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Soybeans in Minnesota:
Research Helps Make a Good Match, page 4

Agricultural Experiment Station
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On the cover: For the past 36 years, the University of Minnesota Agricultural Experiment Station has been improving soybeans for Minnesota's climate and growing conditions, and to suit farmers' needs. For an overview and a look back, see story page 4.

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Special Notice

We are resuming publication of *Minnesota Science* with this issue. Minnesota legislative appropriations to the Agricultural Experiment Station allows it to be continued.

Frontiers in Soil Science: The Next 20 Years

(Editor's note: This is an excerpt from a speech written by ***Lowell Hanson*** *and* ***William E. Larson,*** *soil scientists at the University of Minnesota, discussing the potential and challenges for soil science in the "Information Age.")*

REMARKABLE INCREASES in efficiency of crop production have occurred in the past 50 years in terms of production per hour of labor and per unit of land. But compared to our efficiency potential, our current farming methods are similar to repairing a watch with a hammer and pipe wrench.

A major driving force supporting our future progress in crop production is the availability of low cost computers and other ramifications of the emerging electronic information age. The cover story of a weekly news magazine a few months ago, had a picture of an assembly line of Kawasaki robots welding a row of Datsun cars. This kind of electronic control and automation of a traditional human skill is just one example of technical changes associated with factory production.

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But electronics, robots and computers are only one part of the information age. Parallel scientific and technological developments are occuring continuously in the disciplines of chemistry, physics, microbiology, geology and engineering. Soil science depends on these fields for infusion of new knowledge, which we can apply to the understanding and efficient management of soils.

The availability of low cost computers is particularly significant as it will open up a whole new exciting world of precision farming.

At present, a farmer is forced to apply an *estimated* amount of fertilizer and pesticides based on general guidelines. These guides are based on general ranges of pH, texture and organic matter levels for the variety of soils that occur in a particular field. Similar imprecise management decisions regarding choice of crop and variety, tillage, drainage and irrigation are now the "state of the art."

The person who designed and is using a robot welder knows precisely what is being welded. Before we can control a system intelligently, we need to understand the nature of that system. Up to now our knowledge of the soil systems used for crops has been general and subjective. Scientific soil survey maps are starting to provide needed, reliable information about soil variation. But this information comes hard. Although we have one of the most progressive soil survey programs in the country in Minnesota, our last and best county soil survey report which will be completed in 1992, will only map soil types down to a 3 to 10 acre scale. And this 1992 report will be an order of magnitude better than the 1958 Fillmore County soil map which is defined as meeting "modern soil survey" specifications.

In the Future: Linking Soil Fertility Needs to Soil Type

Finding out the best combination and amount of plant nutrients to apply for a particular crop and soil situation is the basic objective of the soil fertility branch of soil science. Thousands of greenhouse and field experiments have been conducted to develop correlation with chemical plant and soil analysis. A major opportunity of the next 20 years will be to merge this soil fertility data base with the spatial soil survey data, to provide a soil test fertilizer rate guide *specific* for the major

In the future much more efficient use of nitrogen fertilizer will be possible. Here, soil scientist Bill Jokela applies a specific amount of marked nitrogen to a research plot at the Southern Experiment Station, Waseca, as part of an experiment to track its use and progress through the soil.

soils on each farm. We predict that microcomputers will be installed in combines and will essentially construct an accurate yield map of each field of corn or soybeans. A field with an average yield of 175 bushels per acre may have some areas with yields of 210 and other areas where the yield is 125. Knowing precisely the nature of these yield variations can be a powerful tool for the soil manager in the 1990's.

Just as important and closely inter-related to fertility modifications to the soil are the physical modifications that can be made to the soil profile. These changes, which have to affect the massive inertia of 10,000 to 20,000 tons of soil and water in a 5 foot deep acre block of soil, involve the critical plant needs of optimum temperature, oxygen, and available water.

We think that we have made some significant physical improvements in our Minnesota soils through drainage, irrigation, and improved tillage techniques. But relative to the changes that will be made, we have literally just scratched the surface.

Data from conservation needs surveys and other sources indicate that inadequate drainage is still a major problem on our glacial till and lacustrine soil landscapes. We have installed "frame work" drainage systems on perhaps 7 million acres and can now add supplemental irrigation water on about 400,000 to 500,000 acres of our 23 million crop acres. But substantial acres of crops each year produce low yields because of too much or too little water.

Through the application of present and developing technology in hydrology, climatology, engineering and remote sensing, we can foresee that the soil-water system will be controlled and managed much more com-

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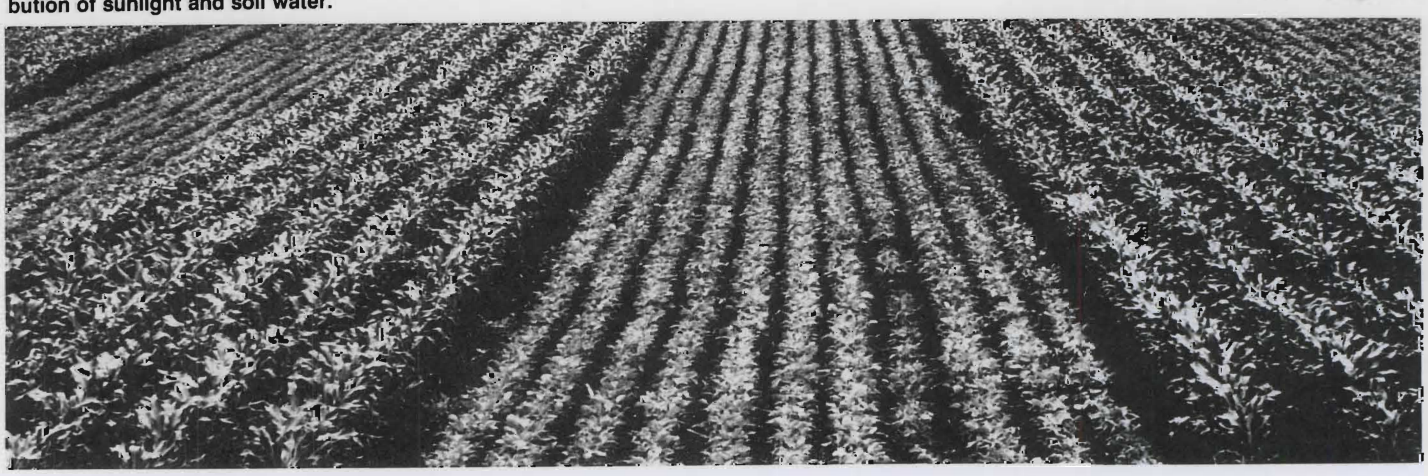
"A major opportunity of the next 20 years will be . . . to provide a soil test fertilizer rate guide specific for the major soils on each farm."

Research at Waseca and at Morris indicate that crops grown in alternate narrow strips rather than bulk fields show yield increases. The crops "complement" each other by a new distribution of sunlight and soil water.



Building a Better Bean

SOYBEANS—a crop with a long legacy, dating back to ancient Chinese farmers—owes much of its Minnesota success to advances through breeding programs of University of Minnesota researchers.

In 1983, $128,000 was allocated to the soybean research breeding program at the University, up about $126,000 from the $2,130 allowed the program in 1946. Acreage planted to soybeans multiplied even more in that time, from 450,000 acres in 1945 to 4.95 million acres in 1983. Bushel per acre yield has more than doubled in those same years with production totals going from 6.6 million to 175 million bushels in 1982.

The man who knows the most about the soybean crop in Minnesota since 1946, when he was assigned to head the University's soybean breeding project, is Jean W. Lambert, now professor emeritus, agronomy and plant genetics. Lambert completed 36 years as project head in June 1982 and James H. Orf succeeded him.

Soybeans are 20 percent oil and 40 percent protein. The oil is used mainly for edible products such as salad oil, shortening and margarine. Soybean meal is the residue which remains after the oil has been extracted and is mainly used for livestock feed. "Soybean oil is the most plentiful edible oil in the world and soybean meal is the most important concentrated protein for animal feed," Lambert says.

Today, about half of the Minnesota crop and half of the U.S. crop of soybeans is exported. "In most years it's the biggest single exchange earner among agricultural exports and helps to reduce the United States' unfavorable balance of payments," he says.

Soybeans really caught on as a Minnesota crop during World War II. Reduced commercial shipping meant that world supplies of vegetable oils were cut off and the U.S. government appealed to farmers to grow more soybeans. "Prices were good in comparison with other crops," Lambert recalls. From fewer than 50,000 acres in soybeans in the state in 1938, the total became 450,000 acres by 1945, the war's end. "But we found out we weren't growing very good varieties," Lambert says. That's when the breeding program began. "When I came to Minnesota in January, 1946, soybean breeding research was just getting underway," he says.

Soybeans developed in the University of Minnesota Agricultural Experiment Station's breeding program now account for 40 percent of the state's acreage. In 1981—in Lambert's 36th year of research—it was estimated that the breeding program, which cost $110,000 that year, added $30 million of extra income to Minnesota farmers. This figure was reached by multiplying 1.9 million acres at 3 bushels an acre (a conservative estimate of the increased yield over the varieties that were replaced) by $6 a bushel, the price paid for soybeans that year. Last year the figure was over $30 million also.

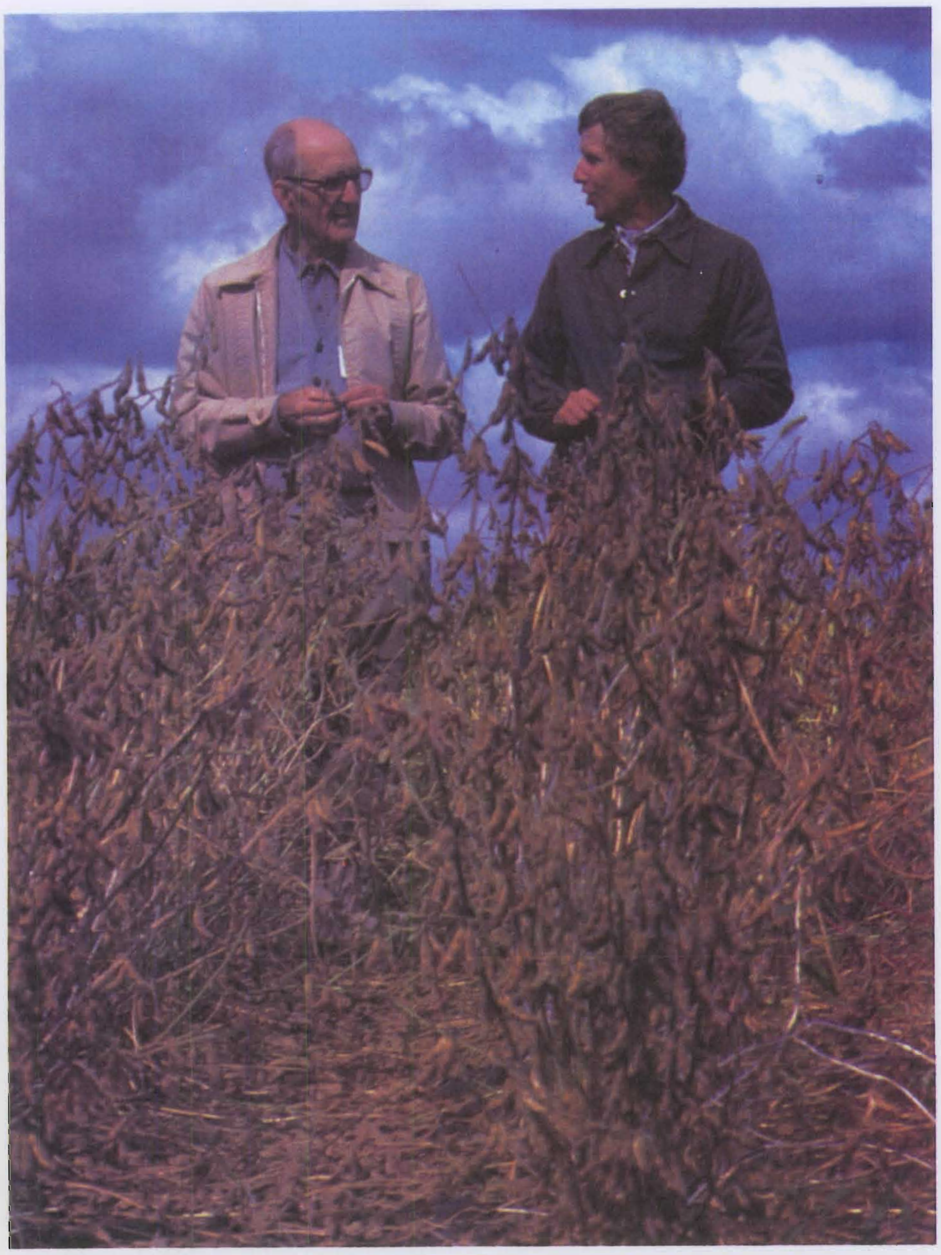
Soybeans Are Sensitive To Location

"The justification for establishing a breeding program here is that varieties have to be developed specifically for Minnesota climate. Because a variety is doing well in Mississippi doesn't mean that it can be used in Minnesota. Growing temperature, lengths of summer days, and the number of frost-free days, all have a major effect on soybeans," Lambert says.

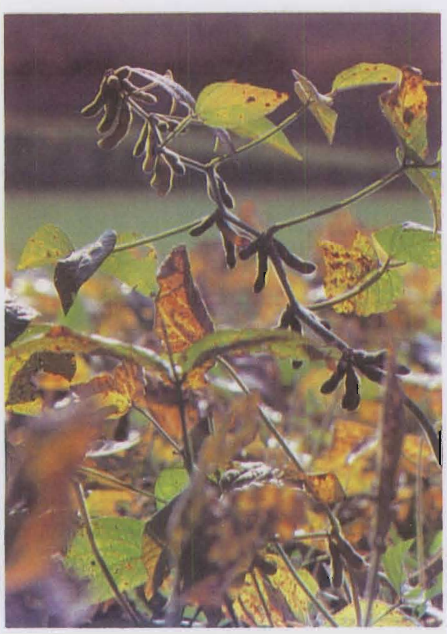
However, some varieties developed in other states that are adapted to Minnesota climate are popular here, and this sharing of research between the states Lambert sees as a particular strength of the soybean breeding program. "Varieties we have developed are used in

The progress of soybean growth: Top: In mid-May the cotyledons are just emerging from the ground, less than 10 days after planting. Middle: By next week the plant is at the primary leaf stage. Here the cotyledons are still attached but within a few days they will begin to shrivel up and drop off as the regular leaf begins to provide nutrition for the plant. Bottom: By late August or early September (depending on variety) the soybean pods are almost full size and the plant is nearing maturity.

Canada, North and South Dakota, Iowa and even some European countries. By the same token, we're using a lot of Iowa varieties, and also some



Jean Lambert (left) and Jim Orf inspect a new variety field test plot ready for harvest.



This high yielding plant has lots of pods, all full. In late summer the lower leaves begin to drop. When all the leaves fall off, in late September or early October, the plant will be ready for harvest.

from Indiana, Illinois and Canada," he says.

In an effort to characterize the many varieties of soybeans, Lambert says, years ago the USDA and the states agreed on a system of classification according to maturity groups, from those grown near the Canadian border (Group 00) to those grown near the Gulf of Mexico (Group VIII).

Jim Orf describes the four different maturity groups adapted to the temperatures, day lengths, and lengths of growing season in stretched-out Minnesota, which covers 5½ degrees latitude.

Maturity Group 00 contains the varieties grown in the Crookston-Rouseau area. Here, short season varieties grow best. McCall is the Minnesota variety and Maple Presto and Maple Amber, the Canadian varieties, planted.

Maturity Group 0 includes the varieties grown in the Moorhead-Morris area, stretching south nearly to St. Paul. Evans is the best known of the Minnesota releases grown there. Clay is an older variety, Simpson a 1982 release, Swift a 1972 release, and Ozzie, Dawson and Chico, all new 1983 releases from Minnesota which show promise. Swift, named for the county, has helped alleviate the problem of varieties yellowing or becoming chlorotic when grown on high pH soils. "And Ozzie has good resistance to Races 1 and 2 of Phytophthora. It has excellent resistance to lodging and good level of oil and protein," says Orf. Dawson is expected to compete well with Swift. Chico is a small-seeded soybean that can be used for sprouting and other specialty uses.

Maturity Group I is grown in the area from St. Paul to Waseca-Lamberton. Hodgson 78 is the Minnesota variety which is a favorite there. Iowa varieties grown there too are Weber, Hardin and Lakota.

In Maturity Group II, the southern two or three tiers of counties across the state, an Illinois variety—Corsoy 79—is the most popular.

"If you look at a map of crop production, Minnesota is kind of a peninsula of soybean growing. We're pretty far north. So perhaps our biggest contribution in research has been in developing varieties in Groups I, 0 and 00," Lambert says.

Soybeans are not hardy like cabbage, but more like garden beans or tomatoes," Orf explains. "It is important to have varieties that mature early. After a hard freeze, they make no more progress and early frosts lower the yield."

High seed yield and early maturation are two valuable traits. Other important qualities are disease resistance, harvestability, good seed quality, and high levels of oil and protein in the seed. Lambert calls the research challenge: "Putting all these factors together and obtaining the best of each category."

For example, an important goal is developing varieties that can withstand cool weather late in the growing season without having the oil and protein content of their seed lowered. "If we could forget about protein, it would be a fairly straightforward process to get high yields and high oil content," Lambert says. "But to get high protein and high oil content *plus* yield is much more complicated. It's a situation where breeders must strike a balance that's the most profitable for the growers, because yield is generally lowered somewhat as they select for higher protein content."

Long-Term Research Is Supported by Many Cooperators

Years of work go into a new variety before it is released for farmers to grow. The cross leading to Hodgson, a variety released in 1974, was made in 1963. "Eleven years—that was a little faster than some," Lambert remarks.

Minnesota soybean growers recognize the long-term nature of soybean breeding research and support it with a 1-cent-a-bushel check-off administered through the Minnesota Soybean Research and Promotion Council. This represents about 20 percent of the soybean research funds and has helped to make possible, among other things, the winter soybean nursery plots in Chile, begun by Lambert in 1962. The five branch experiment stations and other farmer cooperators have also been important in the program. "We operate at a dozen locations in the state, and they've been indispensable cooperators," Lambert says.

Jean Lambert guided the experiment station soybean breeding program for 36 years.

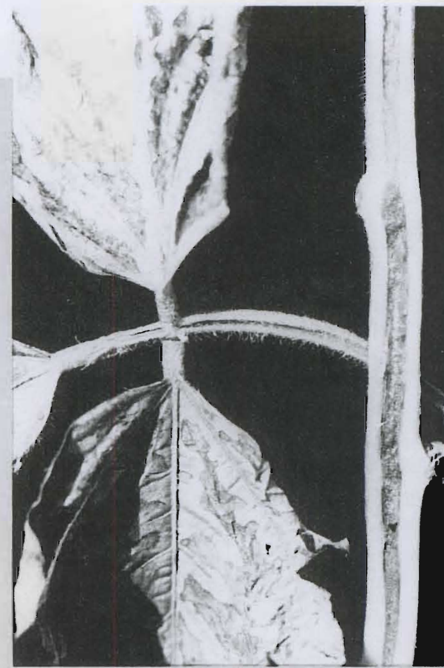
Some facets of the research process can be speeded up with new technology. This year, for the first time, a personal computer was used to tackle putting huge field books together. Actual recording in the field is still done by hand, but what took three people a couple of weeks' preparation, is now on computer and can be finished in three days.

This year the researchers are repeating a field trial they do from time to time. At five different locations in the state several of the old varieties of soybeans, popular 10 to 20 years ago, are being compared with new varieties. Ten or more varieties are included at each location, Orf says. "In the past, we've tried to extrapolate from the old to the new varieties because they were used in different periods of years. But now we can say exactly what farmers would be harvesting if they were still growing old varieties. We'll see how much further ahead they are with the new ones," Orf says.

Orf is grateful that he will be building on a program Lambert developed and nurtured so expertly.

—Mary Kay O'Hearn

Breeding Resistance to Soybean Diseases



The tell-tale signs of brown stem rot in the late season: The leaf shows green veining but it's dead in the patches. When the stem is cut open, a brick red color in the center of the stem is revealed.

AS NEW HUMAN DISEASES seem to gallop ahead of the reins to contain them, so too can diseases affect crops such as soybeans in Minnesota.

Then it's up to the plant pathologists and nematologists to cooperate with plant breeders and build disease resistance into new soybean varieties. They try to stay ahead of the known diseases and protect the second largest crop in the state.

Phytophthora root rot and brown stem are the major diseases Bill W. Kennedy, plant pathologist, battles. Phytophthora is a fungus of wet compacted soil. It kills the whole plant at any stage of development. Brown stem rot, Kennedy says, "has been around for a long time" and it occurs when soybeans follow soybeans. It infects early but becomes obvious in late season when pods are filling, looks as if frost has hit, and of course, reduces yield. Right now control is rotation, Kennedy says, adding, "Iowa and Illinois claim some tolerance to stem rot, but resistance is hard to get."

To obtain resistance to Phytophthora, seven or eight generations of soybeans must be grown in perhaps four or five years. "It takes backcrossing to develop this," Kennedy says. "The fungus is changing here in the state: many varieties that were resistant are rapidly becoming susceptible and this complicates control procedures. We don't want to force the fungus into a corner by continuously planting soybeans specifically resistant to it, since the pathogen can adapt and change into a much more serious threat. We must emphasize generalized resistance," he cautions.

Two other soybean problems Kennedy is watching are Sclerotinia (white mold) and Septoria leaf spot. Sclerotinia usually occurs following sunflowers or garden beans. While it can be a devastating disease on soybeans grown in the humid tropics, such as Brazil, evidence to date indicates its appearance is sporadic in the Upper Midwest. Septoria is common in southern parts of the state and often causes considerable defoliation late in the season.

David H. MacDonald, plant nematologist, reports the soybean cyst nematode hasn't reared its head with any startling new infestations since 1980. It was first detected in 1978 near Frost (Faribault County east of Blue Earth) and infestations in seven other counties have been found largely through the efforts of the State Department of Agriculture.

The most common race of the cyst nematode in Minnesota is Race 3. Jean Lambert began a breeding program for a variety resistant to Race 3 in 1970 when the nearest known infestation was probably 600 miles away in central Illinois. "He certainly should be given credit for correctly evaluating the situation and for beginning work on a problem that would eventually face Minnesota's soybean producers," MacDonald says.

In the lab, a student tends to soybean plants bred for resistance to Race 3 of the cyst nematode. "Our research will be a somewhat slow, step-by-step process as we learn how to use resistant varieties in rotation with susceptible ones and with other crops," MacDonald says.

Lambert's line M70-187, now released as germplasm, has consistently outperformed Hodgson 78 in paired row trials on heavily-infested soil in Freeborn County but is not good enough to be released as a named variety. Instead, it can be used as a parent for better-yielding Race 3 resistant varieties of the future.

Many nematologists think that the soybean cyst nematode may be native to North America instead of having been introduced from the Far East as was earlier believed. They think that perhaps four or five crops of soybeans in a corn-soybean rotation are necessary to allow the nematode to reach damaging levels. Since other factors like soil type, weather, and maybe soybean variety can slow the rate of nematode buildup, they believe that farmers have only recently grown enough susceptible crops for the effects of the nematode to become apparent.

"We know, from what is being observed in 1983, that three non-host crops like corn are not enough to prevent damage by the cyst nematode to soybeans grown the fourth year on heavily infested ground. Ideally, all farmers should strive to detect the presence of the nematode on their property before it can multiply to the point when it can cause them economic loss," MacDonald says.

New Varieties Represent Return on Research Investment

OVER THE PAST YEAR, the Minnesota Agricultural Experiment Station released 13 new varieties and one breeding line of field and horticultural crops. These releases represent a return on the investment in research that can be used immediately by Minnesota farmers and homeowners. A brief description of each new variety follows (Except for the three new soybeans—Ozzie, Dawson, and Chico—described in the story that begins on page 4).

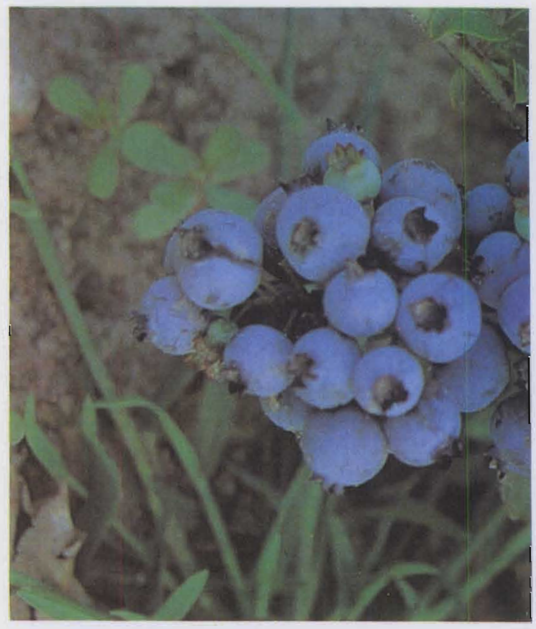
Robust barley—This new malting variety excels in yielding ability and lodging resistance (the ability to stand upright in the field until harvested). In trials at five Minnesota locations, it outyielded Morex and Manker by 13 bushels per acre. Robust is similar to Manker in lodging resistance, and less likely to lodge than Morex, an earlier station release that's now the leading malting variety in Minnesota and the nation. Robust had the highest percentage of plump kernels of any variety in the station's trials. And, it should find favor with maltsters and brewers because of its 79.2 percent malt extract, which is similar to that of Morex and Glenn. Robust's only apparent drawback is that it matures a few days later than Morex and Glenn. This increases slightly the chances of preharvest losses and narrows the time between harvests for farmers who grow both barley and wheat.

Elias annual canarygrass—Most of the U.S. acreage of annual canarygrass, a crop whose seed is fed to caged and wild birds, is in and near the Red River Valley. In trials at three Minnesota locations, Elias outperformed Keet and Alden, two earlier Minnesota Agricultural Experiment Station releases, in yield and test weight. It is estimated that 90 percent of North American canarygrass acreage traces to Alden and Keet. Elias' average yield surpassed Keet's by 11 percent and Alden's by 27 percent. Elias is equal to Keet in lodging resistance and its panicles retain the seed firmly so shattering losses are usually small.

A672 yellow dent corn—This inbred line may contribute better stress tolerance to hybrids says Jon Geadelmann, who heads the station's corn improvement program. "It seems to be standing a bit better at the end of the season than its parent A632," he says. (The station released the inbred line A632 some years ago. It was and still is widely used to produce commercial hybrids.) A672 has displayed several advantages over A632 in trials as an inbred line: it is a couple of days earlier to silk, has more uniform silk emergence, and is slightly more resistant to eyspot and northern leaf blight. It also outyielded A632 by 5 bushels per acre. Seed companies may take advantage of the genetic similarities of A672 and A632 to produce vigorous, three-way-cross hybrids whose seed would cost farmers less than four-way-cross seed.

Wheaton hard red spring wheat—Wheaton, which is similar to Era in agronomic characteristics, was released by the station and USDA's Agricultural Research Service primarily for its superior yielding ability. In trials at Lamberton, Morris, St. Paul, and Waseca, its average yield of 55 bushels an acre was 6 bushels more than Era's and 5 more than Marshall's. In trials at Crookston and Stephen, its yield average was 2 bushels more per acre than Era's or Marshall's. Although Wheaton's test weight averages about 1 pound per bushel less than that of Era, its increased yield should appeal to farmers. Wheaton is similar to Era in percent protein. Although it has a slightly lower percentage of extractable flour than Era or Marshall, it surpasses those varieties in water absorption and loaf volume, characteristics that are important to bakers.

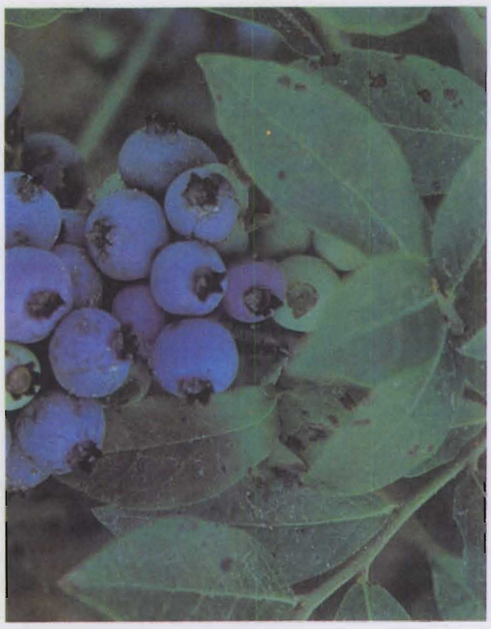
Voyager wild rice—Voyager is the second wild rice variety with some shattering resistance to be released



Northsky blueberries are medium size with a dus- bl

Gold Country, a new 1983 mum, produces a canopy of yellow-tinged, peachy-bronze flowers that change to gold.

by the station. Its significant advantages are its earliness and high yield. Voyager matures four to six days earlier than K2 and one day earlier than Netum. And, it has the yield potential of the high-yielding, later-maturing varieties. In 1982, its average yield at four test sites surpassed those of K2, Netum, and M3. Extension agronomist Ervin Oelke says, "Wild rice growers will now have the opportunity to plant an early



... gives them a sky blue color.

Station potato breeder Florian Lauer sees Agassiz as a variety that gives valley growers an entry into the russet potato market, an interim variety they can grow until something better comes out of his breeding program.

variety without sacrificing yield." He adds that growers can make more efficient use of harvesting machinery by planting part of their acreage to an early variety like Voyager. Also, the earlier a wild rice variety matures, the less likely growers are to suffer preharvest losses from high winds, storms, and blackbird predation or a complete loss of crop from an early frost.

Agassiz potato—Until now, russet-skinned potatoes could not be grown in the Red River Valley because variable soil moisture conditions there caused them to develop hollow heart. Agassiz is the first russet that can be grown in the valley without developing this physiological disorder. Agassiz's oval tubers set heavily. In trials, Agassiz yielded as well as Russet Burbank in the valley, but its marketable yield was less than that of Norgold Russet and of Norchip. However, valley growers may be able to increase yields by adjusting their fertilization practices. Agassiz's overall eating quality is good and its chipping quality is excellent. The tubers store and handle well and the plants are highly resistant to common scab.

Erik potato—This rugged, red--skinned potato can tolerate a wide variety of growing conditions, especially poorly drained situations. It produces its blocky, shallow-eyed tubers early, and this will give it a niche in Minnesota's irrigated sands area, whose growers compete for the early fresh potato market. In dryland trials in the Red River valley and under irrigation at Becker, Erik yielded, on the average, 84 percent as much as Pontiac and 13 percent more than Norland. Erik has only medium resistance to common scab, so it should not be grown in soils that are heavily infested with scab fungus.

Northblue and Northsky blueberries—These hybrids are the first reliably hardy blueberries for Minnesota growers and gardeners. They have survived 30 to 40-below-zero temperatures and are low statured so snow can protect the flower buds which allow maximum production. Northblue has more potential than Northsky for commercial pick-your-own operations because it has larger fruit and is more productive. However, both are suggested for home garden and are ideal for home landscaping, with glossy foliage that turns dark red in the fall.

Northblue produces large, attractive, dark blue fruit which has good blueberry flavor when used fresh and a flavor superior to popular highbush blueberry cultivars when processed. The vigorous plant grows 20 to 25 inches high and produce 3 to 5 pounds of fruit.

The berries of Northsky are medium size with a dusty bloom that gives them an attractive, sky blue color. Their flavor and storage qualities are similar to those of Northblue. Northsky plants grow 10 to 18 inches high and produce 1 to 2 pounds of fruit.

Gold Country and Mellow Moon Chrysanthemums—Gardeners will like these hardy garden mums, which have the largest flowers of any cultivars yet released by the station.

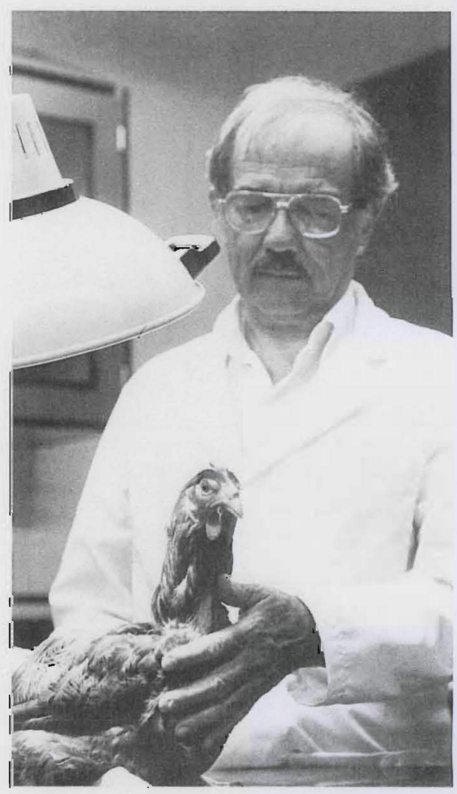
Gold Country produces a canopy of yellow-tinged, peachy-bronze flowers that change to gold. The 4 to 4½ inch, double, incurved blooms usually open by the second week of September in St. Paul. Plants average 20 to 21 inches high and almost as wide, with medium-stiff stems and clean, medium-dark green foliage. Gold Country is attractive in the flower border and also useful as a cutflower.

The 4½ to 5 inch, cream-colored, semi-incurved, double flowers of Mellow Moon don't turn pink in cold weather. The stocky plants' stiff stems are densely covered with clean, rich green foliage. Flowering usually begins the first half of September in the Twin Cities. Mellow Moon produces an attractive mass of flowers atop plants that are 15 to 18 inches tall and 20 to 22 inches wide.

—Sam Brungardt

Pioneering Genetics Research May Produce a Better Chicken

Right: The proof of a successful gene transfer may be in these eggs. Bottom right: Animal scientist Robert Shoffner prepares a laboratory chicken for the minor surgery required to inject the gene. A minor incision is made and the viral DNA is injected into the chicken's ovary, into the cells which surround each ovum.



ANIMAL RESEARCHERS, like the rest of us, may not know which comes first—the chicken or the egg. But they know that if you want to improve one, you have to start with the other.

Nowhere is this so true than right now in Robert Shoffner's cytology lab, where the egg is under acute observation.

Shoffner, animal scientist at the University of Minnesota, and his student Ruth Shuman are working at developing new ways of improving chickens through genetics as part of a North Central Regional Agricultural Experiment Station research project. The results will not make traditional animal breeding obsolete, but have the potential to become a powerful adjunct to it.

Although farmers have been producing animals for centuries and research has made strides in helping them do this efficiently, we know very little about animals' biochemistry. Twenty years ago, when Shoffner first began his cytology research, it was not known how many chromosomes a chicken had, or where any gene was located on those chromosomes.

"There's still lots to learn about these chromosomes, but we now know more about chickens than cattle, or sheep or hogs," Shoffner says. One of the things they have discovered, for example, is that in chickens, it is the female that carries the x chromosome and the w chromosome which plays a role in determining the sex of an offspring. (In humans, it is the male who carries the x and y chromosomes.) This discovery and others won Shoffner the MERCK award last year for progress in animal genetic research.

The Gene Transfer Process

Understanding the make-up of chromosomes opens possibilities for researchers to manipulate that genetic programming to improve the animal. That process proceeds in these stages: First, they must identify the appropriate gene. Then they must pluck it out of one source, then multiply it, and put it into the cells of another, and have it incorporated into the germ line.

All of these steps can be full of unknowns. Like the plant microbiology and genetics research (see *Minnesota Science* Vol. 37, No. 4) the research requires a flexible approach and willingness to try new strategems.

Ruth Shuman has identified a particular gene, multiplied it successfully, and is now attempting to introduce it into the germ line of the chicken. The gene she has chosen is one they hope will give resistance to the virus Rous Sarcoma, that causes leukemia in chickens. The virus does a lot of damage and so far vaccines have been ineffective against the disease. Gene transfer may be an alternative to a vaccine.

The gene is actually from the virus itself. With the help of Lyman Crittenden, USDA researcher at East Lansing, Michigan, a virologist with a life-long interest in this particular virus, they isolated a piece of the viral DNA that produces what is called an envelope protein for the virus. They suspect this gene, once in the chicken, will act to interfere with the cell receptors that bind the virus. "We think it may interfere with the receptors of the virus, perhaps by binding itself to the cell membrane, thus blocking out the virus from entering the cell," Shuman explains.

They have transferred the gene into a vector, in this case a plasmid, and then into a bacterium. The bacterium is used, because it multiplies so rapidly, as a production source to make thousands of copies of the gene. They need a lot of this DNA to inject into the chicken cells.

"We grew the bacteria in large amounts, and then we kill the bacteria and extract the plasmid, and the plasmid contains my gene," Shuman says.

"Now, once we get the DNA, then the next step is biological—somehow or other we have to get this gene into the germ line of the chicken," Shoffner adds.

Introducing the Gene into the Chicken

At this stage, it helps to have a visible target. The reason why frogs were very useful as a subject in the beginning of this kind of research was because they conveniently lay their eggs in the water out in the open.

Shuman's first attempt to introduce the gene did not succeed. Shoffner explains: "When chicken embryos are 24 hours old, right around the tip of the embryo is what is called the germinal crescent. There are only 200 to 300 of these cells, and they are the future germ cells—the sperm or the eggs that are going to be come from these. Ruth developed a method to isolate these cells. The idea was to inject the gene into them."

But the cells reacted violently to this intrusion. They exploded. "So what was a good idea ran into a technical biological problem," Shoffner says ruefully.

They decided to backtrack and try injecting the eggs before the mother lays them. "Before, I was using the laid eggs. In the laid egg there's at least 16,000 cells. The egg—the yolk—in the ovary, however, is one very large cell. So you can see that this is a much bigger target," Shuman says.

Inside the chicken's ovary are clusters of yolks at different stages of development. Five to eight yolks, ranging in size from less than one-fourth inch in diameter, to just over half an inch, are large enough to inject.

"The idea is to inject not even necessarily into the yolk but into the surrounding membrane, so that I'm not injuring the cell. There are cells that surround each ova that gives me a nice little pocket to inject into.

"We anesthetize the chicken and have to work very rapidly. We make the smallest incision possible so as not to traumatize the bird," she says. "They do not seem to suffer any adverse effects."

They plan to inject and collect over 500 eggs. The proof of their success will be when they screen those embryos for the presence of the gene they have injected.

But they know the gene will be present, because they have put it there, right? "Well no. We don't know that. I'm putting it there, but there's no guarantee that it'll stay, or it will become incorporated," Shuman says.

The embryos will be screened for the presence of the gene after 11 days of incubation, before they are

This research may produce a chicken resistant to Rous Sarcoma, a virus that causes leukemia in chickens. Meanwhile, the research is giving new insights into chicken genetics, and the gene transfer process.

Ruth Shuman (above) explains the first attempt to micro-inject the viral DNA into the primordial germ cells did not work. The second method proved more efficient.

hatched. The researchers can also check to see if the gene is incorporated and working by culturing cells taken from an embryo to check for the protein the gene produces. "Finally, we can challenge these cells to Rous virus to see if they can indeed exclude the virus. All of this could be done in culture immediately," she says. Later will come testing of the actual live birds.

Potential Payback Is New Genetic Tool

This kind of animal research is time-consuming, and can be expensive. But the potential payback is the development of a new genetic tool.

"Most breeders are not geared towards thinking about single genes very much, because the total animal is a composite of traits. There are probably not very many single genes that are going to be useful. But one of them could be the growth hormone gene. Another could be single gene resistance to some diseases in cattle, pigs or chicken. So there are certain classes of genes that might be very useful," Shoffner says.

"The main thing is to work out a piece of the system, and if we don't get that in hand we can spend more time looking for genes. We also don't really know what will happen when we get the gene into the animal. It may be recessive, or it may have adverse affects," he says.

Animal breeders have been improving traits for years by crosses and re-selection. The problem with this process is, with each mating, a lot of undesirable genes are introduced along with the desirable ones, so more matings are needed to weed out the bad. In cattle, for example, that process may take 50 years through many generations.

Another example is the modern turkey. The white turkey was originally a very small bird; the ones with the meat were bronze. To get that single recessive gene for white pigmentation—which was desirable for ease of processing—without losing size, took about 10 generations of crosses and back crosses.

"Now if we were at the stage then we would probably will be 10 years from now, we could isolate that single gene that interferes with the deposition of pigment; we could take that single gene out, transfer it, and it would be much more efficient," Shoffner says.

"The main thing now is to find out if we can do it, and how to do it. You can talk about it all you like, but the hard part is making it become reality," he says. Gene transfer has plenty of potential, but as Shoffner says, "It's not magic—it's a sophisticated, refined tool."

—Jennifer Obst

Drapery Liners can be a Hidden Fire Hazard

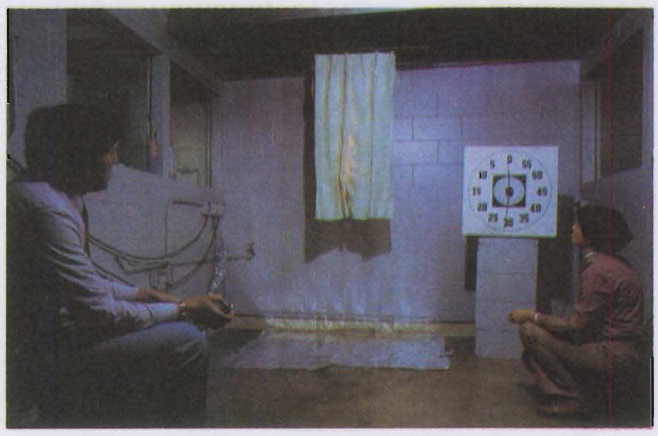
THINK THAT ADDING a flame retardant lining to your living room draperies would make them less likely to burst into flames—or at least reduce the rate at which they eventually burn—in the event of a home fire?

If so, you'd better think again.

Two researchers at the University of Minnesota have come up with surprising results in recent tests of drapery flammability. Draperies with liners, they found, almost always burn faster than those without—even when the liner itself is supposed to be flame retardant.

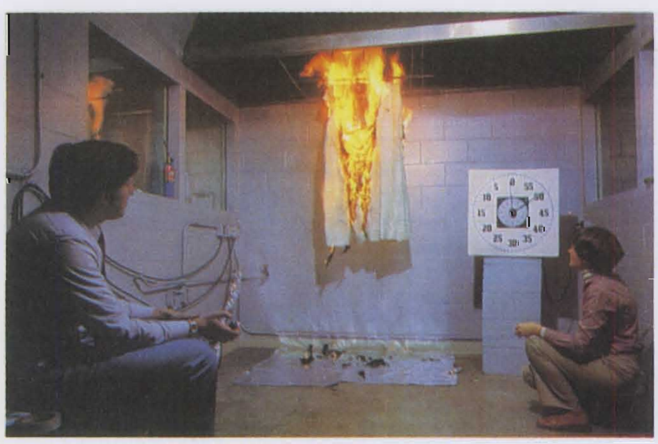
The two, textiles specialist Cherilyn Nelson and Peter Brown, associate professor of the Textiles and Clothing Department, hope the findings will serve as a warning to consumers, who more and more are using draperies with liners as an energy conservation measure. Draperies were the cause of one in twenty building fires in 1978, resulting in lost lives and millions of dollars of property damage because of their ability to act as a vertical track along which fires can travel from the floor to the ceiling, and in many cases, to the floor above as well. Increased flammability due to the addition of liners could make these grim statistics even grimmer unless consumers are made aware of the potential fire hazards of the increasingly popular drapery-liner combination.

Nelson and Brown began their study of drapery flammability after they noticed one brand of liner advertised as meeting the federal standard CS191-53, which deals with flammability of clothing textiles. Because the tests used in establishing this standard were designed for clothes, not draperies, the researchers questioned its use in this case.



At 30 seconds after ignition the flames are climbing up the back of the drapery.

Ten seconds later.



After less than one minute, the drapery is engulfed in flames.

"Since the liner did not ignite after one second of contact with a flame, it was classified as having normal flammability—meaning it could be considered neither dangerous nor highly flammable," Nelson explained. "The average consumer would reasonably conclude that a product advertised as having passed the standard test method is indeed flame retardant and therefore safe for ordinary use in the home."

Because they felt the federal clothing standard was an inappropriate measure of drapery liner fire safety, the researchers decided to study the material under more realistic conditions. Nelson describes the test:

"The draperies for our test burns came right from catalogue stores, which is where most consumers turn when shopping for these items," Nelson says. "We tested the flammability of each drapery first, and then we tested it in combination with the flame retardant liner."

To keep the conditions constant, the researchers conducted the test burns in a special concrete room in the University's textile lab. The draperies were hung from a metal rod, and a flame was held to the bottom for three seconds. The results were not what you'd expect from something labelled "flame retardant."

"The draperies alone burned pretty much as we thought they would. But the surprising thing was they all burned faster when tested with a liner, even when it was a flame-retardant liner," Nelson says.

If the supposedly flame-retardant drapery liner has this kind of effect, the researchers asked, how do other liners react? They began to test a number of other commonly available liners, including acrylic foam-backed fabric, 100 percent cotton, and aluminum-backed polyester.

The results, though diverse, were consistently alarming. Fabrics with a high cotton or rayon content burned extremely quickly. Some liners and draperies curled, forming a chimney that allowed flames to travel rapidly up the surface of the fabric. Others produced a dense black smoke that could be as dangerous as the fire itself. In some self-lined draperies, the flames traveled up the back of the fabric but could not be seen in the front, decreasing the likelihood of rapid detection in a real-life situation.

"In most instances we found that adding a lining to the drapery actually increased the rate of burning," Brown says. "The liners which burned quickly alone, caused the draperies to burn at their rate. This is the weakest link theory: the faster burning member tends to control the rate of burning for the combination. In terms of severity, the combination is also worse than either the draperies or the liners because of the greater amount of material."

What can consumers do about the problem?

For one thing, be aware that draperies—especially those with linings—can be a significant fire hazard, and avoid fabrics that can pose a threat, such as those with a high cotton or rayon content, Nelson suggests.

Consumers also need to remember that there are no established standards for drapery flammability today, and so should be wary of claims of fire retardant properties, which Nelson says "borders on misleading advertising."

If a consumer does decide to invest in a flame-retardant liner, she or he should be sure that the drapery itself is treated as well.

"It doesn't make any sense to have any part of the system flame retardant if the other isn't," Brown says. "Consumers have to realize that unless the whole system is flame resistant, they haven't bought themselves any safety."

Right now, however, such combinations may not be readily available on the market, since there are now no federal regulations for drapery flammability.

"Until something like that occurs, I don't think we're going to see much voluntary development by manufacturers," Nelson says. But, she adds, this study, by under-scoring the fire hazard associated with lined draperies and draperies in general, could be a first step in encouraging members of the window covering industry to put added emphasis on the fire safety of their products.

—Mary Hoff

Soil Science/continued from page 3

pletely in the future. Recycling surplus drainage water to recharge dry soils or later season irrigation may be carried out, for example. Already we are starting to modify entire rooting zones, physically and chemically, for improved plant growth. Except for energy restraints, this is now feasible.

**In the Future:
New Tillage Systems**

One of the major contributors to the control of the physical soil properties will be new systems of tillage. Through developments in both soil physics and tillage machinery, precise seed bed and root zone soil conditions will be created each crop season by the year 2000 farmer.

Another component of the soil-plant system is the space occupied by the crop canopy. There are some exciting developments going on in this area. Current research at the Southern Experiment Station at Waseca and earlier work by ARS (Agricultural Research Service) at Morris indicate that crops grown in alternate narrow strips rather than bulk fields show yield increases of 10 to 15 percent. As we learn more about the effects of crop geometry, we may be able to significantly improve the CO_2 concentration in the crop leaf zone through more air turbulence and optimize "border" affects by a new distribution of sunlight and soil water offered by the strips field pattern.

Another area of research is development of models for predicting the fate of nitrogen in soil with different managements. This new approach will take care of the need for a soil nitrogen test and allow for much more efficient use of nitrogen fetrilizer, and minimize losses from leaching.

We see an exciting future for soil science in the next 20 years. We must start to realistically plan to use the products of our information age.

Science Notes

NORTHWEST EXPERIMENT STATION HAS NEW SUPERINTENDENT

Larry J. Smith, a scientist at the Northwest Experiment Station at Crookston, has succeeded Bernard E. Youngquist as superintendent of that station. Youngquist retired July 1, after 27 years as superintendent.

Smith is a native of Pierz, Minnesota, where he was reared on a grain farm and worked his family's farm equipment dealership. He holds a B.S. degree in agricultural education and M.S. and Ph.D degrees in agronomy from the University of Minnesota.

Smith has been on the staff of the Northwest Experiment Station since 1971, doing agronomic research on many crops until 1978 and heading the sugarbeet research effort for the entire state of Minnesota from 1978 until the present.

Youngquist's affiliation with the University of Minnesota began in 1946, when he joined the staff of the West Central Experiment Station and the West Central School of Agriculture, now the University of Minnesota, Morris. In 1952, he became the principal of the Southern School of Agriculture, now the University of Minnesota Technical College, Waseca. In 1956, he became superintendent of the Northwest Experiment Station and the Northwest School of Agriculture, now the University of Minnesota Technical College, Crookston.

—**Sam Brungardt**

BURNING CORN COBS TO DRY GRAIN LOOKS PROMISING

It's possible to burn corn cobs instead of propane to dry shelled corn, but economics depend largely on costs of extra equipment.

That's the tentative report on a University of Minnesota Agricultural Experiment Station study by agricultural engineers Vance Morey and Cletus Schertz.

Neily Watson, 14 years old, of the Village People 4-H Club, White Earth Reservation, Waubun, practices Indian beadwork, taught by one of the many craftspeople in Minnesota helping to keep alive some of the diversity of Minnesota crafts.

"Our results from the 1982 harvest season were encouraging," Morey says. He and Schertz developed a system for cob collection, transportation, drying and combustion.

They get a mixture of corn and corn cobs from the combine. This is done by decreasing the concave clearance so the cobs are broken up and pass through to the sieves. The bottom sieve is removed and the top sieve is opened up to let the mixture of broken cobs and shelled corn pass through.

Most of the husk and leaf materials in the mixture are removed at this point. Then the cobs and grain are elevated to the combine grain tank and transported as a mixture to the drying facility. Transporting them as a mixture eliminated the need for an extra hauling vehicle.

"At the dryer two approaches are possible," Morey says. One is to dry the mixture of cobs and corn in the grain dryer, then separate the mixture, with the corn going to storage and the cobs going to the burner to provide heat for drying. The other approach is to separate the mixture before drying. The corn goes to the grain dryer and the cobs go to a cob dryer, then to the burner to provide heat for drying.

At this stage in their research trial, it's not clear whether the system will be economically feasible. "Performance requirements of the extra equipment and costs of the equipment aren't clear yet. But the potential for saving both dollars and propane tells us this is a promising alternative energy source that merits continued study and development," Morey says.

—**Jack Sperbeck**

ETHNIC CRAFTS IN MINNESOTA: FROM KUBBESTOLS TO CROSS-STITCH

Minnesota crafts reflect the variety of ethnic groups around the state. According to a survey by College of Home Economics researchers Huldah Curl and Joseph Ordos, though the ethnic craftspeople of Minnesota are keeping their crafts alive, they are not making much money at it.

Curl and Ordos interviewed and photographed the work of 64 craftspeople—34 in outstate Minnesota, and 30 in the Twin Cities. They found woodworkers who make kubbestols (decorative chairs carved from a single tree trunk), toys, furniture and looms. They also found craftspeople who do wood turning, Hardanger embroidery, Danish cross-stitch, Russian punch embroidery, rosemaling, straw work, copper enameling, and basketry.

Ten of the 34 craftspeople are 65 or older. Twelve are between 50 and 65. Only 8 of those surveyed outstate clear more than $1,000 a year after the cost of materials has been deducted. For example, one woman spent 600 hours on a Hardanger tablecloth which she sold for $300, earning 50 cents an hour.

A few more in the metro area have their craft as a sole source of income. Of the 30 people the researchers interviewed in the metro area, they found four: a Ukranian easter egg maker, a couple who make pinatas, an American Indian beadworker, and a Greek stone and wood carver. The remainder compare with the outstate craftspeople interviewed: some sell nothing, some give their work away, some sell a little, some make a moderate income from their crafts.

However, the researchers found that isolation was not necessarily an economic factor. The two who made the highest income of the 34 outstate craftspeople live in decidedly rural areas. But, the researchers found, "As a group these people do not know marketing skills and techniques and some are not interested in developing them." Many live in areas where there isn't sufficient density of population to make selling their crafts locally practical. That makes developing a regional or national market important.

Preservation of these outstate crafts is a prime consideration, the researchers believe: "They exist today because of the zeal of a few teachers and the desire of a few oldtimers to continue traditions in retirement."

"Our job is to sensitize the public to the fact that when you are talking about art, there are many choices besides painting and sculpture. We believe through a fine art gallery type setting in the metro area we could begin to change the public's attitude about ethnic crafts," Ordos says. The researchers believe that finding a metro retail outlet would help compensate these craft workers and possibly attract new people into their production, while helping in the preservation of these ethnic crafts.

—Jennifer Obst

New West Central Experiment Station Superintendent Richard Vatthauer, (left) chats with Les Lindor, who was acting superintendent until Vatthauer's arrival.

VATTHAUER NEW HEAD OF WEST CENTRAL EXPERIMENT STATION

Richard J. Vatthauer is the new superintendent of the West Central Experiment Station, Morris. He fills the position formerly held by Ralph E. Smith, who retired in July of 1982. Les Lindor was the acting superintendent at the Morris station until Vatthauer's arrival.

Richard Sauer, director of the University of Minnesota Agricultural Experiment Station, says, "Dr. Vatthauer's background and experience makes him very well suited to help direct agricultural research that will ultimately benefit the economy of west-central Minnesota. His career has encompassed research and extension work, particularly with beef cattle and sheep, as well as the utilization of corn and many of the other crops grown in that part of the state for livestock feeding."

Vatthauer comes from the University of Wisconsin, Madison, where he was professor and extension livestock specialist in the Department of Meat and Animal Science. His service at that university was interrupted for a year in 1972, when he worked as an animal nutritionist for Swift and Company's Feed Division.

A native of central Illinois, Vatthauer has a Ph.D in animal nutrition from the University of Illinois. Earlier degrees, a B.S. in agriculture and a M.S. in animal science, were earned at the same institution.

—Sam Brungardt

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