

# MINNESOTA *Science*

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## Old Fish Provide New Clues To Past Centuries



*Microscopic rings in a fish ear stone, its otolith, can be accurately calibrated to the environment and climate in which the fish lived. Otoliths are frequently found in trash near places humans lived, and this can help anthropologists and archeologists accurately date sites and activities. This half-inch otolith is from a 22-year-old freshwater drum.*

Fish bones 45 and 160 years old are finding their place in history and science. They are spawning a technique to more accurately age large fish caught today, and to help anthropologists and archeologists learn more about conditions of previous generations. The 45-year-old bones are archived from the Red Lake Reservation. Those 160 years old are from garbage thrown out in the Dakota camp at Little Rapids, near present day Shakopee.

A team of university researchers, led by fisheries specialist George Spangler, has developed a "temporal signature" technique to accurately date the age of fish. They use the ear stone of the fish. The ear stone, more accurately called the otolith, is a solid, bone-like structure shaped like an irregular almond.

It doesn't matter if the fish was caught yesterday or last century. Intact otoliths are now useful treasures that can be found in the refuse left behind by earlier inhabitants of an area.

"We've used otolith histories to infer stock dynamics, past environmental condi-

tions, and to establish correlation with climate," Spangler says. "They may also provide a fairly high resolution record of the environment."

Fish scales also provide a record of growth, but says Spangler, "scales are mainly useful for young fish, up to about 8 years." After that, the growth lines may be reabsorbed or for other reasons are inaccurate. "Bones, fin spines and scales are all used to date fish," he says, "but otoliths make such a good record and also give us a record of the aquatic environment."

The temporal signature technique developed by Spangler's team fixes specific years to otolith growth rings. After a master chronology is developed, instead of knowing only that a fish was, for example, 63 years old, fisheries experts will be able to determine that the fish was in fact a yearling in 1879 and was caught in 1941.

Information this specific provides important details for scientists studying climate or environmental changes. As chronologies are extended back through time, archeologists will be able to use the

information to help date activities that took place hundreds of years ago.

The otoliths that first interested Spangler were from 70-year-old freshwater drum, a rough fish also known as sheepshead. Four large specimens were caught between 1949 and 1951 on the Red Lake Reservation and scale samples and otoliths archived at the University. Their known age allowed Spangler's team to derive a temporal signature for fish in that region that goes back to 1879.

The actual work of counting otolith rings is intricate. Hundreds of annual and sub-annual rings are present in an otolith only a half-inch in size. Some of the rings may reflect growth spurts as a result of heavy feeding; others may be caused by stress or dramatic temperature change. To develop an accurate signature covering 1879-1951, adjunct professor Don Pereira, a Minnesota Department of Natural Resources research biologist, used DNR image analysis equipment.

To bring the record up to date, 60 large Red Lake drum were harvested in the 1990s. The overlap between growth years of the 1951 and current harvests completed the chronology. Then they graphed the growth rings against weather data recorded at the experiment station in Crookston, going back to 1890.

Lyn Bergquist, a university fisheries

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## IN PRINT

### No Uniformity In State Forestry Regulation

Forests are important contributors to the nation's economic, social and environmental fabric. Because much of the nation's forest land is privately owned, how it is used is increasingly coming under public scrutiny and governmental regulation. But the ways governments seek to assure that private lands are managed wisely for the future, and are not abused by their owners or managers vary widely across the nation.

Forest practice regulatory programs, predominately state initiated activities, already exist in one of several patterns in half the states, and many additional states are actively considering them. But, not all such programs are created equally.

The experiment station has published an extensive review of the structure of the various state regulatory efforts across the nation, covering the different approaches states have adopted to protect their forest resources. The 225 page book, *Regulation of Private Forestry Practices by State Governments*, was written by Paul Ellefson, a forest policy specialist, research assistant Antony Cheng, and Robert Moulton of the USDA-Forest Service. See "ordering publications" on the back page.

### New Use For Prehistoric Material

From ancient seas to the tops of grain bins. This could be a one-line description for an alternative pest control treatment using inert dusts to keep our food supply free of pesticide residues and insects.

"Times are changing, and we need to find alternatives to chemicals," says university entomologist Bhadriraju Subramanyam. He leads a research team comparing the effectiveness of six finely ground, diatomaceous earth dusts used to control insects in stored grain.

Diatomaceous earth contains fossilized skeletons of diatoms, plants closely

related to algae. Dried salt or fresh water beds with such deposits are mined and milled into irregular particles as small as one millionth of a meter in size. Diatomaceous earth is about 90 percent noncrystalline silica, a compound which doesn't damage human or animal lung tissue.

But the tiny particles do harm insects. "The particles damage and absorb the waxy outer covering of the insect's body which protects them from water loss. As a result, insects die from dehydration in two to 14 days, depending on the species," Subramanyam says.



To the human eye, diatomaceous earth is but a layer of dust. For an insect, the silica particles can slice through the waxy covering over its body, leading to the insect's death by dehydration.

Subramanyam says this insect control idea dates back to the 1930s, though bad experiences with the material in the 1960s and 70s set its use back. Commercial diatomaceous earth products developed a bad reputation because tests used versions with poor insecticidal value, requiring high application rates for insect control. The high rates affected grain quality, made the grain harder to move with augers, and even damaged milling machinery.

The experiment station researchers are the first to document the dust's success on insect larvae. They have shown that salt water diatomaceous earths are effective, especially for insects resistant to conventional insecticides. But Subramanyam cautions that insects may eventually even develop resistance to diatomaceous earth. Insects may develop instincts to avoid treated grain, or insects with thicker waxy coverings may survive better.

"We recommend treating only the top layers of grain stored in bins, since infestations occur through the exposed surfaces," he says. This way, the top layer gets about two pounds of dust per ton of grain. Older methods mixed four to seven pounds per ton into the entire grain mass.

"Nonchemical inert dusts are viable alternatives in our climate," Subramanyam says. In Minnesota alone, more than a billion bushels of grain are in storage on farms and susceptible to insect infestation.

Scientists in Illinois, Kentucky and Oklahoma are doing companion research to the Minnesota project. Funding is by the USDA's National and Regional Pesticide Impact Assessment Program and diatomaceous earth manufacturers.

— Dave Hansen

## Minnesota Child Support Guidelines: Are Current Notions of Fairness 'Just'?

That divorce and child support deci-

varies only with the parent's net income

"Uniform guidelines don't take into

to an income "shares" formula. She says

sions are hard on families is a gross understatement. Ex-wives and former husbands alike often feel they shoulder an unfair financial burden. Adding fuel to the emotional fires are high profile media reports, both of "deadbeat" dads and of fathers who support their kids but are given only token time to be with them.

So what exactly is "fair" with an issue of such intensity? To help Minnesota's law makers understand, experiment station researchers looked objectively at what divorcees think "isn't fair" with financial



*How financial resources are allocated between divorced parents is often central to their perceptions of the fairness of decisions related to child support.*

support of children. Their project is the first to apply theoretical "principles of justice" to a real world setting.

The conclusions reinforce perceptions that child support practices often fail to uphold basic principles of justice.

Minnesota's legal guidelines require child support to be a fixed percent of the nonresident parent's income. The percent

and the number of children. Under present law, the resident parent's income is not part of the calculation.

Each of these factors is a source of the perceived unfairness that a research team, led by family scientist Kathryn Rettig, sought to document and then apply to the development of a proposal for new child support guidelines.

But, "designing a child support system that is viewed as fair by all parties to a divorce is an unrealistic expectation," says Rettig.

Rettig and graduate research assistants Beth Magistad and Vicky Tam spent a year analyzing 145 pages of comments of divorced parents about how they and their children are affected by child support guidelines. The comments were voiced at public hearings in Duluth, Fergus Falls, Minneapolis and Rochester.

Rettig's team applied 14 basic principles to the comments. These principles have been accepted by social scientists as determinants of whether justice is being served. They found many violations.

"Representativeness" and "correctability" were often cited as problems in determining child support, and as reasons participants felt the system had let them down. "Correctability" means there are adequate grievance or appeal procedures. "Representativeness" means court procedures fairly represent all of the parties—fathers, mothers, and children.

Another often violated principle, "consistency," says procedures should be consistent across persons, within and across cases, and over time. A mother was quoted by Magistad: "The budget that I had to revise and redo at least 10 times before my divorce has \$500 less expenses with a family of four than my ex-husband claims as his expense of one person. Yet he did not have to explain or justify his expenses and I have to go line by line to say, this is why I need child support." "In other words," Magistad says, "two people in the same divorce case experienced inconsistent decision procedures."

account the complexity of diverse family situations," Rettig says, "particularly families of second divorces, kids with high medical costs, or families supporting children attending college." Quoting one father: "There's got to be room for creativity here. There's got to be room for individuality because no two cases are alike."

Money often brings two opposing principles into play: "needs" and "equality." Needs asserts that children with greater needs should receive more money. Equality asserts that all children should receive equal treatment, regardless of needs. Individuals in multiple divorce situations experience this conflict because under current formulas, children of second marriages receive less support than those from a first marriage.

Rettig says one change that the new guidelines propose is moving from a percentage of income, or "taxation" formula,

this would have parents equitably share the responsibility of providing for their children, with both parents' incomes being considered.

Rettig says part of the goal is, "child support that allows children to maintain a level of living the child would have had if the parents stayed together." She says this would, "reflect the real costs of raising children, including food, clothing, shelter, medical and child care." It would also recognize the needs of parents, subtracting a basic allowance for each parent before calculating child support.

The findings should also lead to the development of new educational materials for mediators, attorneys, and judges involved with divorcing parties.

This research is supported by the McKnight, Bush, Bigelow, St. Paul, and Emma B. Howe Foundations.

—Dave Hansen

## Child Support And More, Issues Of Injustice

Using as its test the complex issue of child support (divorce, deadbeat dads, drawn out legal proceedings, and moms who keep fathers from seeing their kids) experiment station researchers are the first documented group to apply theoretical, academic "principles of justice" to the real world.

Family social scientist Kathryn Rettig and graduate research assistants Beth Magistad and Vicky Tam used public testimony to test and revise fourteen principles of justice evolved over centuries of legal history, but not fully articulated by social scientists until the 1980s. Their real world test may lead to revisions, and to the labeling of new principles to match concerns voiced by parents.

Rettig says her application of justice theory should encourage researchers to look at other real life conflicts.

Six procedural principles of fairness were tested and redefined:

- accuracy
  - bias suppression
  - consistency
  - correctability
  - ethicality
  - representativeness
- Changes in the definitions of eight distributive principles were also made:
- equality
  - needs
  - contributions
  - justified self-interest
  - adhering to
  - legality
  - commitments
  - ownership
  - status

The research team evaluated the comments of divorced parents, collected at public hearings held in four Minnesota communities. "We went through all 145 pages of the transcripts, phrase by phrase," says Magistad. Each complete thought expressed was assigned to one of fourteen principles of justice. "The process often required going back to the context of the quote to determine the overall meanings, to decide where ideas appropriately started and stopped, and to decide if more than one principle was demonstrated," says Tam.

## Scab Threat Itself Now Threatened

Scab epidemics which have tormented Red River Valley wheat and barley growers for several years have finally eased. And experiment station research should considerably lessen the threat of its return in the future. Field trials, laboratory work, and a research expedition to China are coming together to bring this fungal disease under control.

Scab has been devastating for wheat producers. It cut yields across Minnesota by about a third in 1993. It took a bite of 18 percent out of normal yields in 1994, and losses were about 8 percent this year.

"Our best sources of resistance are lines coming from China and Japan," says experiment station plant pathologist Ruth Dill-Macky. She says, however, that "these lines are adapted to a very different environment and have very different end uses than the varieties we grow in Minnesota."

The trip to eastern China by three experiment station researchers taught techniques for inoculating wheat germ plasm with the scab fungus; this to learn how Chinese plant breeders screen germ plasm for scab resistance that can be bred into new lines of wheat. Chinese agronomists have been battling the scab plague for decades, because it frequently reaches epidemic proportions there.

Dill-Macky, wheat breeder Bob Busch, and agronomist and interpreter Charles Hu visited scab research sites near Nanjing and Shanghai. The techniques they brought back to Minnesota are already being used to screen varieties adapted to production needs of American

farmers. The search is for germ plasm which can contribute scab resistance to new lines of wheat and barley.

For most of this century, scab was not a major problem in U.S. wheat fields. That changed with several recent years of above normal moisture. It created ideal conditions for the fungus to multiply.

"It takes eight years from the time resistant lines are first crossed with varieties adapted to Minnesota until a new variety incorporating the resistance is commercially available," Dill-Macky says.

The challenge is to maintain quality, high yield, and resistance to other diseases, while introducing the scab resistance. "The Chinese breed strictly for yield," Busch says, being less concerned about quality than western producers.

Busch says that several "insurance" varieties with some resistance are close to release. 'Verde' is one of these. Developed by USDA and university breeders, it will be released in 1996.

Two other wheat varieties developed by university researchers are scheduled for release within two years. Neither is a cure, but each has better scab resistance than varieties currently available.

Using germ plasm from Chinese wheat was not an off-the-wall idea. "We have tried to target materials from other parts of the world that we know have resistance to scab," says Dill-Macky. "However, there is tremendous variability among lines in the type and degree of resistance they express. There is no complete source of resistance."



Finding scab resistant wheat and barley varieties is an agronomic priority. Resistance is bred into productive varieties by cross breeding with resistant germ plasm obtained in China. These test fields are at the Crookston branch experiment station.

Success at finding a resistant wheat will buoy the hopes of breeders of other scab susceptible crops. For Minnesota farmers, one such crop is barley. Minnesota is the fourth largest barley producing state, and according to experiment station barley breeder Don Rasmussen, finding scab resistant varieties of that crop will have significant economic impact.

A special legislative appropriation and support from the Minnesota Wheat Research and Promotion Council is funding this research.

—Joseph Kurtz

## PSS Is Early Target Of Biotech Disease Hunters

Porcine Stress Syndrome is one genetic problem with pig production that biotechnology is on the path toward eliminating. Caused by a recessive gene that must be inherited from both parents, PSS has proved very resistant to elimination from breeding herds. It is a muscular disorder that causes some afflicted animals to die from stresses such as transport, or to deteriorate and bring lower prices at market.

The new techniques identified a genetic marker associated with where the mutation appears on a gene.

## Biotech Meets Traditional Breeding And Everyone Wins

These genetic "road maps" help us



Gene maps have made it possible to totally eliminate some undesirable characteristics from animal herds or flocks, such as susceptibility to porcine stress syndrome.

Hype and hope for biotechnology are well mixed in the popular press. And while controversies over hormones in food and cross-species hybrids capture public imagination and indignation, real progress is being made on less publicized work on tools to simply eliminate the haphazardness of traditional breeding.

The plants and animals we consume are largely the products of laborious breeding by our ancestors. Increased yields, enhanced quality, improved docility . . . all came through centuries of painstaking, traditional breeding for observable characteristics, called phenotypes. You wanted bigger seed heads? Saved the seed of only the biggest headed plants for next year's crop. To get more milk from cows, keep only the best milk producers for breeding.

But breeding for observable characteristics is always a long term project. Improvements from year to year often can barely be measured. And sometimes undesirable traits get mixed and reinforced with good ones, and you have to start over from near the beginning.

Now, with new tools of biotechnology, breeding based on phenotypes is being replaced with precision selection for traits, based on the genetic building blocks of life. This technology is being developed at the FABCenter, the University of Minnesota's Food Animal Biotechnology Center.

The new tools of molecular biology help animal and plant breeders minimize the interactions among visible characteristics, and precisely select traits to improve through otherwise traditional breeding. There have already been significant successes, such as a test for porcine stress syndrome.

FABCenter is a point of first contact with food animal producers throughout Minnesota and across the United States, who are trying to link the laboratory bench with the barn, to get new knowledge out to the animal breeders.

Gene mapping is the foundation of how it's done, and FABCenter is a global leader in the development of genetic maps and biotechnology for food animals, particularly for swine and poultry.

narrow in on the parts of an animal's genetic makeup associated with a particular characteristic. It can help us more quickly breed a characteristic into or out of a herd or flock of animals. It can help us enhance positive characteristics, such as quicker growth, or eliminate undesirable characteristics such as susceptibility to disease.

FABCenter research uses an arsenal of biotechnology tools to identify sections of genes associated with characteristics producers want to reinforce or eliminate. A second group of tools lets them test animals for a gene's presence or absence. The result is precision breeding that can, for instance, totally eliminate porcine stress syndrome from breeding herds of pigs.

The biotechnology behind the success of modern genetically based animal breeding is the subject of a new experiment station publication. *Mapping the Pig Genome: A practical Primer*, uses the FABCenter's research on pigs to explain, in quite plain language, how and why all this is done. Use the form on the back page to order a copy.

—Larry Etkin

Restriction enzymes sliced up gene strands at specific places where recognized patterns occurred. Polymerase chain reactions multiplied DNA fragments to make analysis easier. Electrophoresis sorted the gene fragments into visual patterns that could be compared to locate appropriate markers for the section of the genes of economic interest.

Pre-genetic tests for PSS could only identify animals with the actual syndrome, not one harboring the mutation on a single gene. Now, the FABCenter has a blood test that can find single gene carriers, and has tested thousands of blood samples from around the country for the National Pork Producers Association.

"Economic pressures on breeding stock suppliers to have their animals tested is growing," says Jim Mickelson, one of the test's developers. Some producers, like Minnesota-based Dean Compart, have tested their entire herds and completely eliminated PSS carriers. "The benefits," he says, "far outweigh the cost of the tests."

—Larry Etkin

### **Fish** *continued from front cover*

research assistant, is deciphering drum otoliths from the Little Rapids archeological site, south of the Twin Cities on the Minnesota River. The temporal signature she is preparing will vary from Red Lake's because of the difference in climate, recorded at Fort Snelling since the early 1830s. "Knowing the occupancy dates at the Little Rapids site, together with the climate records, will help us test our methods," she says. She already has a "floating chronology" that indicates year by year changes, but is still working on "fixing" the starting date.

Otoliths don't just survive centuries by accident, and their survival can even complicate the dating process. "They were sometimes used for trade and as jewelry,"

Bergquist says. Ones that were traded may have come from other locations, perhaps even a different river, throwing a "red herring" in the path of researchers.

The lowly sheephead is an ideal species for this project, says Spangler. "It has a very wide range, from Guatemala to Hudson's Bay — 4,000 miles — and the entire Mississippi River basin, almost 2,000 miles east to west." This means it's widely available for researchers elsewhere to build on this dating process begun in Northern Minnesota.

The Red Lakes Band of Chippewa helped fund this Agricultural Experiment Station research, and provided access to their fisheries and collections.

—Dave Hansen

## IN PRINT

### Cultivar Trials: 1995

The newest edition of the annual *Cultivar Trials of Bedding Plants* is now available. It compares the performance of more than 600 bedding plant cultivars, crossing 70 varieties of plants.

Though each edition of *Cultivar Trials* overlaps previous year's performance trials, they each also include many different varieties and cultivars. Each year's performance data are also specific to the types of weather experienced in each publication's respective growing season.

*Cultivar Trials of Bedding Plants: 1995 Edition* can be ordered from the Distribution Center. See "ordering publications" on the back page.



*Internet based 'ForNet' gives forest managers and forest use planners coordinated access to valuable data and images. The technology enables the convenient assembly of maps, satellite images, photos, climate and ground data, and should help land managers in many areas.*

## Internet Puts Forests Of Info At Fingertips

Forest managers are used to spending weeks or months gathering data. They take measurements in the field, search files for aerial photos, and round up satellite images in order to evaluate a site. But there will soon be a one-stop shopping source for natural resource data.

Too good to be true? It's a dream very close to reality, thanks to a project led by forestry researcher Tom Burk.

The project, ForNet, is creating a system using the Internet to merge information from many sources into a comprehensive, data-rich picture of an area. Burk has used computers as a research tool for decades. Now, a push from the National Aeronautics and Space Administration, seeking to increase the use of satellite imagery, has helped him create ForNet.

"DNR forestry people currently use information in the form of maps, photos, satellite imagery, ground data, and so on. However, keeping all that information up to date and of high quality is a daunting task," Burk says. "Our objective is to get a system where the right people are doing the right things to the right data so that up-to-date, high quality data and images will be available for decision making."

ForNet is currently being piloted at Minnesota Department of Natural Resources field stations around the state. Its development is a cooperative project with the DNR.

DNR foresters will use ForNet to advise, for example, a private landowner looking at potential uses for 80 acres of hard-to-access land. The forester will be

son, ForNet-based recommendations will be made on commercial timber potential, water quality concerns, wetlands, wildlife habitat, etc.

"ForNet is going to be quite useful to us in providing access to satellite-based information about the land," says DNR forest health specialist Tom Eiber. He says the tool should also help resource managers track land-use changes, obtain current weather data and better communicate with the public.

Burk says the DNR use may only be the tip of the iceberg in applying ForNet to natural resource issues. "We are initially focusing on DNR-Forestry, but the applicability of the ideas and technology go way beyond that," he says. "Since the system is accessible through the Internet,

### New Legumes May Reduce Soil Erosion And Energy Costs

New crops developed from native perennial legumes could reduce herbicide use, soil erosion and energy costs. But University of Minnesota researchers say it may take 20 years to develop them into productive plants.

"Our project is long-term and focuses on developing sustainable cropping systems for the future," says Nancy Ehlke, an experiment station plant breeder. "These systems must be profitable and environmentally friendly."

She and co-workers David Somers and Donald Wyse are working on new perennial legume crops that could be used for grain, forage and biomass production. They could also be used as cover crops to prevent soil erosion, suppress weeds and add nitrogen to the soil for corn and other crops that don't "fix," or manufacture, their own.



The development team wants ForNet to make a huge difference in a person's ability to quickly and accurately assess terrain characteristics. Its uses may range from predicting fire danger to planning regeneration of forests.

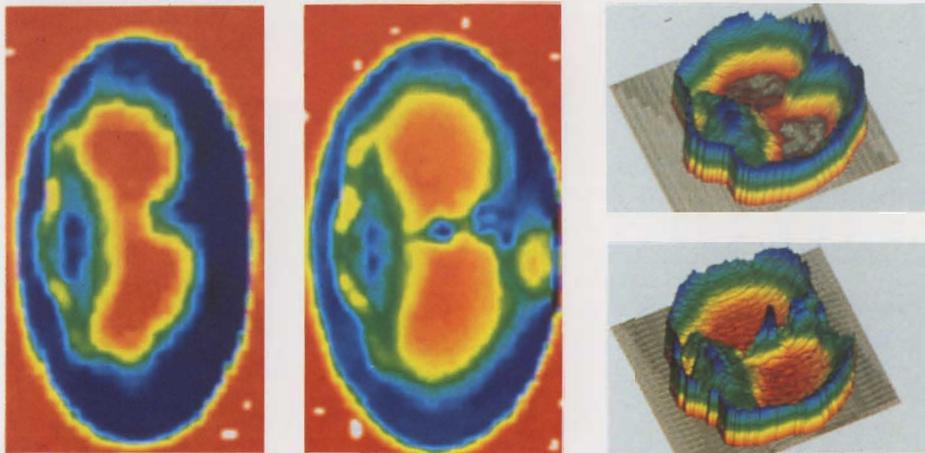
able to retrieve information on that property's trees, soil types, trails and topography. Some of the Internet images may even be more current than when the owner last set foot on the property.

Quickly, at low cost, and in any sea-

we fully expect that it will help land management agencies of all kinds be more responsive to their publics, a very important point as the public wants more, and agencies have fewer resources."

—Mary Hoff and Dave Hansen

## Medical Technology Aids Ice Cream And Other Foods



Moisture absorption in a steeping barley kernel is made visible, in blue, using the FLASH technique of magnetic resonance imaging. "It is almost the only way to monitor food processing in a nondestructive manner," says Roger Ruan.

Technology developed for brain and CAT scans is being adapted to improve the taste and texture of ice cream, and the efficiency of many food processing systems. University researchers have developed magnetic resonance imaging (MRI) techniques to monitor the interior of low-moisture foods. Their goal is to improve food quality, safety and shelf life.

For ice cream — a particularly delicate product — researchers put fresh pints into their unique, insulated, carbon dioxide cooled probe and use MRI to record particle structure without affecting the product in any way. They repeat the readings one and three weeks later to analyze the effects of typical freeze-thaw cycles that distribution, storage and home use present.

Roger Ruan, leader of the team of biosystems and agricultural engineers and

food scientists, says MRI provides many clues of value to food processors. "This sees everything, even the chemical composition. Changes of moisture distribution and structure inside frozen foods have a strong impact on product quality." Without MRI, a product is cut apart, physically examined, and made unusable for later study.

They also use the equipment to improve fundamental food processing methods that have existed largely unchanged "for over 100 years," Ruan says. Speeding up wet-milling of corn, for instance, would have major economic impact.

Products such as corn syrup and ethanol are produced by steeping corn for up to 40 hours at 50 degrees Celsius (120 degrees Fahrenheit). This is how long it takes the kernels to absorb moisture and

soften for processing. "It costs a lot of energy and money," Ruan notes.

Researchers steep corn samples with in their MRI probe and monitor the movement of moisture into individual kernels to see exactly where and when liquid is absorbed, and to test adjustments to several variables. "To improve the process, it's important to obtain fundamental information, such as how steepwater moves through the kernel," Ruan says.

Ruan's pioneering technique uses "short interpulse delay times with the gradient refocused echo technique." They call it "FLASH," for "fast low-angle shot." The hardware to FLASH food will eventually be available commercially. Now it exists only at the University of Minnesota and two other institutions.

"MRI has been largely restricted to the medical industry," Ruan says. A major reason is that MRI works most easily with high-moisture subjects, such as fluid filled bodies.

Another obstacle Ruan had to overcome was that MRI equipment is made to study objects at room temperature, hardly ideal for products such as ice cream.

Ruan says many benefits are on the way for consumers as a result of MRI technology, in products ranging from cheese to cake to frozen foods. "We can solve a lot of mysteries and problems. It will allow us to carry out on-line product monitoring to assure safe, high quality foods. This is very, very new technology and is just beginning its use in food and agriculture."

—Dave Hansen

Agronomist Nancy Ehlke is working on a new crop, perennial legumes. Several native to North America show promise, but years of breeding remain before commercial varieties will be available.

They are working with seven native legumes. One of the most promising for grain production is pale pea, which goes under the Latin name of *lathyrus orchroleucus*. But Ehlke says toxic amino acids need to be removed and seed shattering reduced to domesticate the plant. The other six species are being looked at for their potential to fix nitrogen.

Ehlke says there are many advantages to a perennial legume crop, in comparison to crops such as corn, soybeans and wheat that require annual planting and seedbed preparation, which use energy and leave soil bare and susceptible to erosion.

"There's a lot of interest in developing cropping systems that rely less on pesticides, reduce soil erosion and help the economies of rural communities," Ehlke says. Perennial legumes would be helpful in obtaining these goals.

—Jack Sperbeck

### The Perennial Advantage

- Used in rotations with annual crops, perennial legumes provide alternatives and flexibility to cropping systems and weed control strategies.
- Year-round perennial soil cover reduces soil erosion.
- Legumes fix nitrogen for themselves and leave nitrogen in the soil for future crops, reducing the need for fertilizer nitrogen.
- Perennial plants that produce a useful product (forage, biomass or grain) could be established on marginal lands or adjacent to surface waters to minimize soil erosion and surface runoff.

## Ornamental Grasses Grow in Cold Climates

Ornamental grasses aren't much thought of by people. When they are, it's often only as tall, showy, fuzzy-headed specimens in specially designed landscape gardens.

Only in recent years have ornamental grasses begun to become more generally popular in the United States, according to university horticulturist Mary Meyer. Over a 6-year winter hardiness study, she found 85 types, ranging from 6 inches to 10 feet in height, that can be grown successfully in Minnesota. They present many colors and textures as well.

Meyer started her study in July 1987 with four plants of each of 165 varieties. Her evaluations looked at insect or disease problems, nutrient and maintenance requirements, visual appeal (textures, colors, movement with the wind), and speed of growth.

About half the varieties survived even the worst winter conditions Minnesota



*Ornamental grasses do not need to be a landscape curiosity in Minnesota. Many varieties well adapted to our climate are detailed in Ornamental Grasses for Cold Climates. Grasses are also featured in the Minnesota Gardening 1996 Calendar, a publication which includes timely tips for lawn, garden and house plant care, along with lists of helpful gardening publications, programs and services available through the University of Minnesota.*

could throw at them: the minimal snow cover, low air temperatures, and very low soil temperatures of the winter of 1989-90.

The results of her evaluation are published in *Ornamental Grasses For Cold Climates*. Color photos and line drawings illustrate many of the varieties that can be grown in this region. There are also sections that describe erosion control, landscaping tips, sources of plants, grasses for wet areas, and maintenance of plantings.

Meyer notes that most grasses are fairly low maintenance, and require little water or fertilizer. They do, however, come with one essential chore. You must cut ornamental grasses back to the ground each spring, before new growth starts.

## Ordering Publications

Minnesota Agricultural Experiment Station publications may be purchased at most county offices of the Minnesota Extension Service or from the MES Distribution Center, 20 Coffey Hall, St. Paul Campus, University of Minnesota.

To place a credit card order for any of the following publications, or for alternative ordering information, phone (800) 876-8636 (in the Twin Cities, call 624-4900) 8 a.m.-4:30 p.m. CST, Monday-Friday. Order by title and item number. Prices, good until June 1, 1996, do not include 7% sales tax or shipping.

- *Cultivar Trials of Bedding Plants: 1995 Edition*. 40 pages. \$4.00. Item MR-6484-MS. Also available are the 1994 Edition (\$4.00, item MR-6432-MS), the 1993 Edition (\$2.75, item MR-5864-MS), and the 1992 Edition (\$2.75, item MR-5641-MS).

- *Mapping the Pig Genome: A Practical Primer*. 27 pages. \$2.75. Item MR-6522-MS.

- *Minnesota Gardening 1996 Calendar*. Spiralbound. 30 pages with color photos. \$7.00 (\$6.30 if you buy 5 or more). Item MI-5741-MS.

- *Ornamental Grasses for Cold Climates*. 28 pages with color photos. \$6.00. Item BU-6411-MS.

- *Regulation of Private Forestry Practices by State Governments*. 225 pages. \$15.00. Item SB-6585-MS.

- *Roses for the North: Performance of Shrub and Old Garden Roses at the Minnesota Landscape Arboretum*. 96 pages with color photos. \$11.95. Item MR-6594-MS.

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