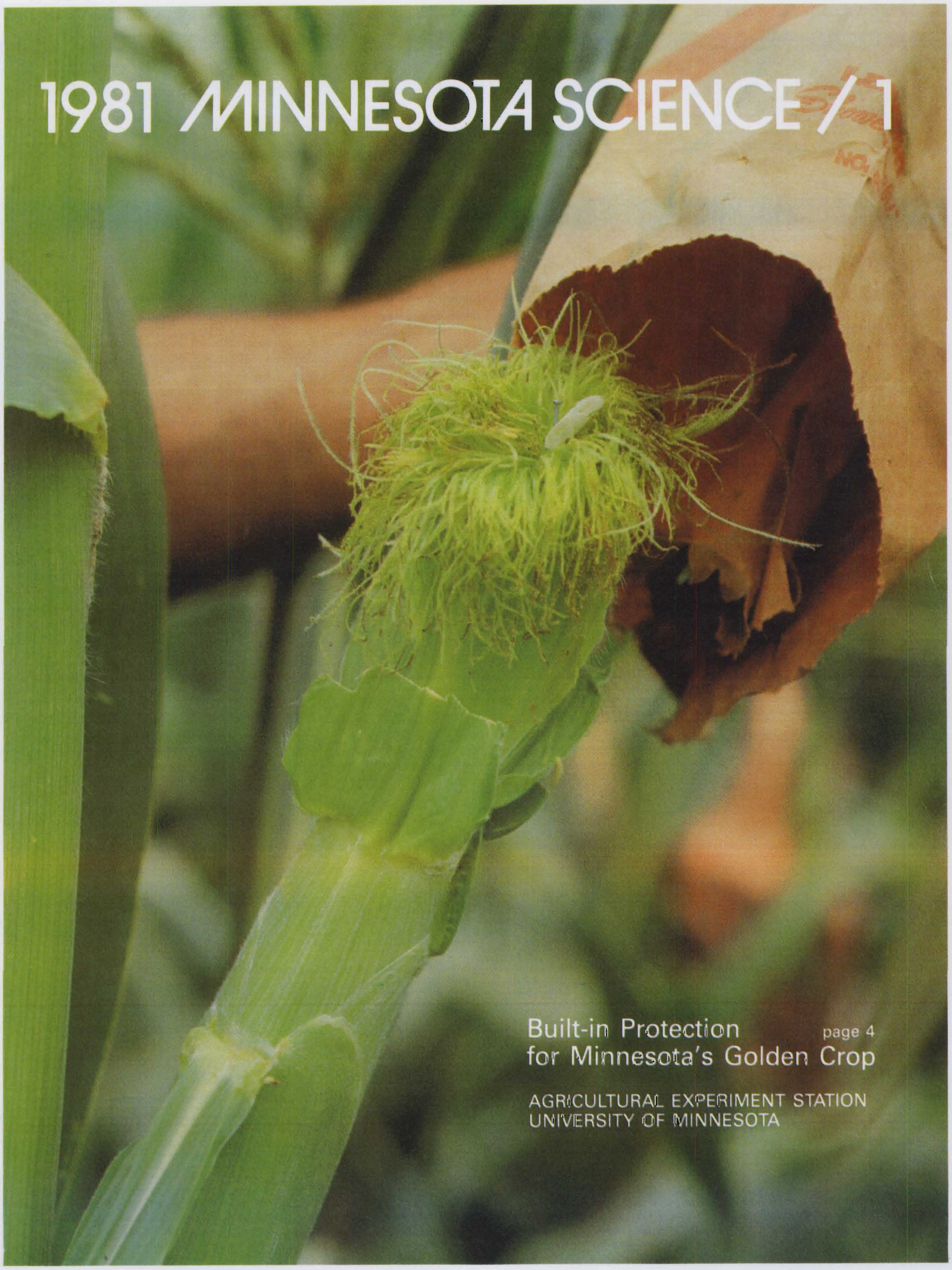
1981 MINNESOTA SCIENCE / 1



Built-in Protection for Minnesota's Golden Crop page 4

AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA

MINNESOTA SCIENCE

Volume 36 ○ Winter 1981 ○ Number 1

CONTENTS

On the cover: The paper disc pinned to the end of this sweet corn ear once held a European corn borer egg mass. The eggs have hatched, and the larvae have migrated into the husk, where they are feeding on the silks, immature kernels, and cob. By observing the extent of borer damage to the ear, Experiment Station scientists will be able to measure the plant's genetic resistance to this destructive pest. See story, page 4.

Minnesota Science is published quarterly by the University of Minnesota Agricultural Experiment Station; Institute of Agriculture, Forestry, and Home Economics; St. Paul, Minnesota.

Editor: Sam Brungardt

Designer: Dianne Swanson

Photo credits: Pages 1, 3, 4, 5, 6, 7, 12: Dave Hansen; page 8: Richard Yahner; page 9: Dave Hansen, Harold Scholten, Richard Yahner, U.S. Fish & Wildlife Service; pages 10, 11: Don Breneman; page 14: Gillette Children's Hospital/McCarthy Associates.

Address all correspondence and requests to Editor, *Minnesota Science*, 433 Coffey Hall, University of Minnesota, St. Paul, MN 55108.

Director Sees Need for More Flexibility

LOOKING AHEAD, Richard J. Sauer, Minnesota Experiment Station director, sees increased challenges: "In the '80s, the Station has to be kept lean and muscular, capable of taking strain, but capable also of moving fast and availing itself of opportunity."

Being able to take advantage of opportunity frequently depends on having the dollars to move around. And being director of a large research institution in these days of tight money often means wrestling with a lack of dollars; figuring out how to get more of them; inventing, without much maneuvering room, ways to be more creative with the dollars one has. The key word, Sauer says, is "flexibility."

"As I conducted listening conferences around the state with Norm Brown (Minnesota Extension director) last spring, one of the signals we kept getting from citizens was that we are too slow to respond; we are too conservative. Anytime we want to do something new, we have to ask the state legislature for new dollars. We do a substantial amount of internal reallocation that I don't think the general public is aware of. At the same time, we do not have a good mechanism for moving our resources around more, and there are many times that we need to take initiative on an emerging new area without waiting for the next legislative request."

> ". . . there are many times that we need to take initiative on an emerging new area without waiting for the next legislative request."

An example Sauer offers is the emergence of the energy issue. One aspect of this complex research challenge is the gasohol issue. "If we'd had sufficient reserve, we would have been able to get into that area without any delay, without having to wait for the new legislative appropriation. What happened was that the legislature appropriated $200,000 and told us to build a gasohol plant at our West Central Experiment Station at Morris. I would have preferred that we'd been able to take an initiative quickly ourselves. Instead, public pressure on the legislature put pressure on us. That is an uncomfortable situation in the long run, if we have the legislature beginning to tell us what to do."

Sauer is quick to point out that most Station funds come from the state, free to be allocated as the Station sees fit. But, he says, "We need to protect this freedom. At the same time, we need to create more flexibility to redirect those dollars and take new initiatives with them."

Sixty-two percent of Station funding comes from the state; 12 percent is appropriations from Congress; 18 percent is gifts and grants, and 8 percent is income from the sale of products.

To increase Station flexibility, Sauer suggests a rigorous annual budget review. "I want to sit down every year with each department head and review the dollars each has and how they are allocated. With the cost of doing research going up faster than the Station budget, every one of our activities needs to be put on trial every few years with the question, 'If we weren't in this already, would we go into it today knowing what we now know?' "

Sauer sees the need for a significant budget reserve—funds for which Station scientists could compete. This reserve would allow the Station to respond to opportunities, such as the energy issue, and also move on other Station priorities, such as interdisciplinary research. For, as Sauer points out, "The kinds of problems we're facing now are much more complex than the ones we faced 20 years ago, when it was much easier for a single scientist to take on a problem and solve it. Now the problems are so complex they can be solved only by the combined effort of scientists from several different disciplines."

One good example is Station research on crop pest management. Horticulturists, entomologists, agronomists, and plant pathologists are working on aspects of this problem. "But farmers are concerned about protecting their crops and getting them at the end of the season," Sauer says. "In some cases, they may be doing something to control insects which enhances weeds. It is obviously most fruitful for the researcher, and the farmer, if there is cooperative research among the scientists. We can't expect the farmers to do all of the integration."

A reserve fund would also help the Station maximize the productivity of its most valuable resource—its researchers. Sauer suggests two ways this fund could be used.

"Firstly, I think we need dollars to help new faculty their first two or three years. I don't think our scientists can reach their full research potential with just the appropriated dollars we're able to give them. I think we can provide the faculty member with a base level of support with the hope that he or she can garner additional funds with grants and so on. But when a new faculty member tries to get a grant, the response of the granting agency is often, 'You don't have any preliminary data to show us that we ought to fund this.' We should give our new faculty extra support to enable them to generate that preliminary data base. Then they will be in a better position to compete for extra funding."

> A reserve fund would help the Station maximize the productivity of its most valuable resource—its researchers.

The reserve fund could also help redirect the research of established faculty. "I visited with a faculty member a while back whom many would regard as one of our outstanding researchers," Sauer says. "He's well funded with outside grants and several graduate students, has been very successful and is recognized nationally, yet he's frustrated. He would very much like to make a significant change in the direction of his research. But his granting agency is not interested. It likes what he's doing now and would rather he continue. In addition, he hasn't demonstrated that he can really do anything in this new area that might pay off. I'm sure there've been times in the past when faculty members felt that frustration, and since they haven't been able to make a move, they continue on and after 20 years or so, really become less productive and creative. We need money to help established faculty who feel the need for redirection."

This reserve or "opportunities budget" would strengthen the Station's ability to meet its own research priorities. One of these is maintaining a good balance

between basic and applied research, between short-range and long-range projects.

Sauer says, "If we ask commodities groups and special interest groups what we should be doing, and base our decisions

(Continued on page 15.)

> "We must resist the temptation to take the short-range look at the expense of the future."

Keeping the Glitter on Minnesota's Golden Crop

To make a controlled cross, horticulturisth David W. Davis bags the tassels of a sweet corn breeding line, thereby ensuring cross-pollination.

IT MAY BE MINNESOTA'S ONLY gold. From the time sweet corn matures in the rolling hills of southern Minnesota until it's canned or frozen and shipped nationwide, it serves as a golden good will ambassador for the state's agriculture.

Indeed, Minnesota vies with Wisconsin for honors as the top sweet corn producing state. More than 100,000 acres of prime Minnesota land are devoted each year to satisfying the sweet corn taste of the country.

But sweet corn is far from a fail-safe crop. It is prey to a number of disease and insect pests. In addition, the requirements of highly mechanized processing plants put a premium on uniform, pest-free ears from fields that mature precisely on a staggered schedule, keeping machines and personnel busy for many weeks in late summer

Several University of Minnesota researchers, financed in part by the Experiment Station, are tackling the pest problems inher-

ent in sweet corn production through a team effort. Their solution to producers' and packers' woes lies in developing improved strains that yield bountifully and can resist common diseases and pests without sacrificing flavor and tenderness.

Breeding so many desirable characteristics into sweet corn is a large order that over the years has proved to be a complex goal, according to horticulturist David W. Davis, leader of the sweet corn breeding work. "Through basic breeding research, we want to improve yield and quality," he says. "We try to put together some of the best characteristics of exotic South and Central American maize as well as hardy, disease-resistant field corn and the best of existing sweet corn types."

Davis explains that the research strives to provide new parent stocks: "They may be either inbreds or populations of unique gene combinations. These are released to the seed industry, where new hybrid varieties that Minnesota farmers grow are developed. We are interested in learning how to combine desirable characteristics, such as pest resistance and quality, more efficiently."

The work is slow and painstaking. Davis estimates that, even if everything goes well, it may take 5 to 10 years or more to develop, test, and evaluate a new inbred. "Before an inbred is useful commercially to make a new hybrid, it must test true and be reliable and stable," Davis adds. "Plus, it must be better than those preceding it."

The scientists are making progress. European corn borer, the most important sweet corn insect pest in the state, sometimes leaves a field completely useless to processors because of worm-riddled ears. Unlike field corn, all sweet corn varieties are susceptible to borer infestations.

New Population Has Corn Borer Resistance

Davis has focused much of his effort on breeding corn borer resistance into sweet corn. Using egg masses provided by the laboratory of entomologist H. C. Chiang, Davis and his assistants infest ears with borer eggs. By evaluating the destruction when the ears mature, they can rate borer resistance. Through dozens of systematic crosses, they have developed a sweet corn with high resistance to the early or leaf-feeding (first brood) stage of corn borer.

The resistant type, known as AS9, is a preliminary but significant step toward controlling corn borer devastation. By controlling the borers' numbers early in the season, fewer pests will infest the ears later in the summer, according to Davis. Other types, with some resistance to the ear-feeding (second brood) stage, are well along in development. With genetic resistance, farmers may some day be able to reduce the number of pesticide applications needed for a healthy stand of corn. Currently, most sweet corn producers spray for borers two to six times during the season at a cost of more than $8 per acre per application.

"And, perhaps even more important, cutting pesticide use is desirable environmentally as a way of reducing the kill of beneficial insects," Davis says. "In addition, there is a considerable energy savings from limited spraying, and this is becoming increasingly important."

Corn borer research has been going on for many years, but 1977 brought a new sense of urgency to two other sweet corn problems. Conditions in Minnesota that summer were right for a double-barreled epidemic; corn rust and maize dwarf mosaic virus (MDMV) cost the state's sweet corn producers some 75,000 tons in yield with a price tag of $3.5 million.

Maize dwarf mosaic virus (MDMV) lowers sweet corn yields and quality. Infected plants are stunted and their leaves have a mottled appearance.

To know when spores are released, James Groth monitors corn rust pustules daily, a necessary procedure if the fungus is to be controlled in yield plots by spraying.

Plant pathologists James V. Groth and Richard J. Zeyen stepped up their efforts to understand and control these diseases. Groth explains that rust is one of the most common corn diseases, but moderate resistance in field corn generally protects that crop from significant losses. Not so for sweet corn. Wet weather and persistent heavy dew encourages the fungus' spores to germinate and infect the plants. In tests on artificially inoculated plots, some hybrids such as Stylepak lost nearly half their yield when infested with rust while others with some resistance—Sugarloaf, for example—lost only about 18 percent.

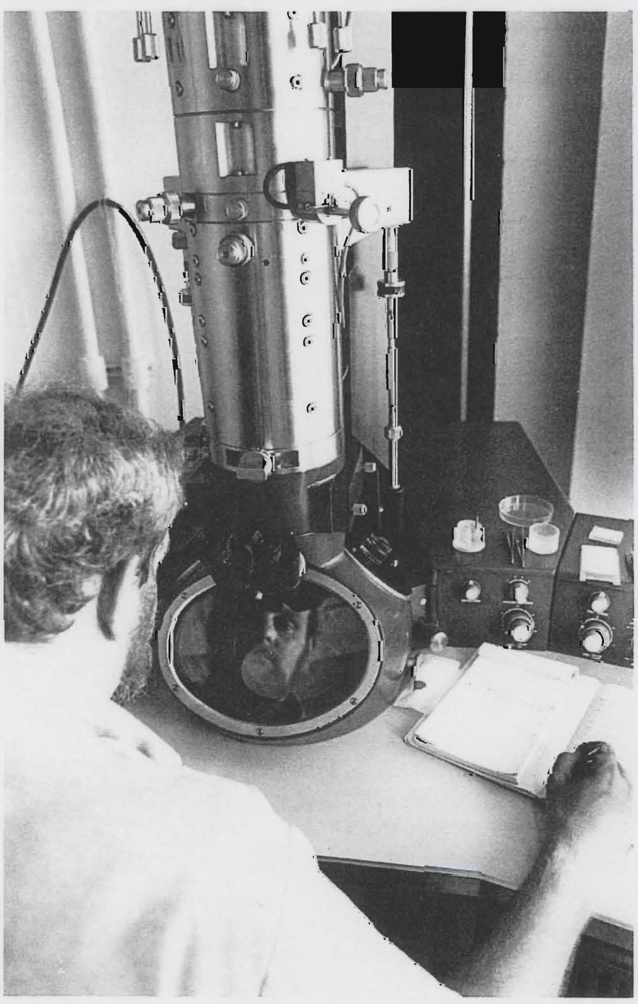
Alternative to Spraying Is Needed for Rust Control

Although rust can be controlled with weekly sprays of Dithane M-45, the plants are then useless as forage. A better, cheaper solution, according to Groth, is to breed in a single dominant resistance gene, Rp^{1}_{d} which has been isolated from tropical corn. He views this solution cautiously, however.

"We think that careful use of the gene could preserve its effectiveness indefinitely," Groth says. "In strategically placed corn plants containing Rp^{1}_{d} over the last two years, we have seen that the present rust population contains no detectable races that can attack the gene. The discovery of this gene is certainly a useful tool to combat the disease, but we need to know more and to incorporate rust resistance into hybrids that are also desirable in other important criteria."

After the devastation of 1977, one such criterion ideally would be resistance to MDMV as well, but that may be five or more years in the future, Zeyen says. MDMV causes stunting, yellowing, and mottling of corn plants, with resulting lowered yields and quality.

Recent research has shown that MDMV probably comes into the state from the southern Great Plains. It is transported by large migrations of aphids borne



With a transmission electron microscope, Richard Zeyen searches for MDMV particles in sap from corn plants suspected of being infected with the virus.

aloft by low-level winds out of Texas, Oklahoma, Kansas, and Nebraska, according to Zeyen. When these warm, moist winds meet northern cold fronts over Minnesota, the resulting rains bring the tiny insects to the state's sweet corn fields.

Unlike rust, there is no chemical that will stop MDMV infection, and this makes it particularly difficult to combat in an epidemic year. Zeyen explains, "Because aphids can transmit the virus immediately upon alighting on plants—like flying hypodermic syringes—conventional insecticides are of little use. They take from 5 to 20 minutes to kill aphids, during which time the aphids may probe the corn many times, injecting the virus each time."

Currently there are no truly MDMV-resistant sweet corn cultivars adapted to Minnesota and many field corn cultivars are also susceptible, although they escape damage because they are planted earlier. Progress in the breeding program is slow because immunity to the virus involves several genes that come from field corn. Undesirable field corn qualities then have to be bred out of the resulting crosses to arrive back at a high-quality sweet corn.

Despite this, Zeyen is optimistic that MDMV-resistant sweet corn will be available to Minnesota producers within a few more years. University researchers are working closely with sweet corn producers and private breeders to find out more about managing MDMV and resistance breeding. Until their efforts produce a resistant sweet corn, Zeyen advises producers to plant as early as possible because the disease usually doesn't appear until after July 1. Corn that is past anthesis (80 percent silking) when infected suffers less damage than younger plants, Zeyen says.

Scientists Must Keep Consumers in Mind

But sweet corn research must go beyond breeding programs and the control of diseases and other pests because, as food scientist William Breene says, "if the consumer doesn't like it, even the most disease-resistant corn will be out the window. Any successful sweet corn has to offer maximum return to the grower as well as optimum consumer satisfaction."

Breene helps the plant scientists keep that consumer perspective in mind. He tests for sugar content, tenderness, color, and weight of kernels cut from the cobs.

Working with a horticulture graduate student, Winarno, Breene has helped devise a speedy microwave test that can tell producers exactly when to harvest for peak flavor and tenderness.

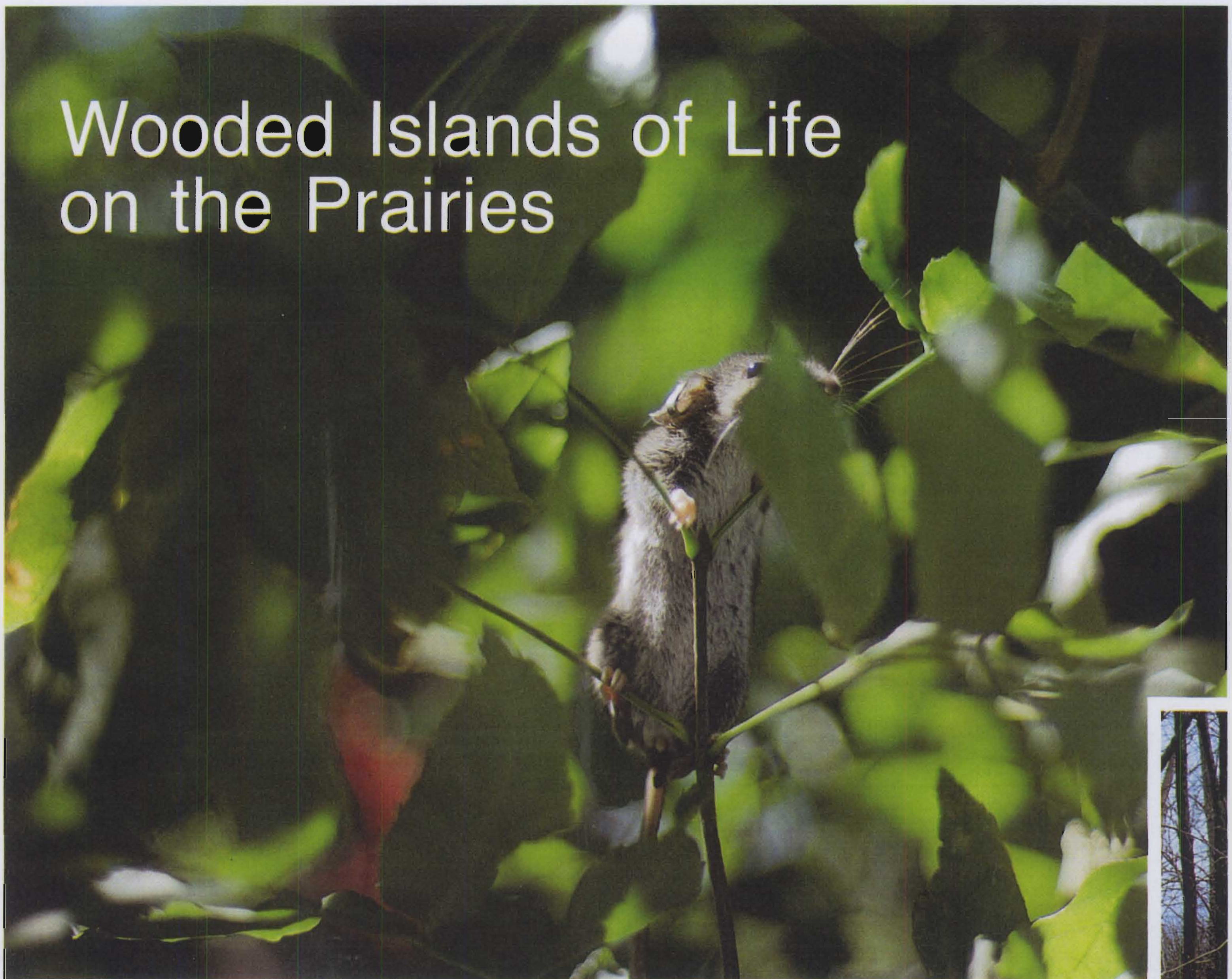
His work has also focused on the quality and cut weight yields of corn infected with rust or MDMV. Until the breeding research provides disease-resistant strains, Breene's work offers producers some guidelines on uses for the salvageable corn from infected fields.

Davis and the other researchers acknowledge that some of their efforts merely buy time and help cope with diseases and pests until a permanent solution emerges. Davis concludes, "The best strategy certainly is to breed in disease and insect resistance as needed. Research to do that is slow, exacting, and costly, but in the long run, it is the cheapest and most effective method of improving the state's sweet corn and benefitting the producers, processors, and consumers who depend on it."

—Diedre Nagy

Just-picked sweet corn is pushed onto a conveyor at a Minnesota plant. It must be processed with minimal delay if high quality is to be maintained.

Wooded Islands of Life on the Prairies



By eartagging and retrapping small mammals such as this white-footed mouse, Richard Yahner has been able to keep track of individual animals in shelterbelts and determine whether they are part of a successful breeding population.

"FARM FAMILIES SPEND WEEK after week looking at silent, barren landscapes during Minnesota winters. The birds and other wildlife in their shelterbelts become significant symbols of relief. That's just one reason it's important to properly manage wildlife populations in rural areas," says Richard Yahner, wildlife scientist studying avian and mammalian populations in shelterbelts.

"I agree with what Rich is saying, and we both recognize that wildlife management has to be done within the economic constraints of farmers. A farmer can't just turn productive land over to wildlife. It's got to be done within the context of modern agriculture," says Harold "Scotty" Scholten, who does forest research and extension work with shelterbelts and field windbreaks throughout Minnesota.

"Basically, we're talking about a whole new environment on today's farms," Yahner says. "Wildlife habitats have been fragmented in recent years with intensive agriculture, and windbreaks and shelterbelts have become wooded islands surrounded by extensive fields of crops, pastures, and natural prairies. These islands provide

(Continued on page 10.)

A row o
spacing
lems lat

Right: W
and find

Left: Scotty Scholten displays container-grown spruce seedlings that have wintered under wood shavings. These seedlings survive and grow better in shelterbelts than do older transplants.

Below: A gentle but firm grip is needed as Richard Yahner tags small mammals he's livetrapped in a shelterbelt.

; was cut from this shelterbelt to relieve crowding. Close early protection from snow and wind, but results in prob-

;rown, these ring-necked pheasant chicks will likely roost e from winter storms in shelterbelts.

food and shelter for many bird and mammal species. My research is attempting to gather base-line information on the ecology and management of wildlife communities associated with these manmade woodlands."

"It's true about the new environment," Scholten says. "Most of the windbreaks and some of the shelterbelts were first planted immediately after the Dust Bowl of 1934 to prevent soil loss. Horses were still being used on many farms when those trees were planted."

Researchers now face the challenge of how to best manage these established windbreaks and shelterbelts with techniques like thinning, pruning, and replacement. They also need to design better windbreaks and shelterbelts.

Ideally, a properly planted and maintained shelterbelt can last 70 years or more. It can protect livestock and farm buildings from wind, dust, snow, and cold, reducing energy bills by as much as 30 percent. It can also provide adequate cover and food for a delicately balanced wildlife community. However, a poorly conceived and maintained shelterbelt can create many headaches for a landowner.

Search Is Under Way for Better Plant Materials

One need is to test and identify the best species and strains or varieties of trees and shrubs for use in shelterbelts and windbreaks. Currently, the Agricultural Experiment Station, the Soil Conservation Service (SCS), the Plant Material Center in Bismarck, North Dakota, the Agricultural Extension Service, and the College of Forestry are cooperating in this effort. Most of the research is being done on experiment station plots at Rosemount, Crookston, Morris, and Lamberton.

"We're doing this through known seed sources so that results can be identified and duplicated," says Scholten. "We're looking for good replacement trees, and we have one that shows a lot of promise—the Siberian larch. It's a deciduous conifer, like tamarack, which is hardy and disease resistant and grows well in alkaline soils. It seems to be developing as a good alternative for field windbreaks and for use in farmstead shelterbelts, where it functions as a hardwood during the dormant season."

The process of testing and recommending new varieties will take at least 10 years. At the same time, researchers are looking at more efficient methods of handling nursery stock. In the past, hardwood trees were often preferred because they grew faster and could be planted as year-old, bareroot seedlings. Conifers had to be transplants; hence, they were three to four years old before they could be field planted. Even then, it often took conifers a number of years to show substantial growth.

Now, research is finding another way. Conifers are being grown in containers in greenhouses on the St. Paul campus. Researchers plant seed in January; in August, they set the seedlings outside to harden off. The seedlings go through several light frosts in the fall, then they are covered with wood shavings to overwinter. In the spring, they are planted in the field.

"There's a good example of container planting near Willmar," says Scholten. "In a SCS belt of two rows of ponderosa pine, one row was transplants and the other row was container seedlings grown in 6-inch pots. After seven years, the transplants average 3 feet in height and have a lot of blanks or missing trees. The container-grown pines have had a survival rate of over 90 percent, and are 10 feet tall on the average."

In addition to his research, Scholten works with county agents, state foresters, and other agencies and groups in teaching and training activities. He likes the combination of research and extension work: "I'm happier in my work than I have ever been before, even though I've been working with shelterbelts for over 20 years. I see the needs in my teaching and work with extension groups and agencies like the SCS and DNR (Department of Natural Resources). That directly affects my research direction and my motivation. I like being able to follow things all the way through from scientific hypothesis to field recommendations."

One of the greatest needs he sees is for a better shelterbelt design. The standard eight-row shelterbelt has a row of dense

shrubs on the side of the prevailing winds, followed by a row of tall shrubs or medium-size trees; rows 3 and 4 are usually tall deciduous trees and rows 5 and 6, tall conifers; rows 7 and 8—closest to the farmstead—are usually shorter, denser conifers. "I don't know what the perfect design would be, I just know we haven't found it yet," Scholten says. "What's good in one situation is not always best in another."

Vegetative Strata Afford Cover, Food for Birds

For Yahner, one essential design characteristic would be for a shelterbelt to have a complex vegetative structure from the ground up where birds can feed and roost. It would have a herbaceous stratum, understory growth, and canopy overstory.

Tall deciduous trees, such as green ash and poplars, are important to warbling vireos, northern orioles, and other songbirds. Conifers, particularly spruce, are ideal nesting sites for robins and doves. Shrubs like honeysuckle and viburnum afford cover and food for pheasants, dark-eyed juncos, and gray catbirds, to name a few.

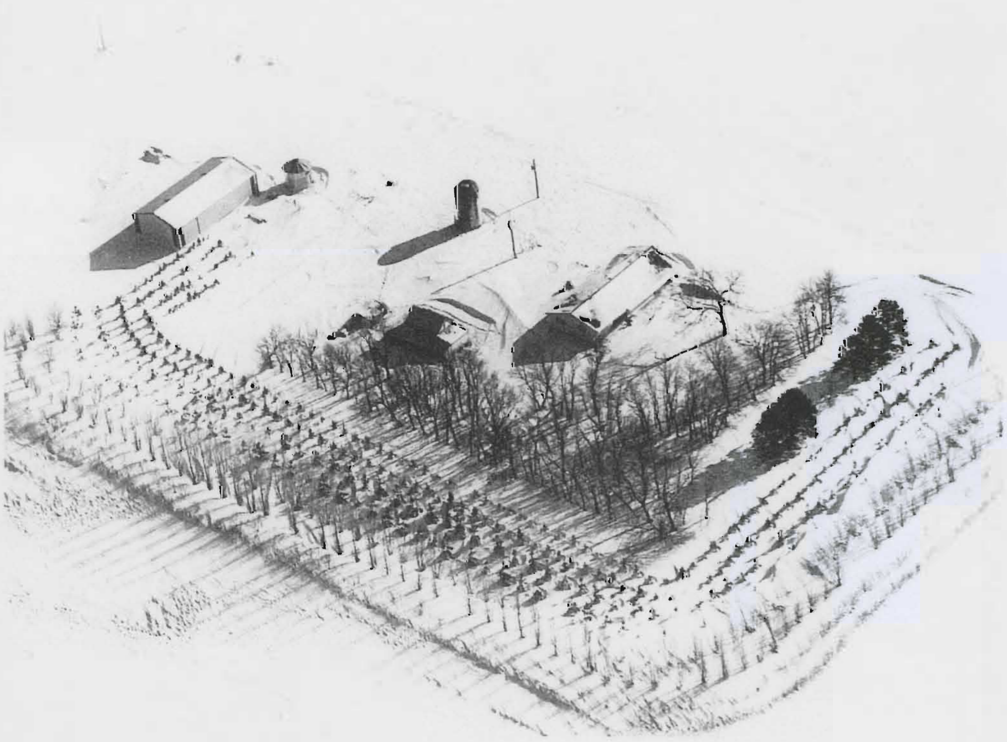
Spacing is the design factor that most concerns the two researchers. "Within rows of trees, there is always a tendency to plant too close," Scholten says. The sooner the lower branches of adjacent trees begin to touch, the earlier the farmer gets protection from wind and snow. However, it's not long before touching becomes crowding. Crowding causes the lower branches to die from shading, and this progresses up the tree over time. Scholten recommends that trees in a well-established shelterbelt be 16 to 20 feet apart and staggered from row to row so gaps fill in as the trees grow.

Yahner points to the need to space shrubs properly: "When rows of shrubs are planted too close, excessive drifting occurs. Eventually, snow covers the shrubs and packs in around the other trees in the belt, depriving wildlife of needed shelter."

In older shelterbelts, where crowding has occurred, it's often necessary to remove trees within rows or entire rows of trees to achieve the desired spacing. Scholten encourages farmers to remove dead and dying trees to make room for the survivors. However, Yahner hopes farmers will leave a few dead trees as foraging and nesting sites for insectivorous birds such as woodpeckers and chickadees.

Forest research has shown that if space is limited, it's better to reduce the number of rows than to crowd trees. "That concurs with what we're finding in the wildlife studies, too," Yahner says. "At Rosemount, I work with shelterbelts ranging from three to eight rows. It appears that the extent of the perimeter or outside boundary is a more important consideration than the width of the belt for attracting wildlife. If two shelterbelts are of equal area, a long, narrow one appears to be more beneficial to wildlife than a shorter, wider one."

A farmstead that has no protecting shelterbelt (left) is subjected to the full brunt of the elements. In contrast, a well-planned and maintained shelterbelt (below) can reduce on-farm heating bills by as much as 30 percent.



Scholten also advises farmers to leave plenty of space between the rows. "Allow an interval of at least 4 or 5 feet greater than the width of the cultivating equipment," he says. "Since shelterbelts require careful cultivation to get established, allowing space for equipment is essential and it's also good for the trees."

Animals can present problems in establishing shelterbelts. Livestock can defoliate and break off young trees unless kept fenced out. Rodents sometimes gnaw off the roots of conifers. Jack rabbits are troublesome in southwestern and western Minnesota, where they have been known to snip off young trees.

Shelterbelt Wildlife Populations Are Held in Delicate Balance

"But don't try to eradicate the small mammals in a shelterbelt," Yahner cautions. "It's easy to adversely affect the avian population too. The two are held in a delicate balance."

He explains that eliminating small mammals such as voles from a shelterbelt may remove a major food source for fox and weasel. These predators might then feed on birds and their young. One aspect of Yahner's research is to examine the nesting success of birds in relation to predator and small mammal density.

Yahner emphasizes that small mammals found in shelterbelts, such as white-footed mice, meadow voles, and shrews, are adapted to natural habitats and seldom venture into farm buildings and cause damage. The house mouse, on the other hand, seldom if ever occurs in shelterbelts. Its populations fluctuate with human activities. It inhabits farm buildings and consumes stored grain regardless of the presence of a shelterbelt.

Scholten agrees that farmers often fear attracting mice. "I see it when I recommend mulching young shelterbelt plantings with ground corncobs," he says. "Farmers are often hesitant to use them for fear of attracting mice. But I see no evidence that cobs around conifers attract mice if weeds and grass are controlled and the belt's properly cultivated."

Yahner and Scholten recommend cultivating between the rows of a shelterbelt until the trees and shrubs are well established. They say that family vegetable gardens and row crops such as sweet corn can be grown between the rows of trees, and suggest leaving some cornstalks and excess corn standing over winter for wildlife food and cover.

And although careful cultivation is a must in the beginning, Yahner hopes that farmers will not continue to mow beneficial wildlife cover once the planting is established. He also suggests that corn, sunflowers, or sorghum be grown adjacent to mature shelterbelts and that several rows be left unharvested. "It's one of the ways farmers can return some of the food and shelter that have been taken from wildlife," he says.

"In the short time I've been here, I've been quite pleased with the reception I've gotten from agencies and individuals to my suggestions," says Yahner, whose research post came about as a direct result of farmers' concern. During meetings with constituent groups around the state, University officials learned that farm families needed help in managing wooded areas. Their request was taken forward, funded by the legislature, and today Yahner's research is beginning to amass useful knowledge that can eventually be used in making sound management decisions that will benefit wildlife on Minnesota's farms.

—Gail McClure

A New Approach to Caring for Chronically Ill Children

As part of her treatment, Leah VandeBerg and her parents, Marlene and Ted, meet with Delores Kaese (far right), nurse in charge of the cerebral palsy clinic at Gillette Children's Hospital.

LEAH VANDEBERG IS A golden-haired five-year-old from Bloomington whose days are busy with school and play and the ordinary business of childhood. But her life is also structured by medical regimen, physical therapy, and regular trips to Gillette Children's Hospital in St. Paul. Leah has cerebral palsy, and she and her family are part of a study, co-sponsored by the Experiment Station and the Medical Education Research Association, that's developing a new approach to help care for chronically ill children.

Most research on childhood diseases focuses on the pathology of the diseases. This study, on the other hand, takes a family perspective. It focuses on the relationship between family stress and its effect on handicapped children, and seeks a way to use that information to improve the quality, cost, and efficiency of care.

The goal is to develop simple, reliable tests for families like the VandeBergs to use at home as a self-monitoring tool, and for the medical team to use in the clinic.

Research Was Begun on a Hunch

Family social scientist Hamilton McCubbin explains that the three-year project was begun with the "hunch" that unmanageable family stress adversely affects the health—already vulnerable—of a child with chronic illness.

The study required and received strong cooperation from the University of Minnesota Hospital's cystic fibrosis unit, under the direction of Dr. Warren Warwick, and Gillette Children's Hospital, with Dr. Thomas Comfort of the cerebral palsy unit and Dr. Roland Birkebak of the myelomeningocele unit. It initially involved 200 families of children with cystic fibrosis. Now it's being expanded to test 180 families with cerebral palsy children, and 100 myelomeningocele (also known as spina bifida) families. Cystic fibrosis, cerebral palsy, and spina bifida are all incurable children's diseases that require extensive home treatment.

This itself causes stress on the family. McCubbin has been investigating the family and its coping mechanisms under many different conditions; he was a member of the task force that advised the U.S. State Department on the proper treatment of the former American hostages in Iran and their families. The stresses families with chronically ill children face may be less dramatic, but the situation requires considerable resiliency and the ability to adjust to pressure. The family needs, in fact, strong "coping strategies."

Not all stress, McCubbin points out, is bad: "We all need stress, challenges. Stress can be very positive. But we are trying to figure out the critical level. Then we need to figure out what families actually do to protect themselves from too much stress, and when they exceed that level, how do they recover?

Goal Is to Find Why Families Succeed

"This is a major shift from traditional studies. Most studies of families of handicapped children emphasize why families fail. They talk about pathologies, hardship, divorce. Yet we know the majority of families succeed, and we want to turn our attention to why they succeed."

First it was necessary to prove the hypothesis, the hunch, that stresses in the family affect the health of the child. The cystic fibrosis families at the University hospital provided the group from which this information was gathered.

McCubbin and his associates developed tests to profile a family. One test determines the amount and kind of stresses and changes a family is experiencing; another measures the family's coping abilities; and a third measures its assets, for example, the family's decisionmaking skills and ability to manage tension.

They identified certain important coping strategies. Families that cope well have strong family integration; they maintain social support and self-esteem and they understand the medical situation they face.

With the tests, "we can now monitor how much stress a family is under and how well they are coping. We can tell which families are at risk," McCubbin says. Families are at risk when they have too many things hitting them at once, when they are not using the coping strategies, and when they don't have the necessary assets, such as economic resources or decisionmaking skills, he explains.

"These tests help develop a quantitative picture of the stresses impinging on a family at any stage of the life cycle. They provide the family's subjective assessment of the amount of strain these events produced. And they indicate the family's ability to anticipate change."

Child's Health Suffers When Family Can't Cope

The tests were matched with medical tests of the cystic fibrosis child's health as measured by changes in pulmonary functioning and height and weight. There was a correlation between the

Certified orthotist Gene Berglund fits Paul Brey of Milroy, Minnesota, with leg braces at Gillette Children's Hospital, a regional care center for Paul and other children who have spina bifida. Paul and his family are cooperating in a study that looks at the care of chronically ill children in relation to the whole family.

family tests and the information gathered on clinic visits. McCubbin says, "We now have data that show that when families don't do well, the children's health suffers."

Why? "Because they are wrapped up in their own problems. When tensions arise in the family, we notice a decrease in what we call compliance—adherence to medical regimen. Even above that, the child responds negatively to tension in the home.

"The home care needed by a chronically ill child is time consuming and demanding and frequently necessitates shared family responsibilities. Under stress, the family routine is out of balance and home therapy procedures must be compromised."

Establishing this link is important for health care quality and cost. The University hospital is the only cystic fibrosis center for a five-state area. Gillette Children's Hospital is a regional center for cerebral palsy and spina bifida. So, a high proportion of the families in the study are from rural areas and must travel far for the care. There is a real question of cost, and how to best provide quality treatment from a distance. Clinical care is crucial for the health of chronically ill children; it's been shown that patients in cystic fibrosis centers have a 400 percent greater chance of surviving to age 20 than those who receive general pediatric care. If the clinic has a tool to monitor long-term care over large distances, it will be possible to decrease the

number of visits for patients who are doing well and identify those who need extra care.

Now, for lack of a more accurate system, the child is put on an arbitrary routine of visits to the clinic every three to four months. This is less often than the ideal monthly examination because of the limits imposed by distance, number of physicians, and clinic space. And while the quarterly examinations are not frequent enough to detect all problems, they are sometimes unnecessarily frequent because of a patient's satisfactory progress. More importantly, when the interval is too long, there's an increase in the danger of acute illness for the child.

The tests have proven useful for families with cystic fibrosis children. Now McCubbin, coinvestigator Dr. Robert Nevin of the University of Indiana, and doctoral students Joan Comeau, Andrea Larsen, Elizabeth Cauble, and Joan Patterson are validating, through Gillette Hospital's cerebral palsy and myelomeningocele units, whether they will work for other families of chronically ill children.

If they do, they will be useful in several settings. They can be used in the home, and the family can send them back to the clinic regularly for analysis. They could also be used in the clinic in the early stages of a child's admission.

Computers Could Give Doctors Rapid Feedback

"I'm looking into ways to put the instruments on microcomputer in the clinic," McCubbin says. "It would take 20 minutes for the family to take the tests while the child is being examined by the doctor. The tests could be programmed, the results printed, and we could cut down enormously on the time it takes to give physicians feedback. As it stands now, we have to keypunch the data, have it processed, and by that time the family has gone home. If we can put the tests on microcomputer, for the first time, when the physician picks up a lab slip that gives him or her information like the patient's blood level, cholesterol, and triglycerines, that same physician will be able to look at a family profile and see whether they are at risk.

"Right now it takes a social worker or a nurse one to two hours of face-to-face interviewing to get a decent picture of the family. And the interviewer only gets to see the family if the physician makes a referral. So the physician may overlook problems that may be there, or he or she may make a wrong referral.

"We would like to see these tools become an integral part of the medical treatment," McCubbin says. "Eventually, they may be useful in routine pediatric care."

Ted VandeBerg, Leah's father, thinks this "holistic" approach to medical care for chronically ill children makes sense. But he also points out, "This approach is only useful for children who have the advantage of living in families. Many of these children live in unit homes."

The study proves that the balance of the family unit is more than a poetic concept—it is a practical reality that can have medical consequences. The child imposes stresses on the family, and how the family manages these stresses impinges on the health of the child.

Offering a home-monitoring system and bringing the microcomputer into the clinic gives the family a tool to help increase their own coping strategies. It also gives the medical team the necessary information to improve the efficiency, the cost—and most important—the quality of care.

—Jennifer Obst

(Continued from page 3.)

only on their recommendations, we probably would end up with a list of rather short-range priorities. A real temptation is to do just that. We must resist the temptation to take the short-range look at the expense of the future."

Another necessary balance Sauer sees is between urban and rural concerns. "I don't think it's to our benefit to focus only on rural-related research and try to communicate only with rural people. In this state, where half the people live in the seven-county metropolitan area, it is to our benefit over the long run to do research that's related to urban concerns. We need to get away from this polarization of urban versus rural."

Sauer proposes some practical administrative moves to maximize the Station's assets and increase its flexibility. One would be to form an informal advisory committee of five to seven scientists with rotating membership to provide a forum and direct access to new research ideas from the faculty. Another would be to offer faculty at branch stations the same opportunities to lead research projects as faculty on the St. Paul campus. Other ideas include endorsing the concept of term appointments for administrators to help reduce stagnation of ideas at the administrative level, and exploring the possibility of hiring some new faculty temporarily, rather than on tenure track, to allow more flexibility in staffing and research directions.

Sauer believes an opportunities budget would allow for increased funding of interdisciplinary research, would help fund the fledgling research of new faculty, and give the opportunity of new beginnings to established faculty. And, it would allow the Station to respond quickly to emergencies and opportunities. "Our challenge," he says, "especially difficult during the budget retrenchment climate, is to build a larger opportunities budget."

Science Notes

MORRIS STATION IS SITE OF ETHANOL PLANT

A farm-scale ethanol demonstration plant is being built at the West Central Experiment Station, Morris. Remodeling of the former warm beef barn, in which the plant will be located, is almost completed. The demonstration plant is expected to be in operation by late spring, barring unforeseen complications.

The 1980 state legislature appropriated $200,000 for the University to construct the small-scale plant and operate it for at least two years. Although ethanol will eventually be produced from more than one resource, corn will be the first feedstock.

A major objective will be to determine how to best use the stillage byproduct produced by the plant. Present plans call for it to be fed to beef and dairy cattle, hogs, and sheep.

Ethanol produced by the plant will be used to fuel one of the station's tractors. Data will be collected and compared with conventional fuels to determine ethanol's characteristics and worth to the farmer.

The Agricultural Engineering Department, which prepared the plant design, will also develop and make available free to the public easily understandable plans for constructing a small-scale ethanol plant.

Operation and monitoring of the plant, livestock feeding trials, and economic feasibility studies will involve the Departments of Agricultural Engineering, Animal Science, and Agricultural and Applied Economics, respectively, in cooperation with West Central Experiment Station personnel.

FINANCIAL STATEMENT
MINNESOTA AGRICULTURAL EXPERIMENT STATION
Research Fund Expenditures
Fiscal Year 1980

Expenditures by Source	**Percent**	**Amount**
Federal Funds	12.1	$ 3,455,065
State Appropriations	61.7	17,573,005
Gifts and Grants	18.6	5,309,826
Fees, Sales, Miscellaneous	7.6	2,162,186
Total	100.0	$28,500,082
Expenditures by Objective Classification		
Personal Services	71.0	$20,254,612
Travel	2.2	618,495
Equipment, Land, Structures	6.0	1,714,635
Supplies and Income	20.7	5,912,340
Total	100.0	$28,500,082
Expenditures by Location		
University of Minnesota—St. Paul	85.6	$24,399,345
Branch Stations—within Minnesota	14.4	4,100,737
Total	100.0	$28,500,082

A NOTICE TO OUR READERS

The Fall 1980 (Volume 35, Number 4) issue of *Minnesota Science* was not published because of temporary reductions in staff due to cutbacks in funding mandated by Governor Quie to cope with an anticipated state budget deficit.

—The Editor

Agricultural Experiment Station
University of Minnesota
St. Paul, Minnesota 55108
Richard J. Sauer, Director
Publication
Penalty for private use, $300
ADDRESS CORRECTION REQUESTED

Minnesota Science reports results of research at the University of Minnesota Agricultural Experiment Station. A copy of the magazine is sent to you on the recommendation of your county extension agent. Your agent represents the University of Minnesota Institute of Agriculture, Forestry, and Home Ecoonomics in your county, and helps make results of UM research available to you. If you are receiving more than one copy, please return duplicate mailing labels to the editor.