MINNESOTA
Science

Agricultural Experiment Station
University of Minnesota
Fall, 1990

North vs. South: Trout Streams and Recreation

Perhaps more than any other sportfish, trout need an unpolluted and undisturbed environment. And the future of Minnesota's trout streams depends greatly on the public's understanding—and demanding—that our natural resources be protected.

"I'm putting more of my time and effort into being a middleman—an interpreter, if you will—between scientists and the general public," says fisheries researcher Tom Waters. "If a scientist works isolated from the public, that doesn't do much toward helping the public understand our natural resources, which are in dire need of protection in many parts of the world. I feel the best solution to that is to have the public informed intelligently with good, sound information properly interpreted."

Waters has written two books, *The Streams and Rivers of Minnesota* and *The Superior North Shore*, drawing on knowledge accumulated over 33 years as a University of Minnesota limnologist. Limnology is the science that deals with bodies of fresh water such as lakes, streams and ponds.

Because Waters also has a passion for trout fishing, his research on stream ecology and productivity, for the Minnesota Agricultural Experiment Station, represents a happy marriage between hobby and profession. He says Minnesotans are lucky to list many very good trout streams among their recreational resources.

Experiment station fisheries researcher Tom Waters (front) leads groups of students up Minnesota trout streams, taking "census" counts. Their "electrofishing" stuns fish only long enough to measure and count them. He has tracked natural and human disturbances on trout stream production and health for over thirty years.

Minnesota trout streams are of two types. The southeast has hardwater streams. Those waters, coming mostly from sedimentary rocks, have a high calcium content. Along Lake Superior's North Shore are more acidic softwater streams, whose waters arise from old, igneous geology.

The vegetation providing energy and nutrients for the food chains in these streams differs also. In the southeast, leaves find their way into the streams from trees and shrubs. Along the North Shore, the material is mostly from conifers; cone bearing trees such as pine, spruce and fir.

"Plant material produced outside the stream is the main source of energy for trout streams," Waters explains. Leafy material is easily used. Bacteria and fungi grow on leaves that fall into the stream, using nitrates from the water to manufacture protein. The protein is eaten by insects and other in-

Trout *continues on p. 3*

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IN PRINT

The past several years have been difficult for rural Minnesota. An uncertain economy and disastrous drought combined to force many farmers into bankruptcy; others to the very brink.

With many farmers being forced out of business, Minnesota put a nationally acclaimed Farm Credit Mediation program into effect. It helped many farmers stay afloat. But even those underwent enormous stress dealing with their crisis.

Can farm families have conceivably emerged unscathed from the process? What about families forced to leave farming? An evaluation of the "family" facet of the aftermath of Farm Credit Mediation has been published by the Minnesota Agricultural Experiment Station.

Adjustments of Farm Families to Economic Stress: A Two Year Study reports on economic, social, psychological and physical effects of the crisis on affected Minnesota farm families. Impacts ranged from changing patterns of communication, to deterioration of physical health. But the team of University of Minnesota Family Social Science researchers also found positive effects.

Copies of the publication are available for $2 prepaid (plus 6% sales tax) from the Distribution Center, University of Minnesota, 3 Coffey Hall, St. Paul, MN 55108-1030. Ask for publication AD-MR-3994, Minnesota Report 220-1990.

—Larry Etkin

Backcrossed Chestnuts May Save American Tree

In the early 1900s, millions of American chestnut trees flourished in eastern U.S. forests. But a blight far more destructive than Dutch Elm disease made the American chestnut nearly extinct as a forest tree. If it eventually survives, much of the credit will go to 86-year-old Charles Burnham, emeritus professor of Agronomy and Plant Genetics.

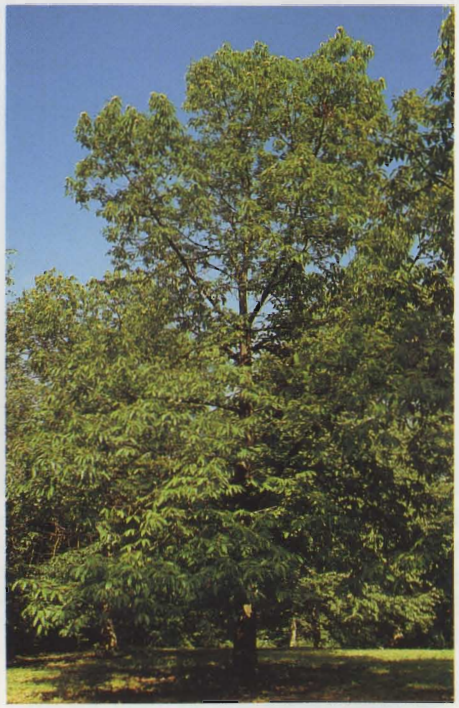
A few widely scattered large trees remain. Also, sprouts from the root systems of afflicted trees and others that began as pre-blight seedlings have been through several cycles of blight infection followed by re-sprouting.

Burnham, by trade a corn geneticist, developed a chestnut breeding program in the early 1980s. His goal was to transfer blight resistance from the Chinese to the American chestnut, while keeping the physical characteristics of the American tree. The Chinese chestnut is an orchard tree that can't compete in hardwood forests like its much larger American cousin.

"The plant breeder's way of transferring resistance would be to make a hybrid by crossing the American with the Chinese chestnut," says Burnham. When this hybrid matures, the pollen from it would then be used to fertilize blight-free American chestnuts.

"Some of the progeny would have moderate resistance and they would be selected again to backcross to the American chestnut. And if you keep doing that, while selecting for resistance, you will eventually get your American chestnut back," says Burnham.

"He is absolutely correct," says plant pathologist David French. "With a decent breeding program carried out for at least three generations, we will get back to a tree that is essentially an American chestnut but is still carrying



This mature American Chestnut is one of few left in Minnesota, and North America.

those factors for resistance." French researches tree diseases for the Minnesota Agricultural Experiment Station.

"The fortunate thing about the chestnut," says French, "is they flower at a very early age, so you can get your crosses in very soon after each generation is started."

Once the fungus contacts a wound on a chestnut tree, the chance for that tree's survival are slim. Blisters form on the tree's surface, under which a fungus that originated in Asia, *Cryphonectria parasitica*, sends down fine, white, octopus-like tendrils. The tendrils fan out, consuming nutrients and water needed by the tree. Small chestnut trees die within months; large ones last a couple of years.

Through 1980, saving the American chestnut by spraying, clear-cutting, radiating nuts and grafting had all been tried, largely unsuccessfully. The USDA also tried backcross breeding to Chinese parents, resulting in progeny more Chinese than American.

Burnham's interest was sparked by that effort. As he saw it, it was a tactical breeding error. He responded by developing the generational backcross model being used today to develop a blight-resistant American chestnut.

Chinese chestnut. . . can't compete in hardwood forests.

This new approach led, in 1983, to the formation of the American Chestnut Foundation, a non-profit organization dedicated to restoring the tree. French is on the foundation's board. "We think we have some trees now that have a reasonable level of resistance," he says.

Breeding is under way at sites in New York, Connecticut, New Jersey,

Rural Housing Needs Often Not Understood

Rural housing has tended to be older and less expensive than urban housing. It has often been built to different standards. A team including Minnesota Agricultural Experiment Station researcher Earl Morris looked at rural housing needs in six midwestern states. Their results are intended to assist small towns and rural groups that are often ignored: homeless, elderly, single parent, handicapped, and other non-traditional households.

Rural residents and their housing needs are often misunderstood by urban-oriented social scientists and policy makers. That's the view of sociologist Earl W. Morris, a view his own rural Michigan upbringing made him aware of, and one supported by a recent multi-state study by a team of researchers.

Morris, a researcher for the Minnesota Agricultural Experiment Station, says he hopes the study will help draw attention to rural housing woes, and bring about action to alleviate some of those problems.

"There's always been a lack of information on rural housing and we thought this might correct the balance and help people pay more attention," says Morris.

Most rural dwellers are not farmers, Morris explains. Most live in small towns. Many are poor. "When people think of poor people, they generally think of the poor in cities, not in the country, and that isn't necessarily true," he says.

He says the study shows rural areas generally have housing that is older and of lower quality than urban housing. That is the case even though rural housing is also usually less expensive.

Rural residents pay a smaller portion of their income for housing, except in lower income ranges. But for those rural poor, housing is becoming increasingly hard to afford. An increasing number of rural residents are homeless or having housing problems.

"An obvious solution would be subsidies for poor people's housing, but we're simply not willing to pay for that," Morris says. "The American people have sort of lost their interest in taking care of housing needs for poor people. We have about one-quarter the number of housing programs that we had ten years ago."

Reducing standards and allowing no-frills housing to be built or rented could be an alternative. Such housing would meet all health and safety standards and would not be substandard in any sense, Morris explains. The "frills" that middle class standards deem important (e.g., extra floor space and bathrooms, the most superior construction materials) would just be avoided.

"If we do nothing, we choose the idea that homelessness is okay, that paying a high percentage of your income for housing is okay, or that very substandard housing is all right."

Morris and others involved in the six state (Minnesota, Illinois, Iowa, Missouri, Nebraska and Wisconsin) survey of rural housing will be publishing their findings in detail. They also plan studies of housing needs for specific rural groups, including the handicapped, minorities, disabled, elderly female-headed households and young families with many children.

The Farmer's Home Administration is the agency responsible for rural public housing. Morris says he hopes that agency will consider the study's results and recommendations when it makes policy decisions on rural housing needs and standards.

—Anne Lewis

Tennessee, West Virginia, Virginia and Kentucky. Last year 30 first generation backcrossed seedlings, grown by Burnham in Minnesota, were planted at the Foundation's first research farm in Meadowview, Virginia. Those that survive the blight will be parents for the next generation of backcrosses.

—Roald Sateren

Water Quality Recommendations Compiled

Practical agricultural chemical management recommendations affecting water quality have been collected in a notebook published by the Minnesota Extension Service. The information is based on the most current Agricultural Experiment Station and other University of Minnesota water quality research, says Jim Anderson, director of the University's Center for Agricultural Impacts on Water Quality.

Copies of the notebook are in every Minnesota Soil Conservation Service office and Minnesota Extension Service county office.

Papers written by experiment station researchers range across topics from managing nitrogen for corn production on irrigated sandy soils, to rinsing pesticide containers. Included is information on nutrient and pest management, weed control and fertilizer recommendations. All take into account both production and water quality concerns, says Anderson.

"We are one of five states to do these as a prototype," says Anderson. The notebook will serve as a technical guide to professionals involved with environmental management of agricultural chemicals.

—Jennifer Obst

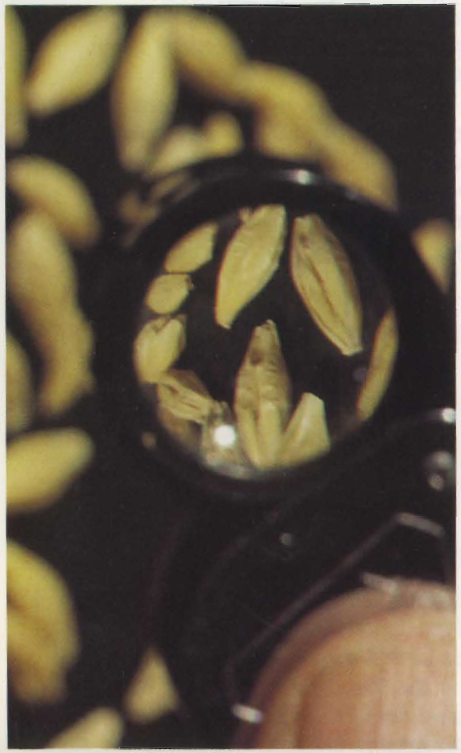
MINNESOTA Science

From Barley to Brew. . .

Barley to beer! The cycle can take nearly a year! Follow a bushel of 1990 barley from field to refrigerator, and you'll be able to drink it next spring.

Growers plant in April and harvest starting in late July. Some sell immediately to local grain elevators, where tests determine if the barley qualifies for a premium malting price.

Some growers store their barley and hope for a better price later. Others grow barley under contract, for delivery whenever their contract specifies. Elevator prices are determined by trading, frequently on the Minneapolis Grain Exchange.



Morex barley, developed by the Minnesota Agricultural Experiment Station, is the indus-

Barley is shipped to malthouses, where it may be started malting immediately, or held for several months. Prior to malting, the barley's chemical and physical attributes are tested. Most important is the test for germination, because if the grain will not grow it cannot be converted into malt.

Malting begins, according to Bruce Sebree of Fleischmann-Kurth Malting Co. of Milwaukee, with the barley steeped in water to increase moisture from 12 percent up to 45 percent.

Barley is germinated at about 65 degrees Fahrenheit for four or five days. Then it's slowly dried to preserve enzymes and form flavor compounds. Rootlets are cleaned off and the resulting malt, no longer called barley, is stored for up to a year, Sebree says.

When the malt is ready to ship, varieties are mixed to customer specifications and most is sent to breweries.

After the malt is tested and aproved for brewing, says Frank Weber of the Miller Brewing Company, it's rolled to a coarse powder and mixed with water. Enzyme activity started in the malt continues in the resulting mash.

"Malt is a key ingredient," says Weber. It provides material for the enzyme activity, husks which filter the brew, and a base that can be toasted for different colors and foaming properties.

Cooked cornstarch or rice is added to the mash for the enzymes to break down to fermentable sugar. Wort, a clear liquid, is filtered out and boiled to develop the flavor, color and other characteristics of a particular beer.

Yeast and hops are added to the wort and fermentation takes about fourteen days, says Weber. Then the beer is aged three to six weeks, finished,

At the University's Northwest Experiment Station, Crookston, a harvesting crew thrashes some of the 6,000 barley varieties evaluated by breeder Donald Rasmusson (front left). More than two-thirds of U.S. brewed beer is made from barley varieties released by the Minnesota Agricultural Experiment Station.

Barley Breeds Recipe for Success

Barley breeder Donald Rasmusson apparently never heard that "you can't please everyone." For pleasing everyone involved in growing or using barley—

The barley breeding program's new releases are eagerly awaited and quickly adopted. Barley acres seeded to Robust went from 2 percent in 1983, to 29 per-

try standard for brewing. It is the most preferred U.S. malting barley variety.

filtered and packaged for sale.

—Anne Lewis

Trout *continued from front page*

vertebrates, who are in turn fed upon by fish.

High calcium content of water also increases the productivity of the system. Nutrients are more available, and the low acidity facilitates breaking down the organic material.

Waters devotes his research energies to developing ways to measure the production of stream invertebrates and fish. He was the first American to scientifically document that stream invertebrates are much more active at night. His work has enabled fisheries managers and conservation personnel to measure the productivity of trout streams and monitor their "health."

The process involves electrofishing. They electrically stun the fish temporarily to get information on their age, weight, and size. "Calculating the growth rate and getting the change in numbers for each age class," he explains, "will give us the amount of fish tissue that is produced in a given stretch of stream over a given time."

Hardwater and softwater streams do differ greatly in productivity, Waters says. "Due mainly to the greater production of the organisms that fish feed upon, there's close to a ten-fold difference. Thirty to 40 pounds of fish might be produced per acre annually in a North Shore stream, and 300 to 400 pounds per acre in a southeastern stream. Anywhere from 100 to 200 pounds is a very productive trout stream."

Waters has documented the susceptibility of trout streams to pollution and environmental disturbance. Washington County's Valley Creek is a good example.

The creek has undergone many changes in the 21 years he has monitored it. Brown trout, more tolerant of environmental degradation, have almost entirely replaced native brook trout. When spring runoff washed silt and clay from a housing development into the creek in the early '70s, the production of *Gammarus*, a crustacean that makes up over half of the trout diet in the creek, was decimated. Trout production nosedived, too, but rebounded with the *Gammarus* once the creek scoured itself in a couple of years.

His observations make Waters a firm supporter of state acquisition and protection of watersheds that feed

Rainbow, brook and brown trout are electrically stunned, measured, aged by taking scale samples, and released.

southeastern Minnesota trout streams. Agricultural pesticides washed into the streams by runoff are a problem, as is sedimentation caused by erosion. Streams along the North Shore are not as endangered, but logging poses a threat in some places. Mining activities are generally too distant to impact them.

"I think things have improved over the decades," Waters says. "But there are times, for example when there's a push to increase agricultural production—and government policy has a lot to do with it—that state protection of our coldwater resource is critical."

—Sam Brungardt

growers, maltsters and brewers—is what he has done for more than thirty years with the Minnesota Agricultural Experiment Station's barley breeding program.

Rasmusson, a plant geneticist, and colleagues such as plant pathologist Roy Wilcoxson, have spent decades developing barley varieties with higher yields, better disease resistance and improved malting characteristics.

The University of Minnesota breeding program has an impressive string of successes. Morex, released in 1978, is still the most favored barley for malting. Robust, 1983, yields five bushels more per acre than Morex. About two-thirds of the beer produced in the United States is made with these varieties.

And the best may be yet to come. Excel, from a cross between Robust and a sister to Morex, was released this year. It has outstripped its predecessors in good malting qualities and yield.

Morex and Robust are not just Minnesota favorites. American Malting Barley Association 1989 statistics show Robust was the leading barley grown in Minnesota, North Dakota and South Dakota. Morex was tops in Idaho.

Robust and Morex together made up about 92 percent of the 1989 barley acreage in Minnesota, 63 percent of North Dakota's and 66 percent of South Dakota's. Minnesota is the nation's fourth largest producer of barley. It's the second largest for malting varieties, from which beer is made.

Breeding barley is a cooperative venture, stresses American Malting Barley Association vice-president Mike Davis. The AMBA funds some of the Minnesota Agricultural Experiment Station barley research.

"One of the best ways to keep malting barley competitive and keep farmers producing it is to work cooperatively with barley breeding programs. The program at the University of Minnesota has been very productive. It's a good return for our money and it's a good return for the state," says Davis.

cent in 1984, and 70 percent in 1985.

The acceptance rate pleases Rasmusson. "During the last five years, Robust has been the most popular variety in the U.S. by a large margin. Each year it has been grown on nearly one-quarter of the ten million acres of barley grown annually in the country."

Minnesota is the nation's fourth largest producer of barley.

The statistics translate into substantial additional income for U.S. barley growers, about $110 million over the past five years, according to Rasmusson.

One very pleased grower is Doug Peterson, East Grands Forks. He grows registered seed barley, and foundation seed for the Minnesota Crop Improvement Association.

"Each time he develops a new barley, it's better yielding, stronger and malts faster," he says. "When is it going to stop?" he asks with a chuckle.

Peterson gives a glowing report of Excel, Rasmusson's latest release. "It's fantastic! It's the barley to have!"

Before each new variety is released there are years of making and evaluating crosses for agronomic traits and for malting and brewing qualities. They are field and greenhouse grown both in the Minnesota region and at Rasmusson's winter site in Arizona.

Rasmusson has been widely recognized for his success in the barley breeding program. Most recently he received the National Council of Commercial Plant Breeders 1990 Genetics and Plant Breeding Award.

—Anne Lewis

MINNESOTA Science

Technology Playing Catchup to Recycling Goals

Paper recycling is a major research problem. Where do you begin with materials as different as trees, ink, glue and clay? And "how many times can paper be recycled? Twice? Eight times? Twenty?" asks Mutombo Muvundamina, a researcher in the Department of Forest Products. No one knows for sure.

How many "cycles" can paper go through? "The fiber changes each time paper is processed. The surface of the fiber changes after the first use. The internal structure collapses when the fiber is dried. How do we maintain the quality of fiber to get a quality product?" asks Muvundamina.

Paper itself is not difficult to recycle. It's "added extras" that complicate the process. "Each year hundreds of new adhesives are developed, hundreds of new inks. We're aiming at a moving target," says Jim Bowyer, Forest Products department head. To ease recycling, he says some standardization by paper manufacturers, printers and packaging companies would be helpful.

Advising the department and the Minnesota Agricultural Experiment Station is a Paper Science and Engineering Council. Council President Gary Kaziukewicz agrees that recycling is complicated by a greater variety and increased quantity of paper products.

"Show the paper industry how laser printed papers and gloss coated grades can be recycled. Show us how to deal with hot melt adhesives. Or, how to more easily recycle inks," Kaziukewicz pleads. He is Corporate Manager of Technical Services for Waldorf Corporation, one of the country's largest users of recycled fiber.

"The problem is bigger than any

Forest Products department head Jim Bowyer, researcher Mutombo Muvundamina and Waldorf Corporation Technical Services Manager Gary Kaziukewicz (right to left) are with collected paper ready for a hydropulper. The paper is turned back into pulp using hot water and mechanical energy, and extensively screened and cleaned on its way to being remade into paper products. The St. Paul Waldorf plant, operating since 1906, makes paperboard from recycled fiber. Experiment station research seeks to help the paper industry overcome technical problems in the recycling process.

improved paper collection systems nationally. Exceeding the goal will require solving technical problems like those being investigated at the University of Minnesota.

The Department of Forest Products is one of a dozen paper science and engineering programs in the United States. It has one of the most intensive recycling research agendas. Goals include improving processing to accommodate glossy, coated papers used for magazines and for *Minnesota Science*.

University research approaches

basis for much of Minnesota's paper industry," says Bowyer. Though all paper, including high quality coated paper is technically recyclable, it is currently just not economical to do so.

—David Hansen

FROM THE EDITOR

Minnesota Science receives letters asking why it is not printed on recycled paper, or commenting that it is glossy and not recyclable. Indeed, we wish it could be on recycled paper, but no company currently makes a glossy magazine stock from "recycled" paper as consumers understand the term.

If *Minnesota Science* is to have accurate reproduction of color photos, it needs to be printed on glossy paper. This is true for all quality publications, including national news magazines and environmental publications.

We would like to use "recycled" paper, and we will continue to seek an appropriate quality recycled stock. As "post consumer paper" collection expands and industry research advances, more paper collected from homes or offices will undoubtedly eventually provide us that option.

As for recycling *Minnesota Science*, it's true that local buyers of waste paper currently do not want glossy paper. But again, in the near future this should change as technology catches up and as new paper recycling mills come on line. Please read the related story in this issue for more information.

—David Hansen
Minnesota Science editor

Maps and Math Predict Pollution

single index that identifies the parts of a watershed vulnerable to erosion.

The schematics of the DEM derived

one company," Bowyer says. "We need an independent based institute working with the paper industry. We need to expand the universe of what can be recycled," agrees Kaziukewicz.

An average American throws out 400 pounds of paper or paperboard each year, says Muvundamina, and "it's possible to recycle 40 percent of the paper, easily." The paper industry has set 40 percent as its goal for 1995.

To reach the goal will require much more consumer education, and vastly glossy paper as a challenge on two fronts. It seeks economical ways to modify production of quality, coated papers to make them more easily recyclable. And it works at overcoming technical barriers preventing efficient recycling of current glossy papers. Uses are also being sought for the clay sludge that separates out in reprocessing the paper.

Economics will remain the key condition determining success of the research. "Minnesota is a major producer of coated paper and it is the

Wheat Labors in Disease Garden

Roy Wilcoxson's wheat "disease garden" isn't meant to be a beauty spot. The plant pathologist and his colleagues grow scab-ridden wheat to aid development of resistant varieties.

He smiles and says, "Some people look at that wheat and say, 'Is this the best you can do?' " He assures us that the sick-looking specimens are vital to scab resistance research.

Uncontrolled wheat scab, also called head blight, can cause economic devastation. "A severe epidemic of scab can cause growers to lose their whole crop, though it's more likely to be a 30 to 40 percent loss," he says. Excessive numbers of blighted kernels in human food or animal feed can also cause health problems.

Scab can cause growers to lose their whole crop.

Scab pathogens also cause stalk and ear rot in corn, says experiment station research colleague Thor Kommedahl.

The disease is weather-dependent. Warm, wet weather at flowering or early in kernel development make the wheat vulnerable, says Wilcoxson. "If you could predict the weather, you could predict the disease," adds Kommedahl.

Weather can't be controlled, and current crop management practices don't always adequately control the disease. The scientists are counting on their test plot to help eventually yield less susceptible varieties.

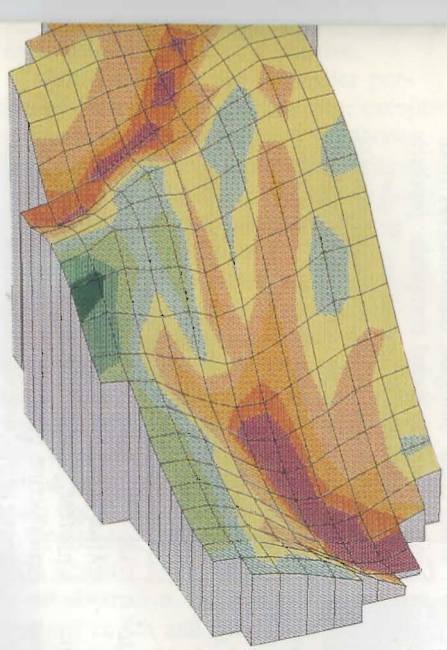
The work has accelerated since successful 1980s Mexican tests of a resistant variety from China. Very little work had been done to breed for scab resistance before that, Wilcoxson says.

Generous irrigation and lab cultured pathogen are used to create artificial epidemics on wheat with the most common scab pathogen, *Fusarium graminearum*, to select resistant plants.

Marshall is the current Minnesota wheat variety least susceptible to the disease. Its maximum scab runs about 25 percent. It also happens to be the region's most widely grown variety.

Crosses are currently being made between Marshall and the resistant Chinese Sumai. It could take up to 15 years to merge high yield and resistance into one variety.

—Anne Lewis



Computer generated 3-D maps developed by Agricultural Experiment Station engineers, are used by conservation agencies to predict areas vulnerable to water pollution from agricultural runoff.

A landscape sketching computer program and a batch of mathematical formulas describing land features are helping experiment station researchers pinpoint environmental trouble spots in farm fields.

The technique is based on computer generated maps called digital elevation models, or DEMs. The researchers use the three-dimensional pictures to calculate concise mathematical descriptions of susceptibility to erosion, and of features such as soil wetness and amount of sun shining on an area. The descriptions predict how vulnerable specific areas are to nonpoint source pollution. Water that runs off land carries valuable topsoil, agricultural chemicals, and other pollutants with it.

"It's a method for targeting critical areas," explains station agricultural engineer John Nieber. The technique lets them integrate many parameters into a

The advantage of the DEM derived indices is how specific they are. "Other criteria give a one-dimensional description," says Nieber. "DEMs give a better description of the three-dimensional landscape so we can describe these processes more accurately." In practice, this means that by using DEMs, rather than withdrawing a whole field from production, to protect water quality, only the most vulnerable spots need be kept from the plow.

"You don't want to put the whole watershed out of cultivation just because part is susceptible," Nieber says. Conventional systems "may cause you to cull out the innocent, nonsusceptible areas too," he says.

The model could be useful in targeting land for set-aside programs such as the USDA's Conservation Reserve Program. The federal government pays farmers to stop planting erosion-susceptible land for crops.

The technique is an improvement over established methods for identifying set-aside land. Nieber and his coworkers applied it to two Olmsted County farm fields, only one of which had been in the reserve program since 1987. Under the DEM method of evaluating erosion potential, both areas were eligible for set-aside. Both also had a lot of variation in susceptibility to runoff, however, suggesting that a wiser move would have been to set aside the most sensitive parts of each field, rather than all of one and none of the other.

Nieber says the DEM approach also has a number of other potential applications, ranging from identifying the best place to plant crops, to helping ecologists estimate where different native plant species might be found.

The technique has already been incorporated into USDA's Agricultural Nonpoint Source Pollution Model (AGNPS). AGNPS is a system used by more than 300 agencies across the country to assess land use.

—Mary Hoff

IN PRINT

To promote growth and diversification in the agricultural and forestry sectors of Minnesota's economy, Minnesota Agricultural Experiment Station scientists conduct research on alternative enterprises.

Several publications on such alternatives are now available from the Educational Development System, 405 Coffey Hall, University of Minnesota, St. Paul, MN 55108-1030. Checks should be made payable to the University of Minnesota. Persons outside the United States are asked to write for prices of the proceedings they wish to buy.

A symposium on dairy sheep, the first held in the Western Hemisphere, featured speakers from the United States, Canada, Mexico and Europe. The 192-page *North American Dairy Sheep Symposium* proceedings ($17) includes information on producing sheep milk, manufacturing sheep milk products and the economics, opportunities and strategies of starting such a business.

Minnesota Agricultural Experiment Station research provides information on a wide variety of alternative agricultural enterprises. Wapiti is one of several traditional game species offering potential income for farmers interested in diversifying.

Farm raised venison, a novelty in North America, is big business in New Zealand and Europe. A 46-page *Deer Farming Symposium* proceedings ($11) includes presentations on wapiti, red and fallow deer production. It covers deer biology, behavior, handling, health, reproduction, nutrition, profit potential and regulations.

Commercial growers, scientists and extension agents should find the 206-page *Stand Establishment for Horticultural Crops* ($20) of interest. It covers emerging technologies such as mulches and row covers; moisturizing, pregerminating and other matriconditioning seed treatments and coatings.

Investment opportunities offering high value-added and increased employment potential are addressed in *Wood Based Economic Development in the Lake States: Proceedings of a Symposium on Specific Forest Product Opportunities* ($20). It covers quality furniture, white birch turnings for interior construction, treated wood products, white cedar shingles, Scandinavian flooring, secondary wood composite products and small sawmill operations. It also discusses forest products industry trends, regional wood flow, methods of evaluating potential enterprises, and ways communities can attract forest product industries.

With more consumers demanding meat and poultry produced without chemicals, farmers aiming for this market will find the 96-page *"Organic" Meat Symposium* proceedings ($17) of interest. Topics include conventional production practices; meat-borne pathogens; antibiotics and hormones in meat production and human health; marketing and market potential; production and labeling regulations; feed and water sources for organic production; and animal health concerns resulting from organic methods.

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