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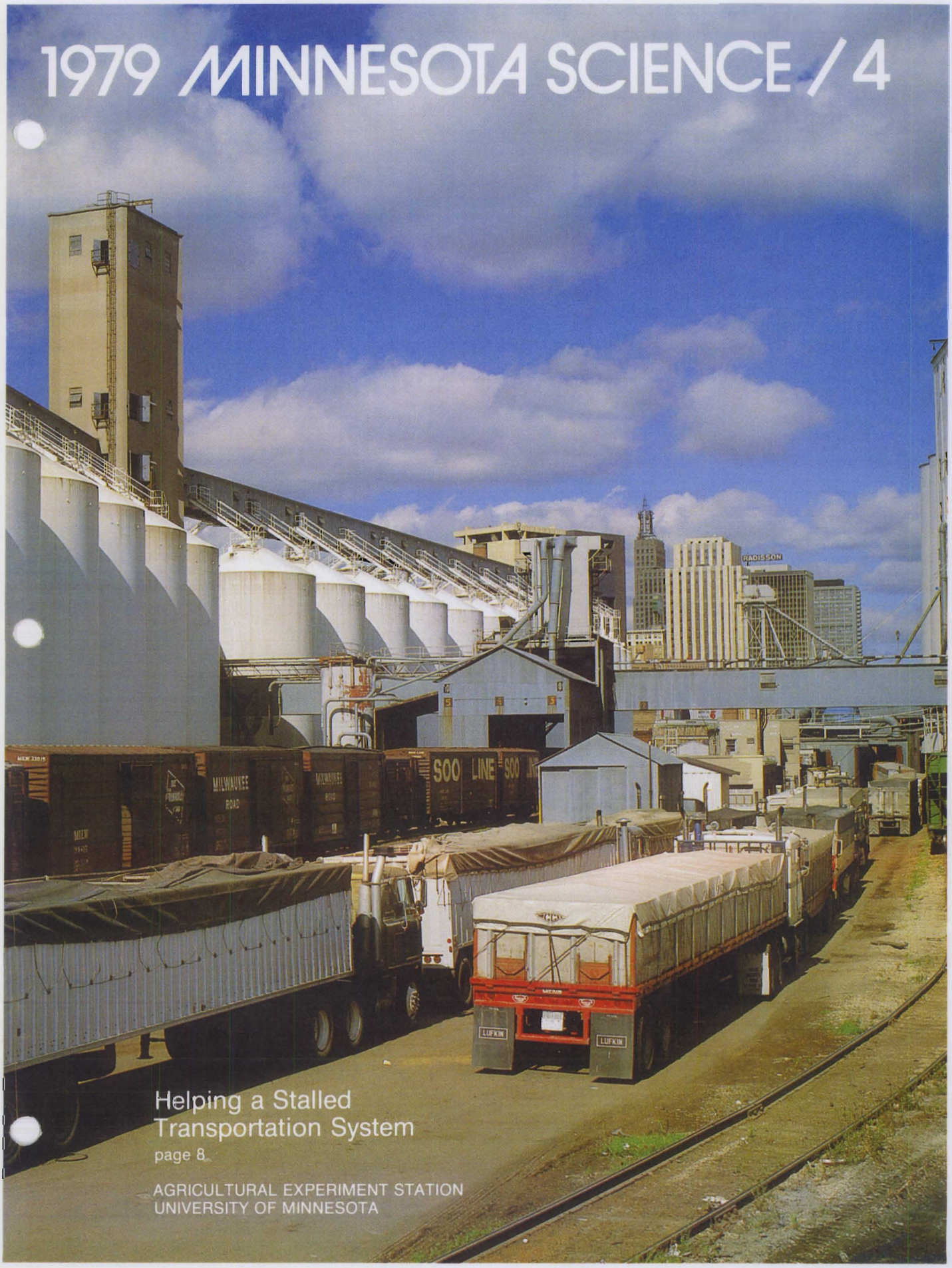

Helping a Stalled Transportation System

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AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA

1979 MINNESOTA SCIENCE

More money needs to be spent on agricultural research to replace a rapidly decreasing knowledge base.

Today, production, storage, transportation, marketing, processing, packaging, more transportation and final marketing require many people in many roles to complete the agricultural circuit from producer to consumer.

That complex circuit needs a constant flow of new ideas to keep it adaptive and flexible to changing times. If the system breaks down at any point, the impact can be considerable. For instance, scientists estimate the recent grain millers' strike created direct losses to agribusiness in the tens of millions of dollars.

Our transportation system is not working efficiently. In response, Governor Quie appointed an Agricultural Transportation Task Force to try to cut through the maze of conflicting information surrounding transportation. Logically, Quie looked to researchers to see what knowledge they had accumulated to help evolve solutions from a careful analysis of the problems. Experiment station scientists, in this instance, have considerable information to share. But that's not always the case.

Fifteen years ago, when the wild rice industry began to expand in northern Minnesota, little was known about the crop or how to raise it commercially. Intensive efforts, aimed at funding and developing a viable research program have now produced results which are accumulating at a rate to favorably impact that new industry. But it doesn't happen quickly.

Research results cannot be garnered overnight. To take an idea and test it carefully and rigorously takes time and an ability and desire to do more than solve problems. As illustrated through the work of Duke, Berg, Jenness, Breene and other researchers highlighted in this issue, it requires a desire to know, a drive to understand, the honesty to question, and the patience to test and retest various theories until the facts become clear.

Roy L. Thompson, assistant director, Agricultural Experiment Station.

Science magazine recently published a report stating that public agricultural research has provided a 50 percent rate of return on its investment. That's a phenomenal rate, yet funding has continued to dwindle in real dollar terms. This will eventually mean less knowledge available to this basic industry.

The purpose of the Agricultural Experiment Station is to provide answers through research which will enable the system to function more smoothly.

An investment in research is an investment in the future — one that will allow agriculture and its related industries to keep our industry and society moving, and to meet new challenges.

MINNESOTA SCIENCE
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COVER: Transportation problems continue to affect the movement of agricultural commodities. Researchers are studying all facets of rural transportation in Minnesota (see story on page 8).

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Wild Rice — Old Crop With A New Impact

In north central Minnesota, wild rice growers produce about 80 percent of all the wild rice consumed in the United States. An intensive research program works to help them achieve better production and profit levels.

NATURAL STANDS OF WILD RICE along Minnesota's northern rivers, lakes and streams have provided humans with food for over 500 years. Chippewa and Sioux tribes relied on it to get through winters as did French explorers and trappers.

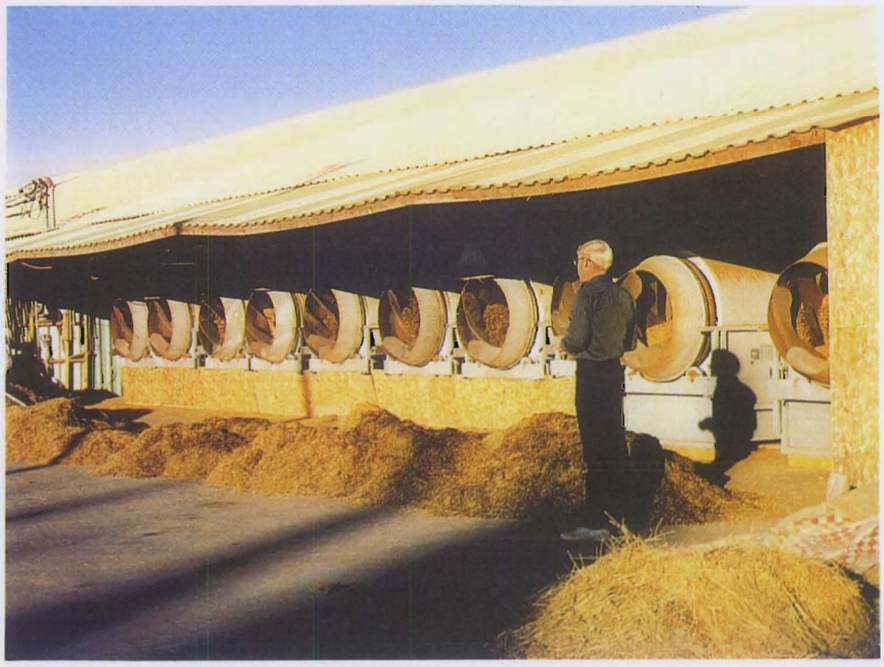
It wasn't until recently, 1959 to be exact, that cultivation of the crop began in Minnesota. Man-made paddies were built to meet a growing demand for the crop and wild rice's importance to the state's economy escalated. Fledgling growers turned to the experiment station for help in establishing and maintaining this new industry. They weren't disappointed.

Now, just 20 years later, 85 individuals and small corporations are growing wild rice, most of it within 130 miles of Grand Rapids in north central Minnesota. These growers supply about 80 percent of all the wild rice consumed in the United States. Moreover, the crop has become vital to the agricultural economy in several Minnesota counties because it can be grown on reclaimed swampland where virtually nothing else could grow.

Wild rice producers expect to get about $5 a pound for their product wholesale and $6-$8 on the retail market. Despite the potential for high profits, wild rice cultivation, like all agriculture, remains a risky business. Fluctuating water supplies, high winds, heavy rains, insects, weeds, disease, early frost, blackbird invasions, and grain processing all pose obstacles which continue to challenge scientists and growers.

Efforts for mounting a concentrated research program in wild rice began in 1964 when William F. Hueg Jr., then director of the station, initiated a proposal to fund a wild rice research and development project. He presented it to the state legislature the following year, and finally received funding in 1969. The first

Early maturing varieties allow for an earlier harvest and less shattering. Producers get about $5 a pound wholesale for wild rice.



appropriation was $75,000 a year, which grew to $105,000 a year by 1973. In the meantime, other research funding was sought and found from the Upper Great Lakes Regional Commission, the National Science Foundation and the U.S. Department of Agriculture through its Northern Research Laboratory in Peoria, Illinois.

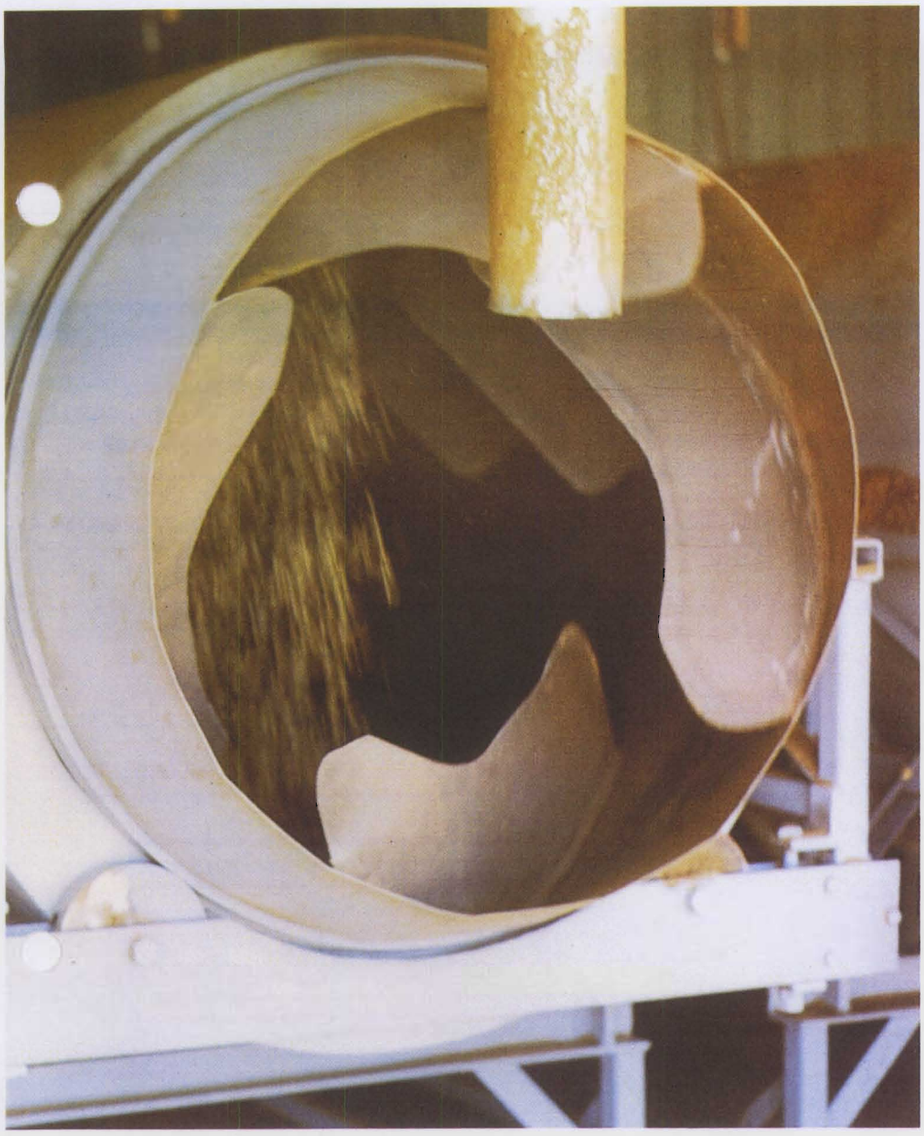
In 1972, experiment station researchers started a multi-year effort to help wild rice growers achieve better production and profit levels. Today, seven ongoing research efforts on wild rice are administered from the St. Paul campus, coordinated by agronomist E. A. Oelke.

Besides campus laboratories and greenhouses, research takes place on plots at the North Central Experiment Station at Grand Rapids (the "hub" of the activity) and at the Rosemount branch station and the Excelsior horticultural research center.

Oelke's main interest is maximizing yields. He has identified optimum plant population, water depth, planting date and rate, and harvesting date for maximum yield. He and his assistants also have screened herbicides for broadleaf weed control. Oelke also has helped develop a way to release seed from its dormant state and identified ways to eliminate volunteer seedlings from fields.

Plant breeder W. A. Elliott was with the project for 5 years. Before he left in 1978, Elliott developed and introduced a new variety of wild rice called *Netum*, an Indian word meaning first. Netum matures 10-14 days earlier than most wild rice varieties, which affords protection from some potential problems.

Early maturity allows an earlier harvest, spread over more days. "When everything matures at once, it's hard for the grower to



Researchers have found that slower drying reduces stress cracks and subsequent seed damage; they plan to study more efficient use of fuel for drying wild rice.

harvest the crop before it starts shattering," said R. E. Stucker, a plant breeder who replaced Elliott on the project. In the past, to avoid shattering, growers owned or leased several combines — one for about every 200 acres.

Optimistic, Stucker predicts that research will develop more early varieties. "There is no doubt in my mind that our research can change maturity drastically," he said. "We must strike a balance between earliness and yield, and I am confident we can. Shattering is a tougher problem to solve, but if we can find a way, it would be a greater contribution to the industry than breeding earlier varieties."

Other University scientists are engaged in a significant amount of research on wild rice:

1. Plant pathologist Jim Percich heads a group working to identify organisms that cause disease in wild rice and to develop techniques of disease control. The group has found a fungicide that protects wild rice plants from leaf blight (brown spot) disease and is investigating ways of improving chemical control procedures. His group cooperates with Oelke and Stucker in approaching disease control through management practices and breeding for disease resistance. Plant pathologists have found several more disease-causing organisms on wild rice. Studies are presently under way to understand their biology, importance, and the role they play in growing wild rice.

2. Entomologist Dave Noetzel continues with the project on a part-time basis to identify problem insects and to find ways to control them. His research has identified chemicals for use against the wild rice worm and midge.

3. Janis Grava, soil scientist, studies soil fertility levels required for optimum yields and investigates the soil chemistry of peat soils. His work has helped growers know what levels of nitrogen, phosphorus, and potassium give best yields.

4. Agricultural engineer Cletus E. Schertz seeks ways to reduce gathering, threshing, and separation losses of grain during harvest. He has suggested design changes in conventional combines for more efficient harvesting. His colleague, John Strait, studies wild rice processing. Strait designed a separator to sort immature kernels from mature ones and decrease processing time by a third. He also found that slower drying reduced stress cracks and subsequent seed breakage. He is now working on laboratory models for improved parching and plans to study more efficient use of fuel for drying wild rice.

A lot of new knowledge has been accumulated since that first wild rice paddy was built in 1959. Oelke takes pride in the fact that 95 percent of all wild rice commercial paddies are located in Minnesota and that the paddies in the state outproduce the natural stands three to one. "University of Minnesota research has contributed significantly to this new industry," he said. "It has helped make wild rice a viable new crop in the state's overall agricultural economy."

— Dave McAllister

Adzuki: Minnesota's New Crop

ADZUKI, A BEAN that's been grown for food in the Orient for more than 700 years, may soon be the basis of an export market for Minnesota farmers and food processors.

Research on the legume has been under way at the Agricultural Experiment Station since 1962, when agronomist Robert Robinson first planted seed.

"I thought some quantities could be sold for human consumption, but realized it would take mass advertising to change American food habits, not really the role of the experiment station," Robinson says. "I believed there was a better market for the adzuki as a protein supplement for livestock. What we didn't know then was that yields would not be high enough to make this type of production feasible."

Today, Robinson's agronomic research on the bean continues, as others further explore the adzuki as a new crop for Minnesota. Their focus, however, is directed toward growing the small, red bean as a human food crop.

A turning point came in 1977, when a Japanese trading company contacted the Red River Valley Edible Bean Growers Association about the possibility of growing adzukis in Minnesota, which is on the same parallel as the adzuki-growing islands of Japan.

The association turned to Lee Hardman, an extension agronomist, and Jim Sutherland, a market development specialist at

Food scientist William Breene watches as Yusuke Asano ladles cooked, Minnesota-grown adzukis into cheese hoops held by graduate students Andres Diaz (far left) and Carmen Tjahjadi. The beans will be pressed to extract the liquor, then they will be mixed with sugar to make *neri-an*.

the Staples Irrigation Center. The first field trials at Staples were promising; yields ranged from 2,220 to 3,300 pounds per acre — high enough to be profitable if farmers were to grow the bean as a food crop.

Once research funds were received from the Governor's Rural Development Commission, a team concept evolved, with Hardman taking care of field production; Sutherland, the marketing aspects; and food scientist William Breene, the processing end.

The most popular way the Japanese prepare adzukis is as *an* (pronounced ahn), a sweetened paste that goes into everything from soups to popsicles to pastries. Isao Hayakawa, a visiting professor from Kyushu University, was chosen to help Breene develop *an* made from Minnesota-grown adzukis.

"Since most of the literature on adzukis is in Japanese, we needed someone fluent in the language who was also familiar with the product," Breene says. "A scientific background was also desired, as well as a sense of the artistic. After all, food products must have aesthetic appeal, especially in Japan."

In 1978, Hayakawa and Breene began to develop an *an* that would have wide application and rival the Japanese product in quality, taste, and cost. They decided to develop *neri-an,* which means *an* with the skins removed.

To make *neri-an,* cooked adzukis are passed through a screen which retains the skins. The resulting reddish paste is rinsed with water to remove bitter, intestinal gas-producing compounds. It is then pressed to remove excess water and varying amounts of sugar are added.

The *neri-an* made with Minnesota adzukis and produced in Breene's lab was put to the test last January when a 10-pound sample was sent to Japanese food processors. It was compared with Taiwanese *neri-an* in a snack food known as taiyaki, a waffle filled with *neri-an.*

The Japanese consume about 440,000 tons of adzukis yearly in such products as (clockwise from top) *shiruko,* a soft drink; *tsubu-an,* sugar-infused whole adzukis; and two types of *yokan,* a confection containing agar-agar.

Breene says the results were more than encouraging: "They told us the Minnesota product was far superior."

Since then, a group of Japanese businessmen has come to Minnesota to discuss possible jointly funded ventures. The researchers have also traveled to Japan to continue negotiations, gather information, and acquire superior varieties of the bean.

Hardman says the adzuki appears to be well adapted to Minnesota. Some of the 200,000 pounds of adzukis grown on 250 acres by farmers in 16 Minnesota counties last summer were shipped to Japan. And, Hardman feels that current market demand could utilize 5,000 to 7,000 acres of Minnesota production by 1980.

Breene has studied the bean's storage needs, and is refining a spray-drying process which would allow adzukis to be exported in concentrated form, thus cutting shipping costs. And a method of replacing granulated sugar with semi-purified sugar has been developed, resulting in a projected 20-percent savings in processing costs.

As negotiations continue on processing plant construction, the researchers are continuing their work with a second grant from the Governor's Rural Development Commission. Sutherland is exploring shipping, plant operation, tariffs, and other marketing-related problems.

Breene is now working with Yusuke Asano, of Tokyo's Meiji Milk Products Company, on rat-feeding experiments to test the Japanese claim that adzukis are the most perfect form of protein.

"Although the protein quality is not as high as we once suspected, it still is comparable to soy and other legumes," Breene says. "Nevertheless, we're still encouraged by the results thus far."

Interest shown by one Minnesota food company has led Breene to predict the development of a domestic market for the adzuki.

"Most people who've tried *an* in the lab have liked it," he says. "And it is a nutritious food source. Based on dry analysis, the bean is about 25 percent protein and 75 percent carbohydrates, which includes a smattering of some fats, minerals and fiber.

"Who knows? Maybe the adzukis will be the next yogurt!"

— Cori Scarbnick

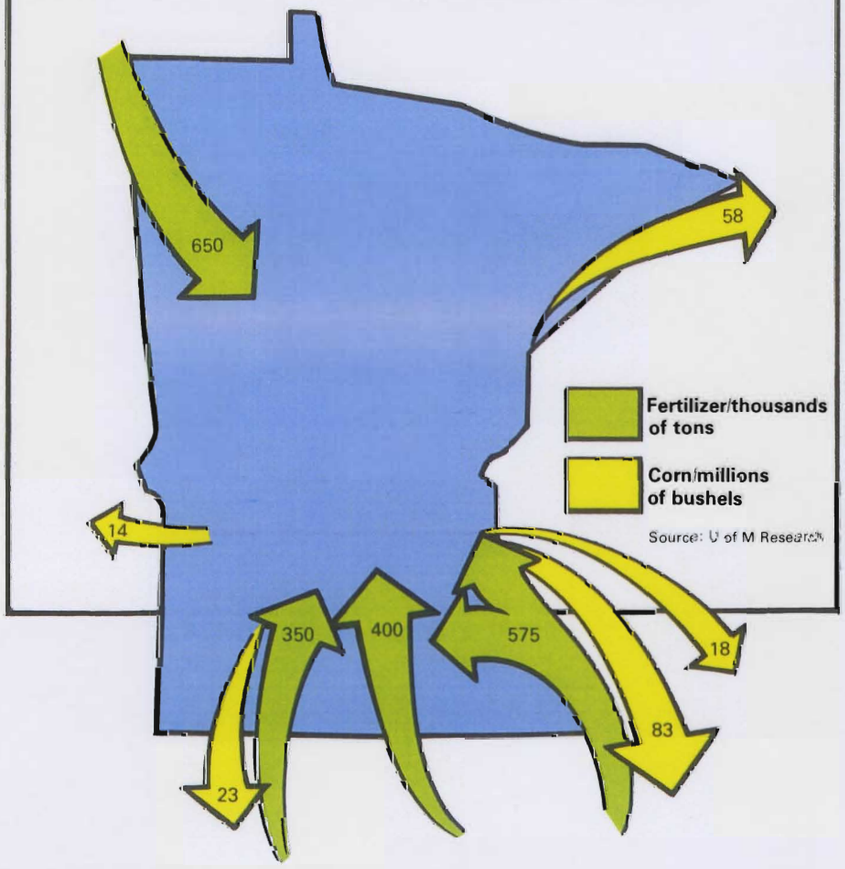
Research to Help a Stalled Transportation System Get Moving

1978 Corn and Fertilizer Flows

This drawing depicts just a small part of the complex logistics system that moved commodities and energy resources in and out of our state in 1978.

Thirty percent (196 million bushels) of our total corn crop was exported the following ways: 83 million bushels by barge to the Gulf; 58 million bushels by vessel out of Duluth; 18 million bushels by rail from the Twin Cities to the Gulf; 14 million bushels by rail from western Minnesota to the Pacific Northwest and on to the Orient; and 23 million bushels by rail from southern Minnesota, mostly to the Gulf.

Almost 2 million tons of fertilizer moved into the state the following ways: 650,000 tons by rail from Canada; 575,000 tons by barge up the Mississippi; 400,000 tons by rail to southeastern Minnesota; and 350,000 tons by truck and rail to southwestern Minnesota from pipelines in northern Iowa.



HARVEST IS OVER, but the transportation crisis that plagued it won't go away until some difficult decisions are made. Fortunately, researchers have been gathering information for some time now on all facets of rural transportation in Minnesota — information that will be needed to help make those decisions.

Our nation's entire transportation system has been operating under tremendous stress since 1972, when exporting skyrocketed. Minnesota is affected perhaps more than any other state. "Although we are major exporters of corn, wheat, soybeans and soybean products, sunflower seeds, and more — and the prosperity of our agriculture and our state depends on these exports — we are about as far away from the oceans as you can be in this country," says Jerry Fruin, assistant professor of agricultural and applied economics.

Consequently, it's more complicated to get our agricultural products *out* and the energy resources necessary for production (coal, oil, fertilizer) *in*. To further complicate matters, agricultural production climbs each year, more is exported, and more is sent farther away. This is known as an increase in "ton-miles."

Governor Quie recently established an Agricultural Transportation Task Force to find ways to cut red tape and make recommendations to the Minnesota legislature and the U.S. Congress when they convene in 1980. This task force and other agencies and committees

Researchers surveyed grain flows by origin, destination and mode of transportation. The results can be used to assist in rail abandonment decisions.

examining the crisis will provide University researchers the opportunity to take their findings directly to decision-makers. Some research findings related to the state's transportation problems are highlighted below.

Getting Down to Basics

Grain is, by far, Minnesota's primary export commodity. But how much grain moves through the state? Where does it come from? Where is it going? And how does it get "from here to there?"

Research results which can answer those basic questions are just coming in. As part of a nationwide project entitled "Evaluation of Alternative Rural Freight, Transportation, Storage, and Distribution Systems," 1977 grain flows (including oilseeds) were surveyed by origin, destination, and mode of transportation. Similar information, based on actual survey, has not been available since the 1950s. Reynold Dahl, professor of agricultural and applied economics, and research assistant Gerhard Wilbert have overseen Minnesota's part of the national project. They will summarize these grains flows for Governor Quie's Agricultural Transportation Task Force.

"These grain flow data are needed to better understand the transportation process and planning purposes," said Dahl. For example, the results can be used to assist in rail abandonment decisions. Railroads periodically ask the Interstate Commerce Commission (ICC) for permission to abandon service on portions of track, in an attempt to improve their financial condition. Survey results can aid the ICC by showing how much grain produced in an area suggested for abandonment would have to be moved by an alternate method.

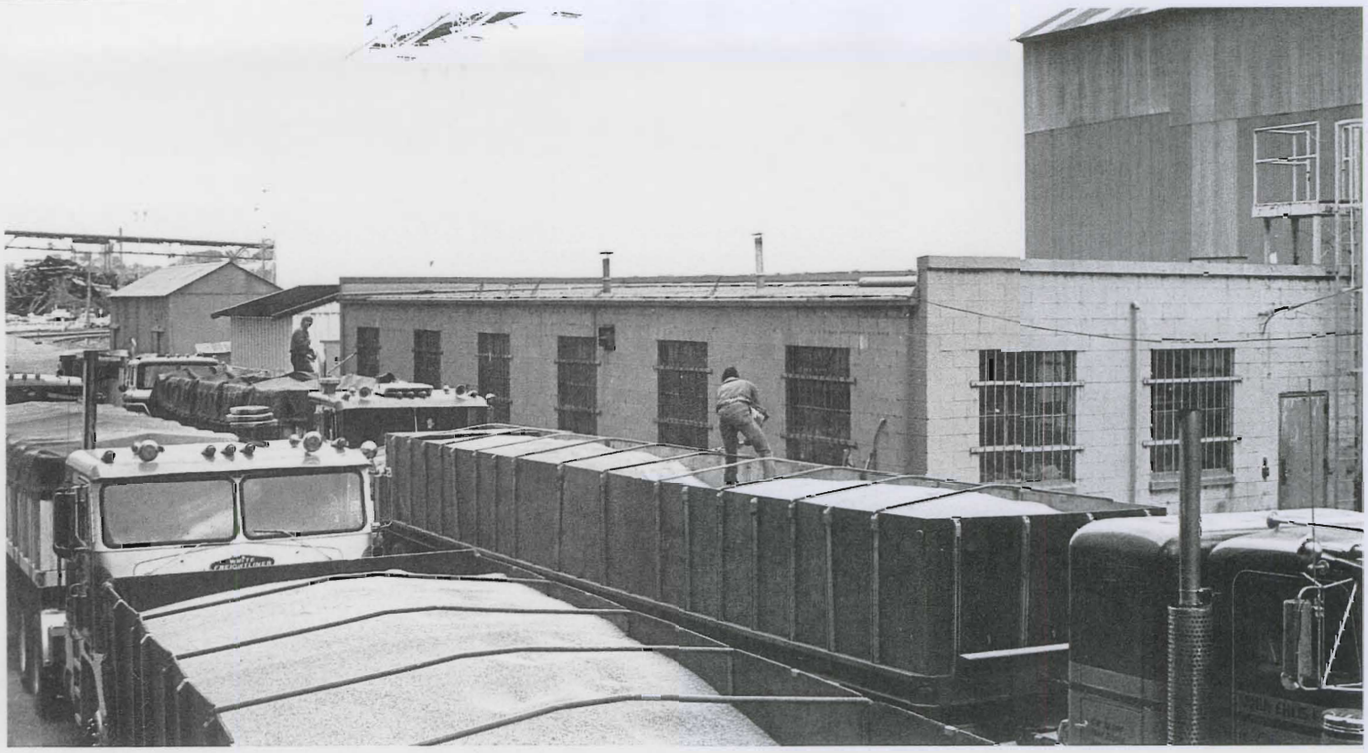
Railroads — Getting on the Right Track

Dahl says railroad deregulation is another important policy issue. Since 1887, railroads have been regulated by the ICC via a structure based on the assumption that railroads monopolized transportation, which was true at that time. Regulation was designed to protect the public and insure that reliable, efficient transportation was available. But the structure now works against that goal by keeping railroads from competing with other transportation modes. Truck rates, for example, are regulated for many commodities but not for agricultural goods, and barges aren't regulated at all.

Little analysis of the costs and benefits of rail regulation had been conducted when Dahl and former research assistant Michael Martin began a study of one specific regulatory issue — rules for ratemaking.

Dahl explains that the rail-rate structure is based on a "value of service" pricing concept; that is, charges are not based on the cost of transportation but on how much the goods being transported are worth. One obvious consequence is that many products which could be moved most efficiently by train were shifted to other modes of transportation.

Dahl's and Martin's research evaluated the impact of a



An improved transportation system would include all modes. According to research, each mode is the best choice in a given situation. Using energy efficiently is at the heart of the matter.

Long waiting lines are a standard expectation for truckers hauling grain. Waits of 36 hours have not been uncommon.

proposed change from a "value of service" to "cost of service" pricing concept on wheat and barley. It showed that the misallocation of grain traffic (at least largely due to the present pricing structure) imposes a cost on society of between $14.9 and $19 million annually in the Upper Midwest.

Based on this and other data, Dahl and Martin recommended that railroads be given more flexibility in ratemaking to become competitive — especially in the Midwest, where transportation alternatives are available.*

Too Many Roads

Just as our railroads were designed with no inkling of what motor trucks would do to America's transportation system, our rural roads were laid out at one-mile intervals with the horse and buggy and a farm on every corner in mind. Both systems suffer from old age.

"There are definitely too many rural roads," says Fruin, "But everybody thinks it's the *next* township that has too many!"

Fruin's research has brought him to three basic conclusions: 1) reduce total mileage of rural roads where excessive, to reduce operation and maintenance expenses and free the land for agricultural production or other use; 2) increase fuel taxes, levying them on the dollar value of gasoline sales to keep pace with inflation, and use the money to maintain, repair or rebuild necessary roads; and 3) vigorously enforce weight limits on trucks to cut down damage to roads.

Better Ways with Waterways

Like our railroads and rural roads, our waterway system on the Upper Mississippi River is getting old and showing it. Meanwhile, volume goes up. This year's demand for barges was greater than ever as grain, originally destined to be shipped out at Duluth-Superior, was sent to the Twin Cities due to the grain processors' strike.

Information is necessary to make decisions affecting dredging, other channel maintenance, and the system of locks and dams. But little had been done in the way of

*The Agricultural Experiment Station, University of Minnesota, has published this study, *Social Costs of Regulatory Railroad Grain Rates in the Upper Midwest* in Technical Bulletin 319-1979.

a systematic study of current or future barge requirements. So a project was undertaken by Fruin, research assistant Robert Hill, and former project assistant Carol Such. Their goal was to project bulk commodity barge traffic between the Twin Cities and Guttenberg, Iowa, in 1985.

Imagine the magnitude of the project! All commodities affecting barge traffic had to be analyzed, their growth potential estimated, and all possible factors affecting their movement considered. The final prediction was an increase in total barge shipments of 59 percent over 1975 levels.

The information was broken down by raw farm products, coal, and miscellaneous products. Future coal movements were the trickiest to project because of uncertainties regarding federal energy policy, environmental requirements, and Western coal (from Montana, North Dakota, and Wyoming.)

Using Energy Efficiently

Fruin, who has been studying the transportation problems of Minnesota and the Upper Midwest for the past 4½ years and is coordinating the University's findings for Governor Quie's task force, says, "Our research demonstrates the need for an improved transportation system that includes *all* modes." Although some modes are more energy efficient in terms of BTUs (see table), each is the best choice in a given situation.

ENERGY USE BY MODE (1975)

	BTU's Per Ton-mile
Rail	687
Semi Truck	2,161
Air	13,152
Barge	535
Oil Pipeline	525

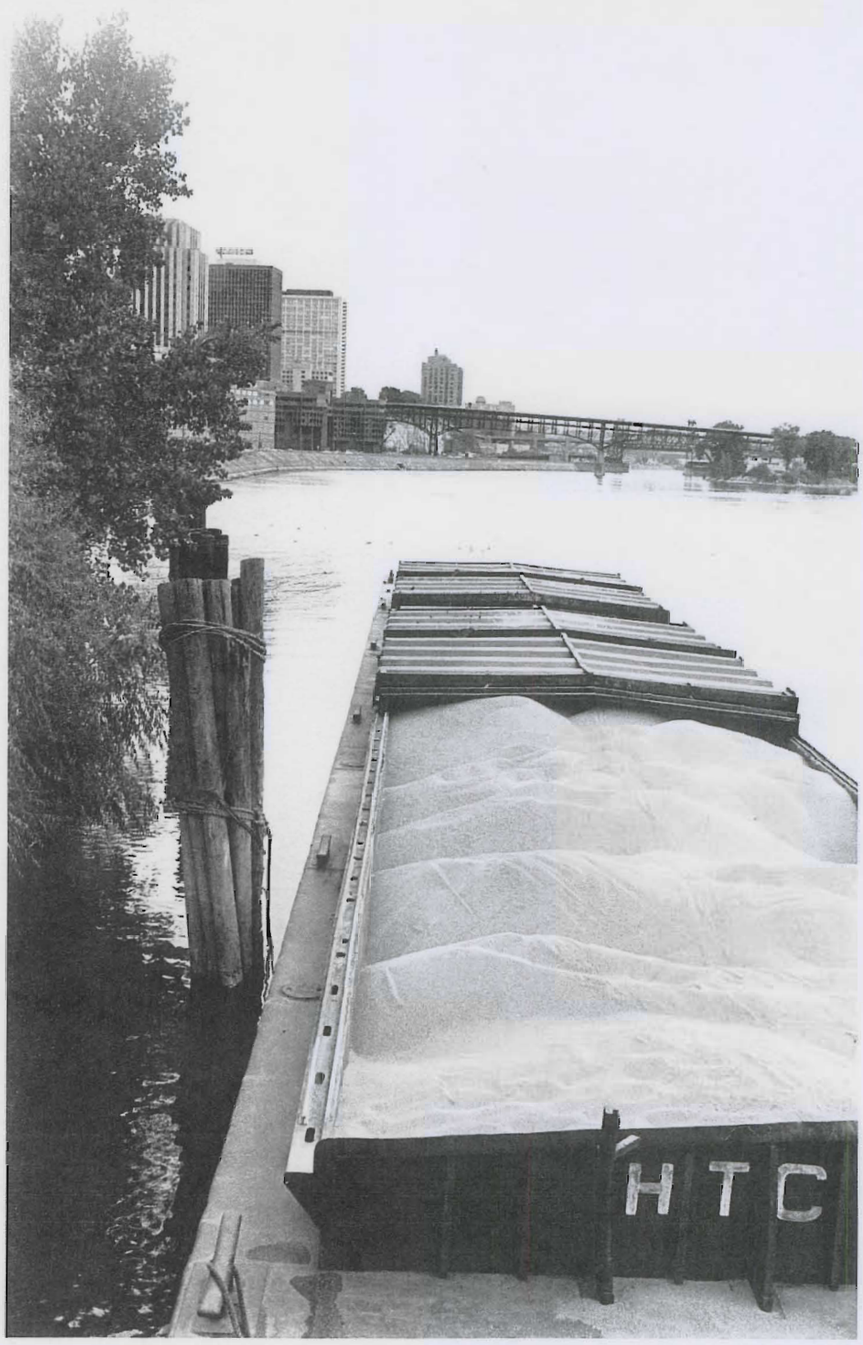
SOURCE: U.S. Department of Transportation. "A Prospectus for Change in the Freight Railroad Industry," p. 106, 1978.

Using energy efficiently is at the heart of the matter. When conditions exist that prevent the most energy-efficient mode from being used, product prices go up and precious energy is wasted. Both producers and consumers lose.

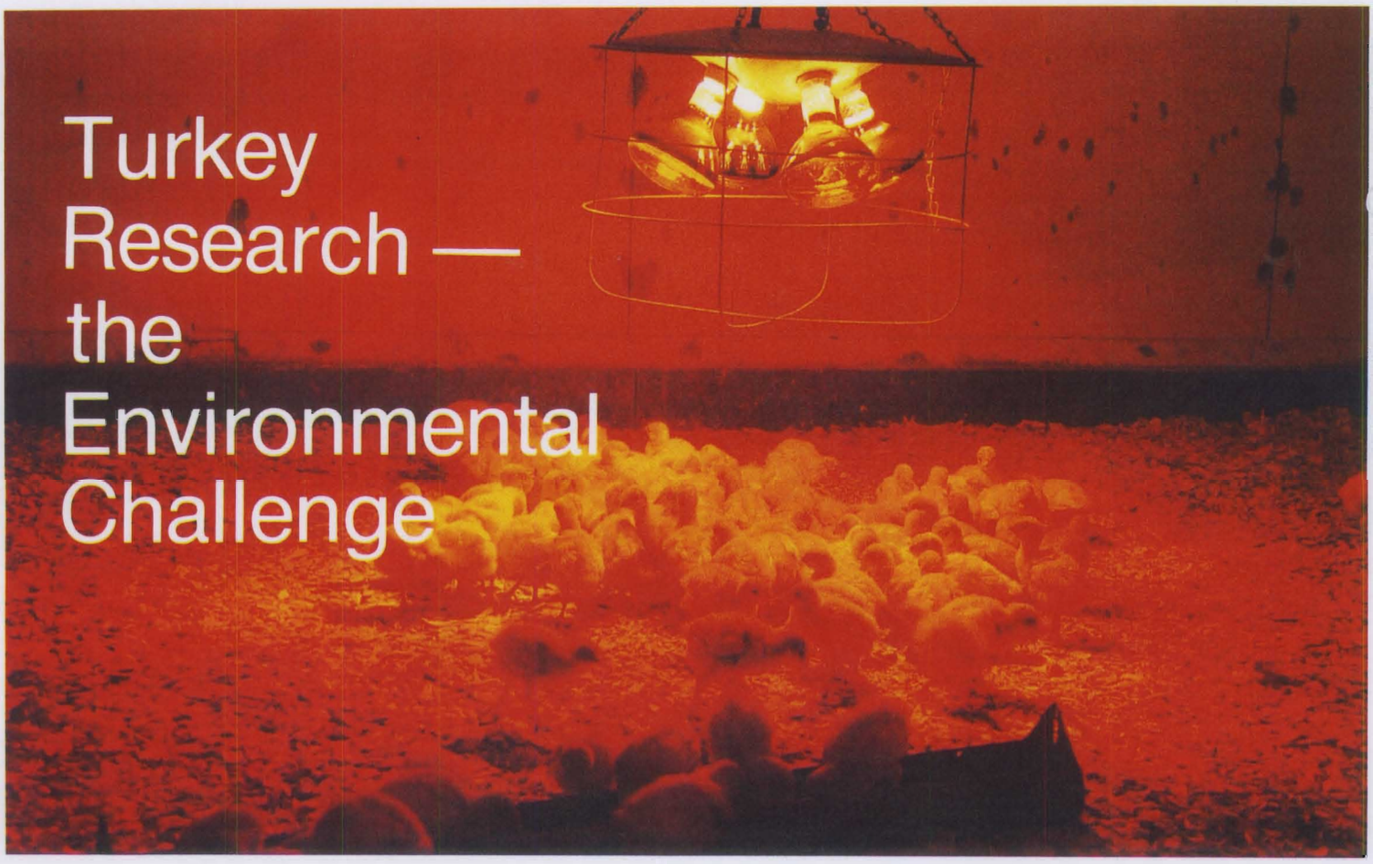
While problems aren't new to our country's transportation system, the energy crisis puts them in a new perspective. Decisions for solving our transportation problems will probably help to solve some of our energy problems, too.

— Sharon Farsht

A recent study projected bulk commodity barge traffic between the Twin Cities and Guttenberg, Iowa, in 1985.



Turkey Research — the Environmental Challenge



Light is a critical environmental factor for turkey growth. The duration and intensity of the light varies depending on age and sex of the birds.

MINNESOTA HAS BECOME the leading turkey-producing state in the nation. Over 25 million were produced last year, and even more will be raised this year.
As the industry has grown so has the number of confinement operations. Raising turkeys in a controlled environment requires operators to take into account many complex interrelated variables. Growers constantly strive for better management of these variables in order to produce the best turkeys in the most efficient and energy-conserving way.

Light Studies

Robert W. Berg, professor of animal science, has been studying a critical environmental factor for turkey growth — light. "It has been the opinion of some turkey growers that the more light the better," Berg says. "Because birds eat when there is light, they assume that if they give their birds 24 hours of light, they will eat all the time and grow rapidly. This isn't so." Berg has found that 2 hours of light, 4 hours of darkness, around the clock, gives turkeys sufficient time to eat, sufficient time to rest.

Studying the best duration of light for turkey growth led Berg to investigate the best intensity to light. Tests revealed that bright light is not necessary for raising hens. In fact, Berg says, "We don't want to give hens too much light because light stimulates sexual development, and when hens develop sexually they stop growing." Dim light produces a ½-pound heavier hen, or saves 1 week's time bringing the hen to market.

The best light program for toms is slightly different. Dim light works well for toms the first 8 weeks. After 8 weeks, they need brighter light because hormone stimulation increases growth for toms.

And, because in research one thing tends to lead to another, Berg says, "Now we want to look at the *color* of light. Since the wave length of red light is known to stimulate hormones, maybe we should be raising toms on red light, hens on blue. Or perhaps fluorescent light would be just as

good as incandescent, and considerably less expensive."

Space Requirements

Berg has also been developing space concepts as part of a total turkey management program. He has designed a long, three-room building for raising hens. Day-old poults are placed in the first, smallest room where they are kept for 5 weeks. Then they are moved into the next two progressively larger rooms as they grow. The advantages to this building, says Berg, is "the grower doesn't have to load the turkeys up and move them to another building at any stage. The smallest space is used when the warmest temperature is necessary (poults need 95° temperature.) Energy is saved and contamination from flock to flock can be eliminated. If a disease problem develops in one room, it can be isolated with no traffic between rooms." Berg also designed a five-room building for toms, since they live longer and grow larger.

Still to be determined is the optimum space for turkeys at each age. Research by Paul E. Waibel and M. E. El Halawani, professor and scientist in animal science, respectively, has shown that crowding can suppress growth. Four square feet per bird produces more growth than 2 square feet per bird, especially in warmer temperatures.

Nutrition and Turkey Diets

Waibel and M. E. El Halawani also have been studying nutritional requirements of turkeys at different ages and under different environmental conditions. For example, "In cold weather birds need more energy and eat more. In hot weather they eat less and therefore get fewer critical nutrients. The only way a turkey grower can compensate is to adapt the feed in warmer temperatures to make it richer in essential nutrients. Feeding for environment is very important," Waibel says.

Adjusting diets to fit age and environment is becoming more common. Twenty-five years ago a grower gave turkeys three diets — a starter, a grower, and a finisher. Now, says Waibel, turkeys grow faster, they finish sooner, and in their total life span, they could have nine diets. These diets vary proportions of corn and soybean — higher in soybeans in the first stages of turkey growth, and progressively more corn as the turkey matures. But if protein levels drop too much, growth slows, making inexpensive feed a false economy. Lysine is the critical amino acid to be monitored, because corn is low in lysine, and when lysine deficiency exists, it means the bird is not getting enough complete protein. Researchers check turkeys' blood samples for free amino acids to determine whether a lysine deficiency exists.

"Nutritionists always strive for greater efficiency of nutrients needed," Waibel says. "We're trying to find the minimum level of nutrients needed to produce a healthy turkey. It doesn't make sense to waste protein growing turkeys to produce more protein."

With over 25 million turkeys produced each year, turkey growers must be doing something right. But with pressures on the industry, such as increasing energy costs and rising feed costs, the more they know about controlling their variables, the better.

— Jennifer Obst

Controlling Turkey Diseases

TURKEY GROWERS MUST deal with disease. The estimated yearly loss to growers due to infectious diseases, such as fowl cholera and avian influenza, is over $2 million dollars.

The poultry industry in Minnesota has relied largely on vaccination for protection of its flocks. Station research is attempting to develop new and better vaccines and to understand the mechanisms of the diseases.

Some diseases can be crippling in themselves, and they also can weaken the birds' immune system and predispose them to other diseases. Samuel K. Maheswaran, associate professor of veterinary pathobiology, has been studying the "immunocompetency" of turkeys and factors which cause "immunosuppression."

"The inability to produce long-lasting immunity in turkeys against infectious diseases may have been because the birds were immunosuppressed at the time of vaccination," he says. In other words, if the natural immune mechanisms of the turkey have broken down, vaccinations will not work. In fact, they could be hazardous. "If there is an influenza outbreak and a turkey grower goes with any live vaccine, (such as fowl cholera vaccine) up to 50 percent of the flock can be lost due to reaction from vaccination," says Maheswaran. Maheswaran is studying how to manipulate the turkey's immune system with drugs and revert this immunosuppression. He says this is possible. The question then is how practical would it be. Growers must always balance the cost of drugs with the cost of disease.

Maheswaran has also been working for the past two years on an improved fowl cholera vaccine — a live vaccine that is administered in the turkeys' drinking water every 5 weeks. "The cost to vaccinate each tom is 9 cents and 6 cents per hen. We are trying to increase the duration of protection of the vaccine from 5 weeks to longer using immunopotentiating drugs. We've gotten encouraging results in the lab. Now we need to do some field testing."

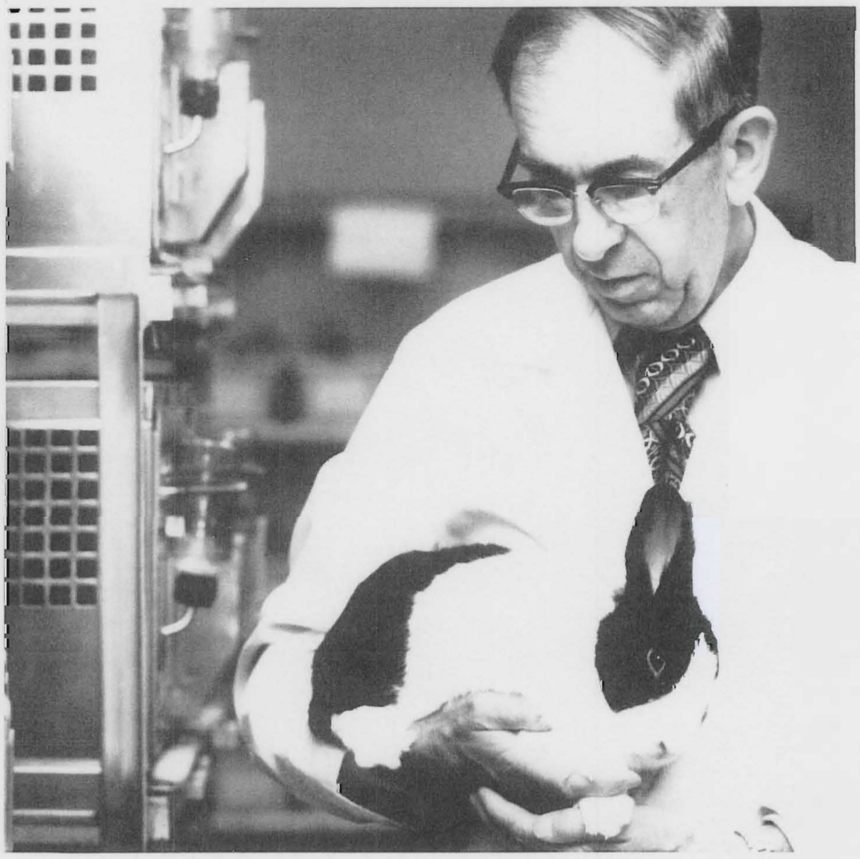
Nutritional Value of Mother's Milk

WHEN THE BODY of a pigmy sperm whale washed up on a beach in Florida, it not only attracted local attention, it also gained the interest of Dr. Robert Jenness, a biochemist who studies mammals' milk. Jenness studies milk to discover the nutritional value of mother's milk for the young of a species. In addition, he notes the composition of milk proteins which allows him to trace the evolutionary development of different species of mammals.

During the past 20 years, Jenness has devoted a part of his research effort to the analysis of milk samples from over 200 species of mammals. He has studied milk taken from the pigmy sperm whale, Minnesota dairy cows and goats, sea otters from California, Mexican bats, Norwegian bears and western United States rodents.

"I have trapped and netted wild animals myself, but I usually rely on and collaborate with zoologists, zoos, research institutes and interested persons around the world to send me milk samples," Jenness says. Milk samples often arrive at his laboratory by parcel post or sometimes by messenger.

Nutritive analysis of mammals' milk has helped devise substitute formulas useful in the manufacture of milk products and when raising orphaned mammals.



The milk is usually packed in dry ice or is freeze dried and later reconstituted with water.

Even with all the help, Jenness still enjoys the field work required to gather milk. "Although I have analyzed lion, tiger and polar bear milk, I mostly collect samples from the smaller and more elusive mammals such as shrews, mice and bats."

Is it dangerous? "Oh, not really," says Jenness, "I've only been bitten once -- that was by a laboratory hamster.

"I am interested in nutritional research because it can provide information on how lactation, one of the more important biological functions all mammals have, fits into the nutrition of the young of the species."

After receiving a milk sample, Jenness says, "I first look at the overall nutritive composition as to fat content, carbohydrates and protein." This nutritive analysis of mammal's milk has helped companies which manufacture milk products and individuals interested in raising young mammals devise substitute formulas. The research also has been helpful to persons trying to raise orphaned mammals of an endangered species.

Once Jenness completes a nutritional analysis and when there is a large enough milk sample, he studies the protein composition of the milk. "Distinctive proteins, found only in the milk of lactating mammals, can provide a document to species evolution," Jenness says.

By comparing the present day differences among milk proteins which have resulted from the mutation of genetic materials, Jenness is able to build up a line of descent or family tree which shows what may have happened in the evolution of a species to its present state and its relationship to other mammals.

"I haven't changed the evolutionary view of mammals," says Jenness, "but I have helped to confirm parts of the process which fit in with previous evolutionary theories."

— Gregg Doerning

Science Notes

SAVE MONEY ON CALF RAISING

Minnesota dairy farmers could save $9 million by following scientists' recommendations on feeding waste milk or colostrum to calves. Waste milk is milk from cows treated with antibiotics for mastitis or other infections. It cannot be used for human consumption.

University of Minnesota dairy scientist Don Otterby has done research showing that using waste milk and surplus colostrum can reduce costs of raising calves. Many farmers could practically eliminate using saleable whole milk or milk replacer from the calf feeding program, he says.

Otterby calculates that 250 pounds of milk (or its equivalent) are needed to support a calf to weaning. If 345,000 heifer calves in Minnesota are raised to weaning, over 86 million pounds of milk or its equivalent in milk replacer are needed. Average savings would be $300 per Minnesota farmer during a year.

In addition, says Otterby, it's likely that some bull calves could be raised to weaning using waste milk. This could salvage value from milk that would otherwise be discarded.

CONSERVATION TILLAGE

What about conservation tillage on sandy soil? Tests so far show good results on irrigated coarse-textured soil.

Agricultural engineer Ronald Schuler is testing four tillage systems at the University of Minnesota Sand Plain Experimental Field near Becker. Corn yields for 1978 showed no significant differences between moldboard plowing, chisel plowing, and till-planting.

Schuler explains that goals of his study are to find tillage systems that conserve soils, water, and energy without sacrificing yields. He started the Becker research in 1973 and plans several more years of testing. Scientists looking at tillage alternatives in other areas of the state include Gyles Randall in Waseca and Wallace Nelson near Lamberton.

TRACKING THE ACTION OF APP

Research on a digestive hormone in the gastro-intestinal (GI) tract of turkeys may help fatten the birds more efficiently someday.

Gary E. Duke, professor of veterinary biology, has been investigating the physiology of the GI tract of the turkey for the past 12 years. He is focusing on one digestive hormone — avian pancreatic polypeptide (APP).

Humans have a similar hormone called HPP. "HPP is not centrally stimulated in the brain like some hormones; we know that it is activated in the digestive tract," Duke says. "We know that people who are chronically obese have less HPP than other people. Researchers assume that this hormone, when activated, slows the spontaneous motion of the digestive system. In people who have low levels of HPP, gastric motility is never slowed; the stomach is always emptying itself, and they are always driven to eat."

Duke thinks APP functions similarly in turkeys. To track the action of APP requires precision sleuthing. Plastic loops are surgically inserted to close off the portion of the intestinal tract to be studied; then purified nutrients are injected directly to that area, and blood samples are taken at intervals. A major tool used is a biochemical technique called radioimmunoassay (RIA), which allows researchers to separate and identify the quantity of a particular hormone in a sample of turkey blood. RIA for APP is performed in the lab of a collaborator, Joe Kimmel of the University of Kansas Medical School.

Until he knows how APP works in birds, and to what kind of stimuli it responds, Duke says it is difficult to make any assumption about how to control it. "Only by understanding the normal control mechanisms of the GI tract of the turkey can we determine which functions are altered by disease. After we understand the normal process, we can consider the possibility of experimental alteration of normal functions to improve digestibility or allow stimulation of digestive functions depressed by disease."

Studies indicate that a digestive hormone in turkeys may influence the rate at which the stomach empties itself. This research may help fatten turkeys more efficiently someday.

Programs for small computers will help farmers mechanize records and calculate and predict things like grain storage costs.

SOFTWARE FOR ON-FARM COMPUTERS

The small computers which are becoming widely available could potentially be useful for farm recordkeeping and decision-making, says Earl Fuller, farm management specialist. A lack of farm-oriented "software" currently limits their usefulness, however.

"You can get a pretty good small computer for about the same price as a four-wheel-drive pickup," Fuller says. "The problem is getting good farm software — programming — to make that hardware worth what you paid for it."

Farm management specialists are writing small-computer programs that will help farmers calculate and predict grain storage costs, grain drying economics, tax depreciation, inventory controls, cattle gains, and other activities.

"These small computers have a real future," he says. "They are becoming very cost efficient. Management information systems are being developed through experiment station funding to let the farmer mechanize records and other data sources the way he or she has already mechanized planting and harvesting. As proper software becomes available, the computer will save hours and hours of pencil figuring."

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