olive-sized fruit. The researchers have found that an extract can be easily made by grinding the kernels and soaking them for from 2 to 12 hours. When the solution is sprayed on plants, "not only does it repel insects, but it interferes with their growth. If the insects ingest a little of the

Stomachs *continued from front page*

focusing on the use of wheat straw, a highly undigestible resource. "Researchers at the University of Illinois have found that treating wheat straw with a hydrogen peroxide solution more than doubles its digestibility. "Since the wheat straw contains only two percent protein, we're testing it as part of a ration supplemented with other protein sources, such as blood meal. Our studies have shown that one effective combination is treated wheat straw, blood meal and liginosulfite treated soybean meal," Stern says. It may not sound tasty, but it may be the right combination for a cow's nutrition.

"The advantage of using the fermenters instead of actual cows is control. All are kept at exactly the same temperature, the same pH, and given the same amount of ingredients at the same time. Our ultimate goal, of course, is to apply the fermenter results to the animal to look at a ration's effect on milk production and growth."

And, while there's plenty left to learn about a cow's optimum diet, the research is also branching into the field of human nutrition. Human nutritionists Dennis Savaiano and Peggy Martini are setting out to study the mechanisms of lactose intolerance in humans. Instead of cows' rumen, the artificial digestors will be set up to simulate human lower intestines.

—Jennifer Obst



Moose prefer a mosaic of openings and cover, hardwoods and conifers. An opening left by an old burn provides this moose with browse; mature trees give protection. Timber management that creates diversity favors moose.

Minnesota's herd of more than 12,000 moose is one of the two largest of the lower 48 states. Only Maine's might be larger. It's an important state resource says experiment station wildlife researcher Peter Jordan. "Canoeists in the Boundary Waters who see a moose remember the encounter as the high-point of their wilderness trip."

Jordan is particularly interested in how timber managers can improve moose habitat. His studies have followed two timber management approaches common in northern Minnesota: natural regeneration to favor aspen, or planting seedlings to produce conifers. The conifers, or evergreens, go mainly to paper mills. Aspen, only two decades ago considered a weed, is now the mainstay of Minnesota's expanding waferboard industry, largest in the world. In 1988, we

harvested almost twice as much aspen as in 1980.

"Moose prefer a diversity of forages," Jordan explains. "In the summer they eat leaves of trees and shrubs, plus aquatic vegetation. In the winter they eat deciduous twigs plus some conifer foliage." Throughout the year they need mature stands for cover. "Some small changes in timber management could really improve the habitat for moose," he says.

On the U.S. forest lands where Jordan works, timber is managed in stands of 10 to 200 acres. When harvested, the stand is cleared of almost all trees, which makes the site better habitat for moose and many other wildlife. Jordan explains: "Forest re-growth is nutritious, abundant, and within reach. In a sense, clear-cutting simulates natural wildfire,

continued, usually with chemical herbicides.

For aspen regeneration, no chemicals are used. If aspen trees were present before, then clear-cutting stimulates resprouting, and the vigorous sprouts take over rapidly. This is an economical form of forest management, and it leads to a sudden flush of an important forage for moose—aspens sprouts.

However, the speed of aspen growth, and the way it squeezes out other forages, results in much less forage for moose within a decade or two, according to Jordan.

In conifer plantations, where broadleaf species compete with the timber crop, the Forest Service applies the herbicide glyphosate. This chemical kills off most broadleaf plants. "If a different herbicide—2,4-D—is used, the competing plants are set back for a few years rather than killed," Jordan says. "This serves moose better by allowing some browse, while adequately controlling plants competing with the conifers."

Jordan and experiment station colleagues have demonstrated that the presence of some broadleaf shrubs is actually better for spruce sapling growth. "Reduced spraying will save money, and save food for the moose and other browsers such as deer, hares and beavers," he says.

Jordan also recommends that timber be managed "to produce a more diverse mosaic or mix of the two major timber types—aspens and conifers—each with its advantages to moose and to the timber markets."

The U.S. Forest Service is committed to a policy of "integrated resource management," including wildlife and recreation as well as timber, Jordan says. Can such mixtures be both economically and ecologically reasonable? Jordan thinks so, and is convinced that mixed mosaics would offer habitat for a larger number of plant and animal species, benefiting them both.

—Dave Hansen

Neem continued from p. 4

were unsuccessful because neem didn't kill the big larvae. They had enough reserves not to starve to death even if they didn't eat for several days.

But the potential advantage of neem is not an ability to induce wholesale insect annihilation. The war against pesticide resistance requires more subtle strategies. Radcliffe explains: "Pesticide resistance normally begins in one insect in a billion. It's rare because, initially at least, the resistant insect is usually at a fitness disadvantage, since it has to devote some resources and energy to this resistance mechanism.

"But if you keep the insecticide pressure on, over time the resistant insects will become increasingly more fit, because they will have to adapt." Radcliffe thinks neem may help take that pressure off.

To test the theory in the field, he plans to rotate neem with other pathogens and insecticides. "If we can treat the hot spots this way, and dilute the resistant population, we might be able to run resistance back down. That's the grand strategy."

—Jennifer Obst

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Delivering Education in Rural Areas Varies Widely

A recently completed six year study of vocational education alternatives has illuminated the challenges facing rural Minnesota in offering education to sparsely populated areas. The last of six publications based on the study, by University of Minnesota Agricultural Experiment Station researchers Roland Peterson and Ruth Thomas, has been published.

"The question that drove our study was, how can vocational education best be delivered in rural areas? We discovered the cooperative school pattern is the most common for rural areas. A lot of schools are pairing and sharing," says Peterson.

Peterson and Thomas examined several cooperative patterns, including centralized and decentralized systems, systems that transport students, and systems that transport teachers to the students. "We learned that transporting students to another school for this type of education will work in the short term and if distances are short, but in the long haul it loses its popularity. It becomes too much of a chore. It's easier to move two teachers than 50 students. Of course, that becomes hard on the teachers," Peterson says.

"The most viable system is one that is centralized enough to have at least one person to administer the program.

Without someone promoting it, the program will lose its way," he says.

Minnesota's rural areas find other ways to offer vocational education; through Minnesota Extension service programs, educational TV, and a variety of apprenticeships and internships. But Peterson and Thomas focused on the most popular school-based approaches. "We hope that schools will find the principles we uncovered in this study helpful in making decisions."

—Jennifer Obst

IN PRINT

Volume six of *Access to Education in Rural Communities* examines an approach where two smaller high schools physically transport some students to a larger district for one or two class periods at the beginning of the day.

"Access to Educational Opportunity in Rural Communities: Alternative Patterns of Delivering Vocational Education in Sparsely Populated Areas, Volume 6: Glencoe, Lester Prairie, Brownton, A Centralized Non-Center Agreement" (Item No. AD-SB-3401) is available from the Distribution Center, Room 3, Coffey Hall, 1420 Eckles Ave., St. Paul, MN 55108. Cost is \$4.00, prepaid. Include complete title and item number. Minnesota residents add 6% sales tax.

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