

MINNESOTA Science

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DNA Markers Identify Nematode Resistance



Each yellow nematode cyst on the roots of this soybean is the size of a small pinhead. Using DNA markers, experiment station researchers have identified two genes that provide 60 percent resistance to the soybean cyst nematode.

An experiment station soybean research team is one of the first to mark the specific genes that make a plant resistant to soybean cyst nematode (SCN). The nematode, a microscopic roundworm that destroys soybean roots, is one of the most serious soybean pests. The team is led by plant pathologist Nevin Young and soybean breeder Jim Orf.

Breeding varieties that resist nematodes is the most effective way to fight them, economically and environmentally. Breeding resistant varieties traditionally requires lots of time, money and labor. It is also limited by the need to screen thousands of potential parents to find a few promising ones to begin from.

The beginning and end of plant improvement remains the same. It starts by crossing a proven parent with 'donors' that are resistant to SCN. It ends when a

plant with desirable characteristics—the proven variety plus resistance—is selected, propagated, and distributed to farmers.

In between, hundreds or thousands of offspring must be grown and evaluated. A great deal of variability can be introduced by nature during the growing seasons, such as this year with many experiments being affected by excess moisture. This makes it difficult to test resistance accurately. The risk is that genetic traits may be masked by environmental quirks.

Up to five backcrosses with the parent may be needed to get a desired new variety. The first cross will have about half the proven variety's desirable characteristics. With each backcross this improves: to 75 percent, 87 percent, 94 percent, 97 percent, and finally, perhaps 99 percent.

DNA markers remove the guess-

work. "After the first cross, we can use the markers to select plants that we know have disease resistance plus the best yield," says Orf. Varieties with DNA potential can be identified early, "so we don't need to carry others in our breeding program. It increases the odds that we can find something that is truly beneficial."

Precision is possible because DNA—and the genes they contain—is the true indicator of resistance. Either genes for resistance are present in a plant or they are not. They are not subject to weather, soil conditions, sunshine, or other variables.

The genetic mapping isn't easy. "At least five genes control SCN resistance, and any resistant soybean probably carries only a few of them," says Young. "We

Nematode continues on back cover

How Markers Help

Three concepts help explain how DNA markers help plant breeders.

- Markers are a tool for monitoring inheritance of important genes. A plant can be selected which is known to have DNA with the desirable trait. And, DNA isn't affected by environmental factors.
- Characteristics such as disease resistance can be precisely identified, even if controlled by several genes. Characteristics controlled by several genes can be difficult to monitor with conventional breeding.
- Instead of choosing just any plant with desirable characteristics, breeders can select the best one. They can also eliminate plants that carry DNA associated with undesirable traits. And, this can be done efficiently, without waiting through six or seven plant generations.

Men Who Batter: Much Still Not Known

"Fifty to sixty thousand Minnesota women are severely beaten each year. And for every woman that's battered there are one or two children who witness it. Often it just becomes a part of their lives.

"How does a man make the decision to be nonviolent, after a history of violent behavior?" asks Jeffrey Edleson, a researcher in the School of Social Work. Answers may someday come from his experiment station supported investigation of domestic abuse treatments. The research may someday help women, children and men get out of that violent cycle.

Three major areas of function determine a man's behavior, says Edleson. He says these factors and men's violence toward women, "can be very different for different cultures and ethnic groups." Edleson has studied behavior intervention in the U.S., Israel and Singapore.

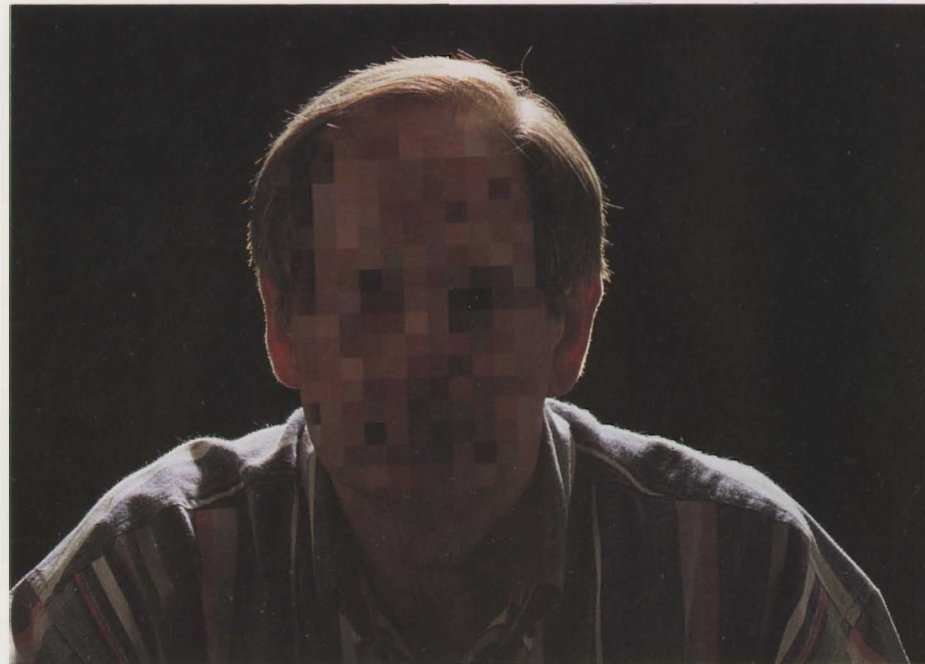
"Minnesota's efforts to intervene in women battering have probably received more attention than efforts in any other state," he says. Two of the first three U.S. shelters for battered women are here.

Rural intervention programs were Edleson's initial focus, "because abuse is not just an urban problem. Organizations serving rural areas, towns, small cities, and reservations make up more than half the state's programs," he says.

"Programs for battered women are almost entirely independent, nonprofit

Areas of Function that Determine Behavior

- Biological/intrapersonal: a person's experiences and abilities. "Can he make the change? Does he think he's able to make the change?"
- Attitudes toward behavior: cultural



Which treatment programs are most effective in changing behaviors of men who batter women? The problem knows no rural/urban boundary. Successful interventions seem to require structured, psycho-educational programs, according to Jeffrey Edleson of the School of Social Work.

organizations," Edleson says. The result has been financially struggling programs, driven by dedicated volunteers, and lobbying for change at the state level. "Change will be slow," he says.

Studies of men who batter are really just beginning. "Little is known about the success of intervention," says Edleson. A few studies have looked at pieces—the role of alcohol, the impact of police action. Edleson's work on group treatment is one of the most comprehensive.

One Edleson study randomly assigned 300 violent men to different treatments. "Shorter treatments were as effective in ending violence as longer ones. And, structured, psycho-educational

change is important nationally in the broad context of our increasing violence."

"People are talking about violence and reporting it more, especially among families," Edleson says. "Most violence—over 50 percent—occurs among people that know each other in personal relationships. As people feel less connected, they are even more prone to violence."

"Ultimately, we want to design new interventions," he says. "Now, programs have some impact. Some interventions can help, but none have dramatic impact."

—David Hansen

Cytogenetic Testing Helps Livestock Producers

When a cow gives birth to twins and one is male and the other female, the owner often assumes the female calf will be a sterile 'freemartin.' The situation is well-known among people familiar with cattle, but is an assumption that research shows may be an expensive error.

Producers, especially of purebred cattle, may now find it profitable to use a chromosome test developed by experiment station veterinary researchers to determine if the heifer is truly sterile.

George Ruth, Lance Buoen, TinQuing Zhang and Alvin Weber have documented that almost 10 percent of heifers born twin are normal, not sterile. That finding comes from chromosome examinations of blood samples submitted for freemartin testing. Many such heifers are sold to slaughter without being tested.

The University's Veterinary Diagnostic Laboratory is one of a handful that do cytogenetic testing of cattle. The test can also determine if an animal has some other abnormal chromosome condition that may lower fertility, such as "1/29" or "14/20" centric fusion.

Centric fusion occurs when two chromosomes join permanently head to head. They can occur in Charolais and Simmental cattle in the U.S. The abnormalities lower fertility and breeders who sell cattle to overseas customers must often provide proof the animals are free of such chromosome abnormalities. Cytogenetic testing can provide such proof.

—Joseph Kurtz

Forest Change Harms Songbirds

attitudes and beliefs. How does he feel about his behavior? What does he think about the violence he's committed and what does he think about being nonviolent?"

- Social/situational: "How well connected is he—with friends, coworkers, relatives—and what does he think about the messages he's getting from others?"

programs seemed to achieve longer, more stable outcomes," he says.

Edleson says he'd eventually like to develop a five year monitoring project to truly determine if treatment is successful.

"We want to put all the pieces together to determine which are the most influential factors—positive or negative—in their journey to nonviolence," he says. "Understanding how violent men

Sustainability Needs Management

"Integrated resource management and sustainable development is the focus of our College of Natural Resources. Both economic and environmental health are essential—one without the other is an empty situation," says Alfred Sullivan, new dean of the college, and experiment station associate director.

Natural resources includes the departments of forest resources, fisheries and wildlife, and forest products.

"We're concerned with the entire ecosystem, in what is becoming known as conservation biology," says Sullivan. Research in fisheries and wildlife ranges from aquaculture to moose to computer simulated ecosystems.

"We need to think globally, holistically, in looking at wood as a raw material. We, as a society, need many things, and they have to come from somewhere."

"Forests are a renewable resource," Sullivan says. "Forests provide us with so many other things as they mature: a place for recreation, watershed protection and wildlife habitat."

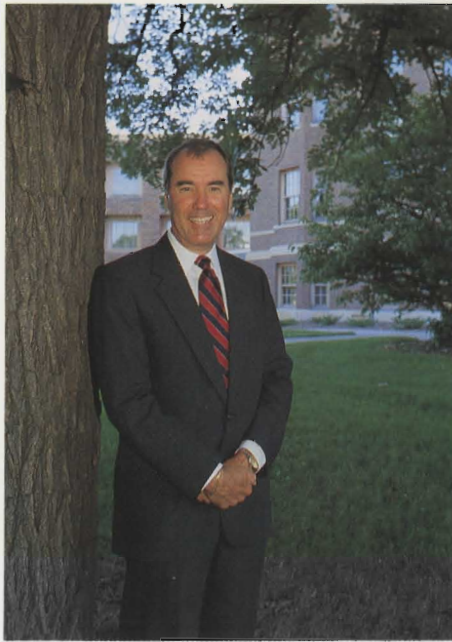
"Our forest resources program is concerned with forest management and forest biology, with attention to timber production. Conservation has always been part of our ethic," he notes, "but we understand conservation today much differently than 50 years ago."

"Minnesota's economy depends on our natural resources. Our quality of life, tourism, recreation, forest products manu-

facturing, hunting and fishing all depend on our natural resources. This College of Natural Resources, unquestionably regarded as among the top in the country, provides the science based information that helps society make intelligent decisions about how to manage its resources."

Sullivan was previously the director of the School of Forest Resources at Pennsylvania State University.

—Dave Hansen



Alfred Sullivan.



Researchers monitor nests of forest songbirds, such as this Scarlet Tanager, to gather information about what forest conditions lead to their reproductive success.

The woodland melodies of Minnesota's many migratory songbirds are dwindling. For the last two years, researchers from the university's Cooperative Fish and Wildlife Research Unit have sought to know why.

During the 1980s, half of Minnesota's migratory neotropical songbirds experienced significant population declines. The suspected causes are fragmentation of North American breeding habitat and deforestation of their wintering areas in Central and South America.

"We know next to nothing about reproduction success of forest songbirds," says David Andersen. "If we are going to make informed decisions about managing Minnesota's forest areas, this type of information is needed." Anderson is an Avian Research Center investigator and an assistant professor in the Department of Fisheries and Wildlife.

Andersen directs a group of students who are searching sections of North

Central Minnesota's Chippewa National Forest for nests of birds most people never hear of: Ovenbirds, Red-eyed Vireos, Yellow-bellied Sapsuckers, and more than 30 others. Nests are monitored to see if baby birds successfully develop to the point of flight.

They evaluate vegetation surrounding each nest to see the effect of habitat on reproduction success. Individual species are counted to monitor overall populations. "Last year we found reproduction success to be reasonably high even though weather conditions were cool and wet," says Andersen. Cool, wet weather can affect the parents' ability to catch the insects they eat, how well they can incubate eggs, and the mortality of hatchlings from exposure.

The project also evaluates whether forest edge areas are as productive for songbird reproduction as deeply forested

Songbirds continues on back cover

Understanding the Hmong Will Help Helpers Help Them

Try moving to, say, Laos. Bring along parents and young children. Try to earn a living and adapt to local customs. And try to find people able to help you. That's the situation, in reverse, for extended Hmong families moving into large U.S. cities.

Minnesota is a center for Hmong population in the U.S. Many professionals and service agencies struggle to provide Hmong with needed and appropriate help, but few people understand the Hmong. However, that may change a bit through research by family resource management specialist Sharon Danes, and her former graduate students Kathleen O'Donnell and Doaungkamol Sakulnamarka.

Educators, service providers, doctors and other professionals who work directly with middle generation Hmong are a group that Danes says needs help understanding "the dynamics of the Hmong couples, and what their concerns are in everyday life . . . what pieces they have maintained from their own culture and what they have begun to change."

"You have the elders who often for language reasons aren't out beyond the Hmong culture much, and you have the children who may or may not have been born in the U.S. but are very comfortable here. And so you have this clash of cultures and the middle generation adult or parent gets caught in the middle, responsible for supporting both generations."

Cultural differences are particularly apparent with health care, Danes says. "In the U.S. most people are going to respond to 'How do you feel?' with their physical state of health.

"Hmong look at a combination of physical health, mental health and spiritual health—our culture generally does not



Middle generation Hmong are sandwiched between parents who need help dealing with English and the western culture, and their children for whom traditional Hmong culture may be alien.

to both. Some still do go to both."

Hmong even define sick differently. "In the Hmong culture, you are not sick unless you cannot perform your everyday responsibilities," says Danes. "You have to be practically on your death bed before you really say you're sick."

Danes' material focuses on how daily life decisions, such as where to go for medical help, are made by the Hmong. Not all are made only by the individual. The spouse, extended family members, and even clan leaders can be involved in resolving some family conflicts or issues.

"The decision making part, who's involved in certain discussions, that can be very telling if you're trying to get something done in that community, in terms of how to go about it," she says.

"It would be an absolute must to go to the clan leaders when people have said

dynamics can be very useful to service agencies. Ramsey County extension educator Janice Rasmussen says, "It should help us work more appropriately, and a lot more effectively, if we understand where they are coming from and how they are dealing with the old and the new, and with sorting the differences out."

Results of this research are in a new publication of the Minnesota Agricultural Experiment Station. *Middle Generation Hmong Couples and Daily Life Concerns* is available for \$1.50 (plus tax) from the MES Distribution Center, 20 Coffey Hall, 1420 Eckles Ave., St. Paul, MN 55108-6064. Ask for item number MR-6202.

—Larry Etkin

Home Front: Who Helps Whom?

"A piece that might be particularly interesting to community workers relates to the strong gender roles you hear about as having existed in Laos," Danes says. Her study asked what kind of help middle generation Hmong received from organizations, from within the Hmong community, and from each other within a marriage.

"Do men help women alone, or do women help men alone, or is it only in groups? We found that a lot of things happen in mixed genders when they help each other," Danes says. "There are also certain indications in the data that reflect some of the traditional gender roles that you hear about the culture. But at least with the indications we have here, it's not as strong as you sometimes hear, as others talk about the Hmong.

"Of course, what goes on in the confines of a home may be different from what goes on or is reported in the public arena. And, what most of us in the US culture would be viewing is what is portrayed in public."

Which isn't too different from the U.S. mainstream. "It's not something people think about on an everyday basis," Danes points out, "what goes on in the household even in our own culture, in terms of the dynamics of decision making or gender roles and what we portray in the public arena may be different in many ways."

—Larry Etkin

Shrubs Can Work as Windbreaks

Test shrubs were challenged from the

- infant death rate
- deaths from pneumonia and influenza
- deaths from chronic liver disease and cirrhosis
- suicide rate
- percent of children living in married-

Hennepin and Ramsey Counties substantially improved their social well-being between 1980 and 1990. The urban counties ranking lowest on the index are Polk and St. Louis.

The lowest ranked rural counties in

Food Research Twists and Turns

When you eat your way through a bowl of cold cereal, you take for granted that each individual piece looks, tastes, smells and crunches exactly like every other piece. You don't expect surprises.

Creating and maintaining this uniformity challenges the makers of cereals and snack foods. Their response is increasingly apt to be "extruding" their products, a one-step process that cooks and shapes food pieces simultaneously.

Aiding food companies in their search for consistency is Mrinal Bhattacharya, an experiment station agricultural engineering researcher.

Extruders large enough to process thousands of pounds per hour were first used by the plastics industry. Ingredients in an extruder cook while being mixed by single- or twin-screw apparatus that move them to where the finished mix is forced through holes, emerging in the shapes of cereals or snack bits. It can take as little as twenty seconds, or much longer.

Bhattacharya's research tests rheological characteristics—texture and viscosity—of a mixture at different points in the process. Graphing these characteristics tells technologists when more moisture or other changes are needed. Computerized sampling "replace the hit-and-miss method of a technician trying to correct the end product by the process of elimination," Bhattacharya says.

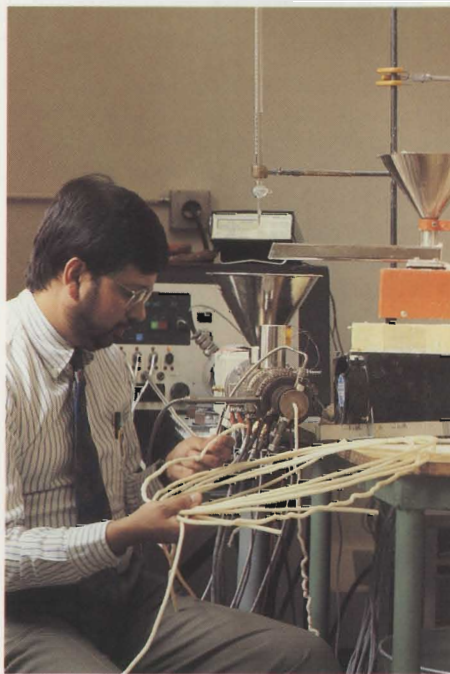
One project is testing Minnesota and North Dakota grown wheat to see if it is suitable for extrusion. Regional wheat producers would benefit if manufacturers could be convinced to use local wheat.

Bhattacharya is also testing 'plastics'

made from plant starches and polymers. Blends using up to 80 percent grain starch could be used for lightweight products such as cups and shampoo bottles. The starch/plastic product has a smooth satiny feel and is theoretically biodegradable.

Bhattacharya's research is funded by the experiment station, the Minnesota Corn Promotion and Research Council, USDA, the Northern Regional Agricultural Utilization Consortium and the Agriculture Utilization Research Institute.

—Anne Gillespie Lewis



Mrinal Bhattacharya monitors an extruder's operation. Food processors use large extruders to produce many cereals and snack foods.

Compost produced from city garbage may someday fertilize vegetable, landscape and field crops. Experiment station researchers are testing the product's performance and safety so standards can be developed for its wider use, as an alternative to landfill or incineration disposal.

Beyond the three "Rs" of environmental protection—reduce, reuse, and recycle—another practice, composting, is identified by the U.S. Environmental Protection Agency as a landfill alternative.

"Landfills are closing because they have reached capacity or because of more stringent pollution control, and new ones have become difficult to site," says soil scientist Tom Halbach. That's why experiment station researchers are reviewing economic and environmental aspects of composting garbage, more accurately termed municipal solid waste (MSW).

Minnesota MSW composting plants operate in Baudette, Benson, Buffalo, Mora, St. Cloud, Preston, Thief River Falls and Truman. That's eight out of 19 such plants in all the U.S.

"Disposal of garbage in landfills is four to seven times more expensive than ten years ago. Composting now appears to be more feasible than it was in the past, though it is still not cheap," Halbach says. In 1992, Minnesota composting costs averaged \$69 per ton compared with \$64 for incineration and \$48 for landfill.

Soil scientist Carl Rosen and horticultural scientist Bert Swanson study MSW compost on vegetable, greenhouse, landscape and nursery crops. Swanson says, "We're producing trees and shrubs in containers with these mixtures and having considerable success. Our biggest concern is variability of the compost, and consistency from year to year. Unlike compost added to an open field, it is the major part of the growing media for container grown plants. It must have consistent quality."

To determine the effect of a specific waste stream component, Rosen grew lettuce and corn in soil mixed with compost from the St. Cloud plant that included "four times the amount of diapers, compared to normal."

Leaf scorching, a symptom of salt

toxicity, was apparent in both corn and lettuce. "Corn is more tolerant than soybeans, and small grains are the most tolerant. I feel there will be more applications for this compost with field crops than vegetable crops because field crops are further away from humans in the food chain," Rosen says.

"We analyzed the N-P-K, trace elements, heavy metals, carbon to nitrogen ratios, and physical characteristics of the compost," Rosen explains. "We found that variability is a problem for both the plant operator and the end user."

Variability in batches of compost is a major problem. One load can have a high level of nitrogen and make an ideal fertilizer, while another batch may actually take nitrogen away from a crop.

The speed at which materials compost varies by the type of garbage it starts as. Sugar products decay in two or three days, carbohydrates in three or four weeks, paper takes months, and wood chips years. Plastics take centuries, so some plants try to remove them before composting.

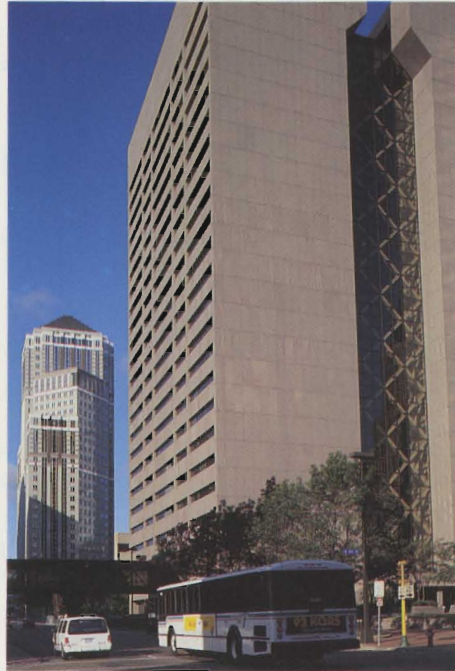
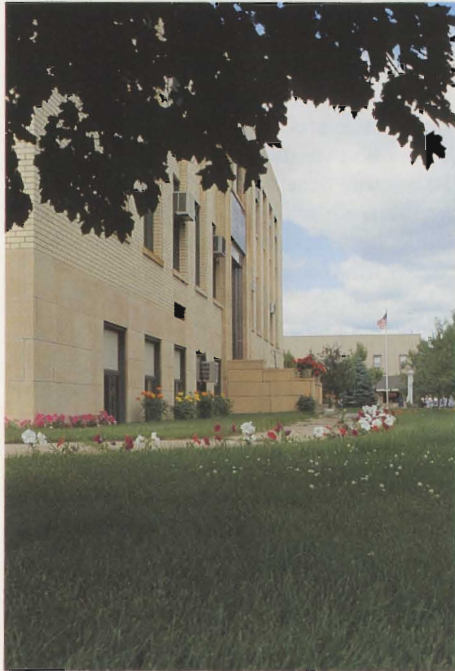
Minnesota is the national leader in compost research. Much of the work is funded by the Minnesota Office of Waste Management. Information from this project will be used to develop standards governing compost uses.

The standards may end up similar to those for sewage sludge that is used as fertilizer. For over 20 years, university researchers have monitored the effects of sewage sludge on cropland at the Rosemount Agricultural Experiment Station.

"The ability to market, or even give away, MSW compost will depend on producing a uniform and safe product," Halbach says. "Safety" considerations include eliminating pathogens, toxic heavy metals, and glass and other sharp debris.

—Dave Hansen

“Well Being” Index Favors Urban Counties



Urban counties such as Hennepin (right) generally provide their citizens with greater “social well being” according to a new index developed by the Center for Rural Social Development.

Do people in urban areas live better than those in rural counties? The answer depends on what yardstick you use to measure, but by an objective index of social well-being developed by university researchers, Minnesota’s urban counties do come out on top.

The index evaluates eleven social and economic indicators. It was applied to all Minnesota counties, using estimated values for the years 1980 and 1990. The indicators are:

- median family income
- educational attainment
- families above poverty level
- housing units with complete plumbing facilities
- death rate

- couple households
- single parent households headed by women

“In 1990, seven of the state’s 16 urban counties had the best scores for social well-being as measured by the index,” says rural sociologist Dario Menanteau. Dakota County ranked highest, followed by Washington, Olmsted, Carver, Scott, Anoka, and Hennepin.

Menanteau directs the university’s Center for Rural Social Development. Agricultural economics graduate student Christos Papadas helped develop the social well-being index.

Metropolitan counties generally ranked higher on the index than non-metropolitan counties, says Menanteau.

1990 were (from highest to lowest) Traverse, Aitkin, Mahnomon, Clearwater and Norman. “These counties do not follow a strict regional pattern,” says Menanteau. “However, looking at rankings across the state, it’s clear that large areas in the western and northwestern regions rank significantly lower than the south, central and northeast.”

Counties with the largest improvement from 1980 to 1990 were Lac Qui Parle, Hennepin, Becker, Cass, and Ramsey. The lowest rates of change were found in Lake, Traverse, Grant, Red Lake, and Swift.

Continuing the evaluation, Menanteau has begun to measure income inequality within counties—is wealth

concentrated among the few or more evenly distributed? He also wants to determine where wealth is more evenly distributed, in rural or urban counties.

Information from county commissioners, auditors and administrators is being collected to see how counties are responding to emerging challenges. “Economics is not all of development,” Menanteau says. “A major concern is that development should be closely connected with the needs of people, not just economics.”

The Center for Rural Social Development, funded by the Minnesota Agricultural Experiment Station and Minnesota Extension Service, focuses university research and resources on social issues and problems affecting rural areas.

—Joseph Kurtz

Minnesota Leads U.S. in Composting



even recognize spiritual health. And so we asked whether Hmong people go to a western medical doctor or to a shaman, or

their clan leaders are very involved in that particular decision," she says.

Understanding these Hmong social

Rotational Grazing May Help Sustain Dairy Farming

Rotational grazing research at the West Central Experiment Station, Morris, should help Minnesota dairy farmers remain competitive while reducing environmental problems of manure disposal. Rotational grazing provides a dairy herd with fresh acres of high quality pasture each day.

Animal scientist Dennis Johnson says, "while intensive rotational grazing is common in New Zealand and some European countries, it is not widely practiced here because U.S. systems use stored feeds."

But with about five percent of Minnesota dairy farms going out of business each year, some farmers are interested in anything that can reduce costs.

Rotational, or intensive grazing, recycles nutrients from plants to animals and more directly back to the soil.

The project should provide information emphasizing "practices that reduce

off-farm inputs and are friendly with the environment of the farmer, farm land, dairy animals, and the community,"

Johnson says.

A research team of agronomists, economists, and animal and soil scientists are looking at many contributors to sustainable dairy farming.

- Improving production techniques for raising dairy cattle on pasture: extend grazing season, enhance quality and quantity of pasturage, control pests and diseases of pasture plants and animals.
- Increasing profitability by reducing purchased inputs: fuel, food supplements, pharmaceuticals.
- Improving the quality of life for dairy farmers.
- Studying the flow of nutrients through animals, crops and soil: identifying crops that remove excessive nitrogen and phosphorus from soils.

—David Hansen



Minnesota cropland under center-pivot irrigation systems has increased sharply, from 13,000 acres in 1970 to 350,000 acres today. But conservationists and farmers are concerned about losing fertile topsoil in dust storms that usually follow removal of field windbreaks.

"When irrigation systems were installed, windbreaks were either bulldozed out or topped to accommodate the travelling booms," says Harold Scholten, an experiment station research forester.

Windbreaks have protected fields from erosion for generations, "but no one had experience with planting short trees or shrubs that would not interfere with overhead irrigation," Scholten says.

So, in 1978 a group of farmers, Scholten, and a team of soil scientists, agronomists, and irrigation specialists began the country's only long-term project evaluating lower profile shrubs and small trees for use with overhead irrigation.

Over an 11 year period, 34 shrub species and two types of trees were evaluated at a central Minnesota site between Glenwood and Sauk Center.

"Most soils where center-pivot systems are used are light, sandy, and susceptible to erosion," says Russell Haas, plant materials specialist with the Soil Conservation Service (SCS) Plant Materials Center in Bismarck, North Dakota.

"Wind erosion needs to be kept to a minimum to comply with farm programs," he says, "and the areas are highly productive if irrigated and fertilized."

beginning. Quackgrass competed savagely with the shrubs the first few years, despite chemical and mechanical control efforts which included hand weeding.

After eight years, both of the trees and half the shrubs were eliminated from the study. Scholten gave the remaining shrubs three more years to prove themselves.

The SCS provided the shrubs used for testing. "We have access to materials from other countries as well as all over North America," Haas says, "but we prefer to use native materials. We screen tree and shrub species in long-term trials at three experiment stations in Minnesota—Crookston, Morris, and Grand Rapids—for their potential in field and farmstead windbreaks and wildlife plantings."

Besides slowing the prairie winds, windbreaks also "improves growing conditions by creating a 'micro climate' that increases humidity and reduces water loss through transpiration," says SCS conservation agronomist David Breitbach.

Slowing the surface wind also protects crops that are sensitive to abrasion by wind-blown soil particles, Breitbach says.

—David Hansen

The Winners

Five species are recommended for windbreak plantings under irrigation:

- Persian Lilac
- Chinese Lilac
- Peking Cotoneaster
- Glossy Buckthorn (also called Tall Hedge or Columnar Buckthorn), and
- Caragana.

The shrub Arrowwood also performed well, except when irrigation was turned off during 1984 and 1985 university budget cuts. "We wouldn't expect farmers to shut down their systems when crops were in need of water," Scholten says. "However, the shutdown demonstrated drought tolerance and how they adapted to soils having excessive internal drainage."



Rotational grazing uses a movable electric wire fence to keep cattle rotating through fresh pasture and off recently grazed areas.

1994 Minnesota Gardening Calendar

The Minnesota Agricultural Experiment Station developed Swanson Red Grape is featured in the 1994 Minnesota Gardening Calendar, now available. Twelve months of tips on gardening and lawn care accompany brilliant color photography and lists of helpful extension and experiment station publications. (Actual size is 9 x 12 inches.)



1994 Minnesota Gardening Calendar Order Form

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Nematodes continued from front cover

have identified two genes in one resistant soybean that control most, 60 percent, of the genetic variation for resistance. No one else in the country has gone as far. Using DNA markers we can choose plants in our breeding program that retain the resistant genes and also as much of the desirable parent as possible."

When the genes responsible for SCN resistance have all been located, evaluating offspring will simply involve looking for plants that carry all five genes, from among plants also showing the desirable yield characteristics of the original parents. Orf and Young use the word "precision," for that's what DNA marker breeding provides, in contrast to the relative unpredictability of conventional breeding.

The project is funded by the experiment station, and by the Minnesota Soybean Research and Promotion Board.

—Dave Hansen

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Songbirds *continued from page 2*

habitats. Edge areas are expanding as Minnesota's pulp industry cuts more acreage and creates more open areas.

Forest edge research uses artificial nests with quail eggs to compare predation rates along the forest edge with predation deeper in the woods. Many bird species, and mammal species such as squirrels, will raid such a nest.

"Birds will nest in fragmented forest areas but their reproduction is poor," says Andersen, "With this year's data we may have a better idea of why this happens, and eventually offer recommendations to improve logging practices."

The U.S. Fish and Wildlife Service is coordinating the collection of data from

ten states. "It is important to have information from the same time period on the same species in different areas. For example, the Ovenbird is being studied in Minnesota, Ohio, New York, Arkansas, Missouri, and North Carolina. Following the birds's reproductive success from a variety of locations gives researchers a better foundation to evaluate population changes," says Andersen.

Andersen says the project will need four or five years of data to be statistically valid, and periodic monitoring will likely be needed. When the project is complete, Minnesota policy makers will have information they need to help ensure that Minnesota's forest songbirds perform in chorus for years to come.

—John Wold

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