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AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA

Research Opportunities: Forestry, Housing and Others

KEITH HUSTON
Director, Minnesota Agricultural
Experiment Station

ENERGY QUESTIONS ARISE now more frequently than ever. And, as we attempt to respond to them we find we need additional research expertise. Two areas in particular demand new research leadership.

One of these areas is forest resources. Minnesota's forests currently are underutilized, but that likely will change. However, for that change to be orderly and of the greatest benefit, new forest resource assessment techniques are needed. When, what, how, how much, and where to harvest are key questions. And, equally important are questions about the economic and social consequences that relate to future demand and supply, energy requirements, and the need to protect water, wildlife, and recreation. Two new positions in forest resources are needed to help address some of these issues.

Subsequent use of forest products in construction is the second area for new research leadership. New energy conservation technology is needed both in producing wood-base materials and in wood-frame construction, particularly with new materials to be specially created to reduce heat transfer and infiltration. In addition, energy conserving homes, which will be built in new ways with new materials, will require special consideration be given to the exterior and interior design.

Each new generation of discovery brings with it a need for more complex and sophisticated equipment and experiments. So, beyond the need to employ a few new research leaders in special areas, one effective use of new resources is in support of existing research.

And still another significant use of new resources is for encouraging young Minnesotans to become research scientists by employing them as research assistants to our scientists. Already shortages of scientists in crops, soils, economics, and engineering are at hand. Other shortages are developing. Almost every week we are asked to loan or send our scientists to help poor nations develop their food supplies.

I am gravely concerned about these shortages for they seem likely to be only the beginning. In the next eight years, the pool of talented students from which we must attract future scientists could shrink by 15 to 20 percent. Students with experience in agriculture are likely to be even fewer. Without sufficient research assistantships to attract and encourage students to enter research careers, we could find ourselves in the mid-1980's with acute shortages of agricultural scientists and all the consequences attendant on that.

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COVER: Experiment Station scientists are trying to find new ways to reduce energy consumption in agriculture. Energy saving in livestock and poultry production is a major area of concern (see story on page 8). Photo by David Hansen.

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Searching for a Superior Alfalfa

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Department of Information
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THREE SCIENTISTS at the University of Minnesota are breeding alfalfa strains that they hope will free farmers from some of their dependence on the nitrogen fertilizer market. Their energy-efficient alfalfa could potentially yield more tons per acre of high protein forage and leave behind large amounts of nitrogen for subsequent crops.

The researchers, agricultural geneticist, Donald Barnes and plant physiologists, Gary Heichel and Carroll Vance, are employed by the Federal Research branch of the U.S. Department of Agriculture, Science and Education Administration. They are trying to improve the nitrogen-fixing ability of experimental alfalfa strains. This would conserve billions of cubic feet of natural gas, the primary raw material for commercial nitrogen.

Prior to the 1950's, a common practice was to partly replenish nitrogen in soils with forage legumes, says Heichel. Then, nitrogen became inexpensive. "Farmers got it from a bag rather than from a renewable source."

Nitrogen fertilizer cost the farmer about five cents a pound until a shortage in the early 1970's drove the price up to 30 cents. It has since declined to 10 to 15 cents. The gradual de-regulation of natural gas prices approved by Congress makes future nitrogen cost increases likely, however.

According to Barnes, two of the strains being designed are for normal alfalfa usage in the Midwest. "After two breeding cycles, these lines have fixed 65 to 70 percent more nitrogen than the original plants," he said. "And, we believe that plants that are outstanding for nitrogen fixation will probably be outstanding yielders because nitrogen fixation is a very complex system which is essential to many types of processes in the plant."

The research goes beyond the standard Midwest varieties, however. The team is also developing an annual alfalfa that will store more nitrogen in the roots. They hope this legume will heighten the economic appeal of an "old fashioned" soil enrichment practice — crop rotation. The annual would be especially useful for set-aside acreages, they say.

"A cropping system of three years of alfalfa followed by two years of corn may again become attractive," Heichel says. His research predicts a 39 percent total energy savings of such a system when compared to five years of continuous corn fertilized with the commercial nitrogen.

He also points out that if 10 percent of the national corn crop, about 7.5 million acres, could annually be fertilized through rotation with alfalfa, 28 billion cubic feet of natural gas would be saved. "That quantity would heat 440,000 Minnesota homes a year."

"One criticism often made of rotations is that their average annual productivity is often less than that of continuous corn," he notes. "Rotations are becoming increasingly cost-effective, though, because of stronger demand for forage crops."

Development of an annual alfalfa would make rotations even more attractive. Winter hardy varieties of perennials become dormant in late summer or early fall to prepare for cold weather. An annual, however, would continue to fix nitrogen until a killing frost.

Barnes and his team are working on their goal of developing an

Alfalfa research plots at Rosemont branch station.

annual alfalfa that would make 150 lb. of nitrogen available to the following year's corn crop. In many situations, this would eliminate the need for added commercial nitrogen. An annual alfalfa, seeded with oats under Minnesota conditions, would provide one crop of oatlage. Two cuttings of the legume could also be made before the crown and root were plowed under in late October.

The researchers have found that cultivars vary in their ability to store nitrogen in their roots. They are now selecting varieties with increased nitrogen storage capacities, since this would make more of the nutrient available to following crops.

Barnes looks forward to releasing new alfalfa varieties in the mid-1980's. However, the greatest impact of the joint USDA-University research will come from the development of practical methodology, he says. Other breeding teams may use methods to upgrade nitrogen fixation in all major forage and grain legume species.

An Ounce of Prevention

DEIDRE NAGY
Department of Information and
Agricultural Journalism

Although adult males generally are most knowledgeable about energy conservation alternatives, both partners participate in decisions about thermostat settings and weatherizing the house.

MANY OF US TALK a great energy conservation game. Our consciences nag if we nudge the thermostat higher on sub-zero days. Or, we feel a twinge of guilt if we drive to work alone in a fuel-thirsty car.

But how much are we cutting our consumption of dwindling energy resources? And, how do we feel about the lifestyle changes that government leaders and our own pocketbooks are asking us to make?

These are among the questions that M. Janice Hogan, associate professor of family social science at the University of Minnesota, researched with 40 Twin Cities families during 1977-1978.

By interviewing families, having them keep diaries of thermostat settings, and driving and checking electricity, natural gas and fuel oil bills, Hogan and her team of research assistants saw some consumer habits and attitudes emerge.

"We found that families were concerned about energy. And, although they differed in how successfully they conserved, most were making efforts to save," Hogan said. "The motivation to conserve seems to be there, possibly triggered by the about 17 percent increase in energy prices during the 12 months of the study."

The 40 families included equal numbers in lower and upper income levels and were matched for family composition and age of their dwellings. The research, which was funded by the Agricultural Experiment Station, the Minnesota Energy Agency, and the University Graduate School, showed some patterns.

- Thrift-oriented families, who believed energy shortages would continue, did the most to conserve. But even among families with little interest in energy, there were some efforts to save money on utility bills.

- Upper income families striving to conserve trimmed their electricity use the most and made small cuts in natural gas use.
- Most lower income families reduced their heating demands.
- Older persons lowered their thermostats less frequently. However, they used their automobiles less. Younger families and individuals often kept their homes cooler in the winter but continued to use energy at much the same rate for transportation.
- Neither income level group changed driving habits. "Dependence on the car seems to be one part of our lifestyle that few of us are willing to give up," Hogan said. "A few families used small cars for fuel economy, but most said they didn't know how high gasoline prices would have to rise before they would cut down their driving or switch to public transportation."
- Energy conservation decisions involved conflict in about one-third of the families studied. Conflict over thermostat settings was the most common. Although adult males were most knowledgeable about energy conservation alternatives, both partners participated in decisions about thermostat settings and weatherizing the house.
- Air conditioners were used frequently. Among families who had them, central air conditioning and window units were used an average of 7 days during the summer of the study period. Most owners of either type turned them on only when their

Upper income families tend to conserve energy by reducing consumption of electricity and natural gas and better insulating their homes, rather than reducing use of their automobiles.

homes became uncomfortably warm.

Family responses to energy shortages and high prices varied, according to Hogan. One lower income family of four, for example, reduced gas consumption by 10 percent and electricity use by 12 percent, largely to offset increased utility rates. Although they owned a car, the husband uses a car pool to get to work and the wife occasionally rides a city bus to appointments and to do errands. This family viewed the energy shortage suspiciously, however, and stated that utility companies may have created the crisis so that they could raise prices.

In contrast, an upper income family of five who cut fuel oil needs by 32 percent did so both to save money and because of their concern about natural resource shortages. They insulated their house and reduced the temperature, keeping their bedroom thermostat at 55°F and their main floor and basement living areas in the low 60°F range. At the same time, however, they were logging more than 500 miles a week in their three cars. They rarely used public transportation. Despite their success in saving fuel oil, the family increased electricity consumption by 12 percent over last year.

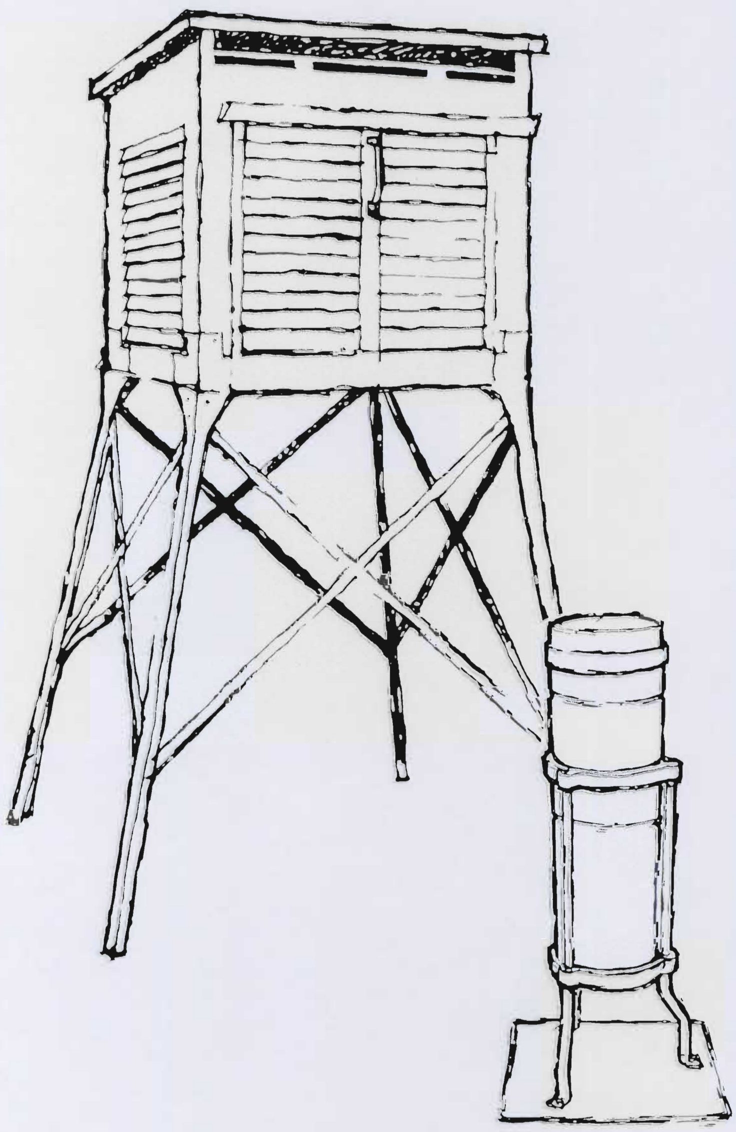
Hogan thinks that rising prices will increase conservation efforts. They may, however, also produce tension in families where members differ on temperature preferences, transportation habits or other energy-related decisions.

Rising utility prices will hurt low income families who have limited money for the types of home improvements needed to conserve. Hogan's researchers found that women, particularly those who are single parents or widows, often lack the time, money, and skill to make energy efficient home improvements, such as insulating, caulking, or weatherstripping.

As the burden of energy costs increases, Hogan thinks that community-based self-help groups may spring up to meet these needs and to put conservation methods within everyone's reach.

Weather Experts Help Meet Energy Needs

LINDA J. CAMP
Department of Information
and Agricultural Journalism



WHEN FUEL SUPPLIES suddenly become tight in one location, people throughout the region may ultimately feel the pinch. The experiences of several states during the past two winters have demonstrated that even fairly localized energy shortages can disrupt the lives of people many miles away. However, these unexpected problems may one day be kept to a minimum. UM researchers in climatology are finding out some things that may help the people of the state to manage their energy resources more effectively.

When the mean air temperature is less than 65°F, heat is usually required for buildings. Most gas and electric companies keep careful track of such dips in temperature and use these measurements in calculating overall fuel requirements for particular locations. A common way of expressing the energy calculations is in terms of "heating degree days." Because of such factors as latitude and altitude, during the course of a year different parts of the state accumulate different numbers of "heating degree days." A typical annual total for International Falls might be 10,000, while the Twin Cities might be estimated at 8200.

Although this system does enable utilities to estimate energy requirements fairly accurately, calculation errors can and do still occur. According to UM scientist, Donald Baker of the Department of Soil Science, an important reason for this is the way in which temperature measurements are taken.

"The major source of weather information for utilities, agencies, and the media is the network of weather stations throughout the state," he observed. "And these stations are usually located near airports or away from highly urbanized areas. Since temperatures are generally higher in cities, the airport temperatures do not represent urban areas. As a result, energy requirements for a city can easily be miscalculated."

To get around these kinds of measurement problems, Baker has been working with graduate student Julie Winkler and professor Richard Skaggs, Department of Geography, and Earl Kuehnast, a climatologist with the Minnesota Department of Natural Resources to find some better ways of estimating temperatures for urban areas. There are 21 weather stations throughout the Twin Cities area with daily temperature records which are at least 20 years in duration. Data collection is now nearly complete.

"We know that urban areas produce heat because of the heat generated by people and buildings. In addition, the man-made structures alter the way that solar radiation is absorbed," Baker said. "The temperature readings we have been gathering will enable us to determine more specifically the magnitude of this heat 'island.' And from this we will ultimately be able to make generalizations about temperatures in other cities throughout the state. People who need weather information for such purposes as calculating energy demands will thus have access to much more precise data."

Baker and others have also been involved with a different project which complements the temperature measurement research. While considerable work is being done on solar and wind energy as alternatives to fossil fuels, most seems to center on the development of engineering designs and technological applications rather than on the actual amounts of these elements available. In the second project, Baker has looked at the availability and dependability of solar radiation in various areas of Minnesota. He used lengthy climatological records of radiation and can estimate probable solar resources for any time of the year.

"This kind of information should be a real asset to people such as engineers, who are designing alternative energy systems," he said. "It will help them to determine what kind of backup energy systems must be provided, and at what times of year energy reservoirs may be needed."

There is probably no way to completely avoid energy shortages. However, by keeping better track of the climate it may be possible some day to keep one step ahead of at least some energy problems.

Conserving Energy in Livestock and Poultry Production

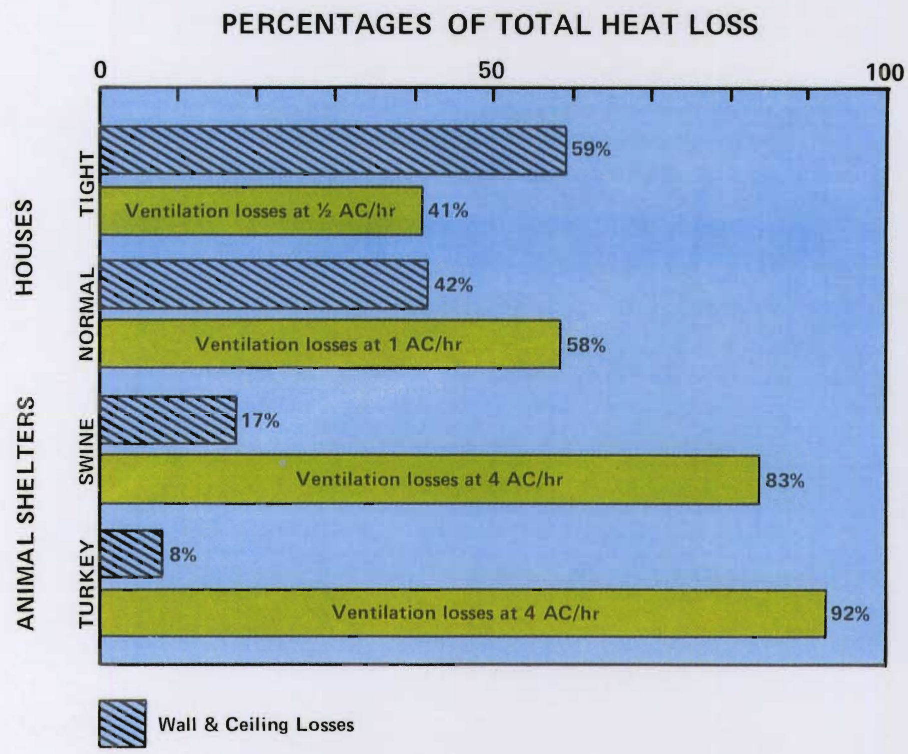
JACK SPERBECK
Department of Information and Agricultural Journalism

FOR MANY YEARS farmers weren't convinced that extra insulation and energy conservation practices in livestock buildings made sense. That was understandable in the days of cheap energy.

But now some farmers are going too far in the other direction. They're talking about putting in extra wall and ceiling insulation — insulation that will ultimately result in very little extra energy savings.

This is just one of the problems currently being uncovered by Experiment Station scientists who are looking at energy conservation in livestock and poultry production. Kenneth A. Jordan and other agricultural engineers are involved in a research to identify areas

Methods to save energy in poultry and livestock housing are being studied in this turkey housing at Rosemont.



where some real energy savings might be possible.

Methods to save energy in confinement livestock buildings is a major area of study. In Minnesota, most of the energy that goes for heating animal confinement buildings is used for poultry and hog systems. The equivalent of 23 million gallons of propane a year is used for heating turkey houses and 9 million gallons to heat farrowing units. And, according to Jordan, major heat losses in these livestock buildings come from warm air that escapes through the ventilation system. "From 80 percent to 90 percent of the heat is lost through ventilation systems," he observes. "Very little heat escapes through the walls and ceilings."

OVERVENTILATION LOSSES

Jordan and his colleagues are studying ways to increase the efficiency of ventilation systems and save energy. The average cost of heating a turkey barn 70 feet by 300 feet on a typical day in January in Minnesota can be as much as $100. But the researchers believe that by fine-tuning ventilation systems so that less air escapes, many farmers can save from 10 to 20 percent on energy costs. Some may be able to save as much as 50 percent.

"The trick," says Jordan, "is to exhaust only enough warm air in winter so that the air isn't foul. It is important not to overventilate. By watching the animals in a building, it is possible to get a pretty good idea about whether the ventilation is adequate."

The researchers have found that significant fuel savings are possible with improved ventilation management. Jordan, along with Larry Jacobson and other co-workers, has built a fan testing unit. They have also analyzed the effects of dust and conditions of shutters and the guards on fan capacity. "Just oiling and shutter hinges improved the fan capacity up to 30 percent," says Jacobson.

INSULATING FLOORS

The agricultural engineers have also developed a computerized simulation to measure heat losses to the soil from heated concrete floors. They have found that insulation was more effective at reducing heat losses when placed under the concrete slab than when it was placed vertically on the foundation wall. They also found that soil moisture was an important factor in determining heat loss from the floor.

Researchers say using a floor system to provide a portion of supplemental heat requirements for animal ventilation systems may save money. "This may be a cost benefit technique for storing and using energy from alternative energy sources, including solar energy," says Jordan. Adding heat to the litter in a turkey barn may increase moisture vaporization from the litter and thus reduce ventilation air and supplemental heat requirements.

The computerized model has showed that higher soil moisture causes more heat loss. When high water tables are present, however, the researchers don't recommend using heated floors. In any case, a vapor barrier needs to be placed over the soil to control the rewetting of the soil which tends to cause excessive heat loss.

The researchers recommend placing an insulation strip 4 feet wide under the slab instead of along the wall. They say that full floor insulation might be useful where a floor is used for solar storage. However, the amount of level saved probably does not justify the cost of full floor insulation.

HEAT EXCHANGE

Still another aspect of the work has focused on "capturing," or recovering heat lost through ventilation systems of animal facilities and recycling it through the building. The scientists have developed a formula for estimating heat recovery. This concept is basically like the heat exchange system in a car's radiator, where heat from the engine block is exchanged into the radiator fluid. However, there are many problems to be ironed out when applying the formula to animal buildings. Moist, dusty air fouls the heat exchanger and limits its usefulness. Filters plug up easily and need to be changed almost every hour to keep them clean. Thus, filtering air in animal ventilation systems is not recommended.

Jordan and his co-workers are also studying using solar energy to heat livestock and poultry barns. They plan to develop a complete model of a turkey production facility to estimate the economic feasibility of alternative fuel sources, such as solar energy, with varying production schedules.

WASTES, BY-PRODUCTS FOR ENERGY

A final dimension of the energy conservation study is recycling wastes for feed. Animal wastes contain energy that can be used in feeds for cattle and sheep. Poultry litter and cattle waste have been incorporated into cattle feed at levels as great as 20 to 25 percent of the ration with excellent results. Research shows that poultry manure is roughly equal to average quality hay for energy purposes. It also has from 25 to 30 percent protein — higher than good quality hay. Beef cows will eat this poultry manure, provided it is processed properly. So animal scientists have been investigating ensiling poultry manure to preserve its energy value as a feed and to avoid added energy costs in drying the material.

In addition to poultry manure, Minnesota animal scientists have studied other feeds, including dried rumen wastes, sweet corn cannery waste, soy protein products and aspen bark. By recycling these feeds through ruminants, better use is made of potential energy materials.

Producing feed is only one option for capturing energy in the wastes. Other options include adding the manure to the soil (the fertilizing effect increases the amount of solar energy captured by the crop); using the wastes to produce combustible gases; and using the material directly as a dry fuel source.

Energy and the Economics of Farming

MARY KAY O'HEARN
Department of Information and Agricultural Journalism

Robert Sandt examines the varying maturity of his corn crop. He staggers the seeding so that picking and drying can be done at intervals.

IF TOTAL FARM ACREAGE in Minnesota were to shrink during the next decade, energy costs could be the cause. There could be other major shifts in agricultural production for the same reason.

Changes in energy resources are likely to have a significant impact on Minnesota agriculture in the future. And, because no one knows enough about where that impact might be, a UM research project is now taking a careful look at the interrelationship between energy and agriculture. The study, which is in its second year, is being conducted by agricultural economists, Harold R. Jensen and Vernon R. Eidman. The two are trying to investigate a wide range of problems and come up with some ideas about what will be best for individual farmers in the years to come.

About 4 percent of the energy used in this country goes for agriculture. And, according to the two scientists, direct energy costs are fairly easy to investigate and add up. For example, it is fairly simple to figure out the amount of diesel fuel that it takes to disk a field to produce an acre of corn. But Jensen and Eidman point out that there are significant indirect energy costs which need to be looked at as well. The energy cost of products before they reach the farm must also be considered, including such things as the energy required to produce tractors, harvesters, storage bins, and to produce and transport fertilizers.

In addition, the scientists are trying to consider the inter-con-

Sandt describes his corn drying operation on his farm near Lake Crystal, Blue Earth County to Vernon Eidman, Harold Jensen, and Cole Gustafson, UM graduate assistant.

nectedness of agricultural energy problems. "We're asking some fairly straightforward questions, such as if corn production in Minnesota decreases, what will the impact be on livestock feeding," says Eidman. "And from this we may get information that relates to the entire United States."

Variables in the weather are part of the study too. Back-to-back growing seasons can be as different as neighboring farms, and corn moisture is much higher in some years than others.

Although it will take five years before all the results of the study are in, some conclusions are already emerging.

GRAIN DRYING

The work on grain drying has looked at eight case farms, ranging in size from 100 to 2,000 acres, from the standpoint of initial investment, costs of energy, ownership costs, and operation costs. Two rates of inflation have been included as variables, along with three rates of energy price increases. Thus far, low temperature storage and drying appears to cost the least for smaller operations, but a combination of high-low temperature drying works best for larger systems.

This study hasn't evaluated solar energy sources because they are experimental at this point, and there is little data. However, Jensen feels solar energy could be important some day. "The solid evidence needed for an on-the-farm system could develop as the technology improves to meet energy price rises," he says.

IRRIGATION

An early look suggests that increased fuel costs are not serious enough to halt investments in irrigation projects which are currently considered sound. "The effect of increasing energy prices on investment costs in irrigation equipment will probably be more important than the cost of electricity or diesel fuel to operate the irrigation units," Eidman says. "Water scheduling better timed to plant growth provides an opportunity to partially control operating costs," he adds.

TILLAGE

Reduced tillage, which means fewer trips across the field, can cut energy requirements. However, the effect on crops and soil still needs to be determined.

As some of the "givens" in the study change, for example, current energy costs, the study will be adapted to meet these changes. However, the goal will still be to come up with information that can help individual farmers decide which production system is best for them.

Eventually, Jensen and Eidman hope to share their results with farmers at meetings throughout the state. And the day might be in the offing when a farmer can plug his farm profile into a computer and receive back an assessment of the least-cost, most energy efficient method of operation for him. But before that can happen, Eidman and Jensen know they will expend lots of their own energy fastening down the important variables involved — initial capital investment, insurance, depreciation, machinery parts replacement, etc.

Both agree that sophisticated use of energy on the farm is here to stay. "I can't picture American agriculture going back to animal power," Jensen says.

From City Waste to Country Gold

WILLIAM E. LARSON
Soil Scientist, SEA, USDA
Department of Soil Science

USING THE WASTES of the city to fertilize the crops on the farm — is it an utopian idea, or an eminently practical one?

Researchers with the USDA — SEA — AR and the University of Minnesota have been investigating the possibility of applying sewage sludge and effluent to agricultural lands. If it works, it would be a means of returning the materials to a natural cycle which could solve disposal problems and be agriculturally beneficial at the same time. It could also save farmers the money they now spend on fertilizers and save the energy now used for sludge disposal.

The researchers have found farmers and treatment plant operators enthusiastic about applying sludge to land, but anxious for guidelines on rates and methods of application.

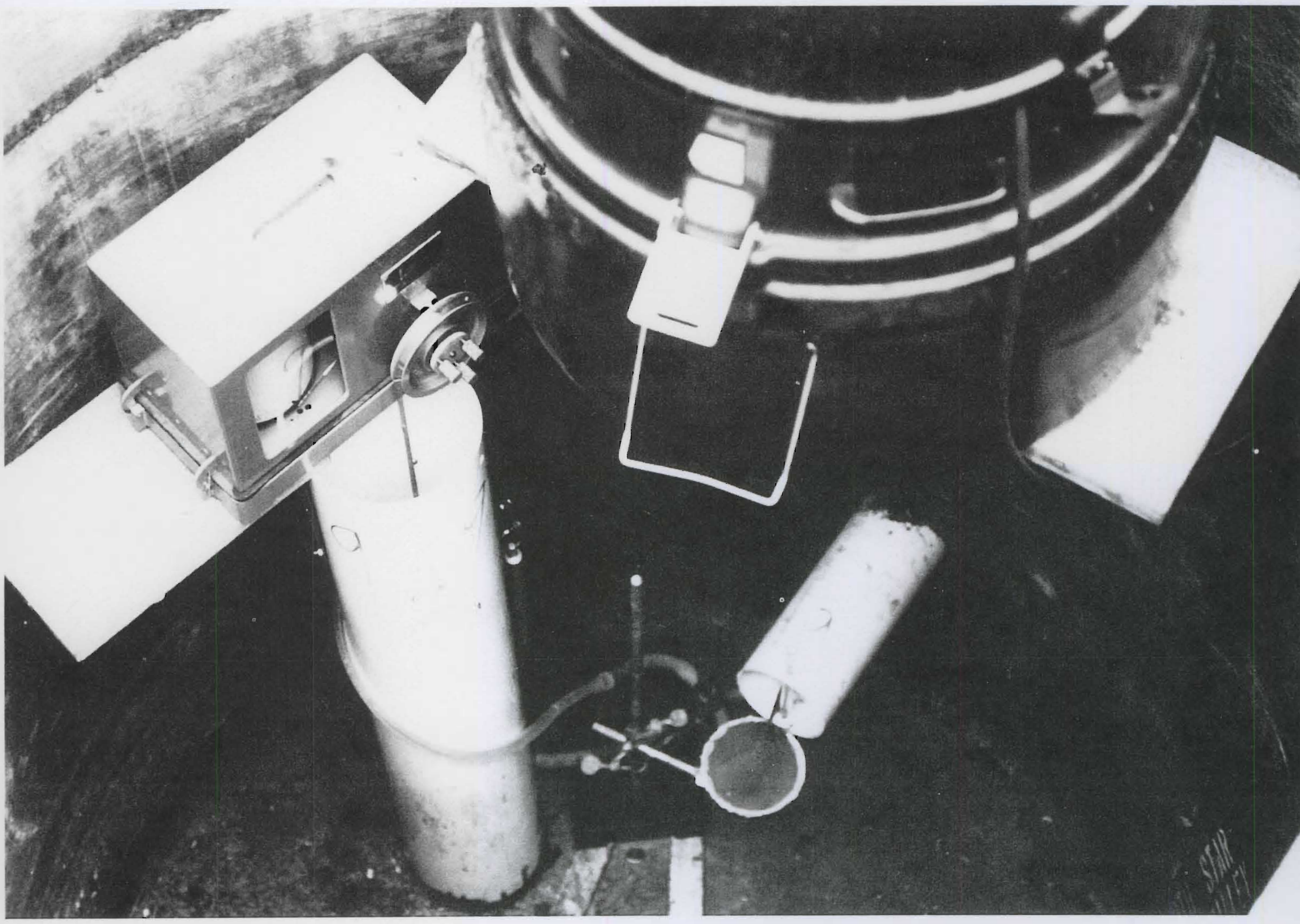
A preliminary experiment in 1971 at Hastings, Minnesota compared dry and liquid sludge with regular commercial fertilizer on corn plots. High crop yields and analyses of soils and plants showed no detrimental effects from the sewage sludge applications. Since then, other experiments have been done to answer the key question: can sludge and effluent be used on agricultural land without creating problems such as metal uptake by the plants or polluting runoff water or ground water from the area?

During the course of these projects the researchers have found that sludge and effluent each have a unique set of problems to be tackled. With effluent containing significant amounts of nitrogen, the major concern is how to apply large amounts of water to a limited land area without creating water pollution problems. Because effluent contains much nitrogen, when such treated water is applied to the land, about eight times as much nitrogen is being applied than most crops can take up during a growing season. Research has shown that corn, corn with ryegrass, and forage crops use up nitrogen best.

With sewage sludge, on the other hand, the major problem is the variability of the sludge. The

Below, sewage sludge may one day be used in place of fertilizers for forage crops.

Right page, researchers analyze sludge regularly for trace metals and major plant nutrients.



Digested liquid sludge from five metropolitan wastewater treatment plants was used to determine problems related to metal uptake by plants.

composition varies widely, depending on the extent of the treatment and the type of community it comes from. In addition, composition from a given waste treatment plant varies from hour to hour, day to day, week to week, and season to season. Therefore, the sludge must be analyzed regularly, particularly for trace metals and the major plant nutrients of nitrogen, and phosphorous. Zinc, copper, nickel, and cadmium are generally the metals of greatest concern. The first three are important because they can be toxic to plants, and cadmium because it can potentially enter the food chain.

Scientists have found that beets are very sensitive and usually are the first plants to exhibit metal toxicities; feed grains are less sensitive and grasses are the most tolerant to metals. Analysis has revealed that most of the absorbed metals accumulate in the leaves and stems, leaving the storage tissue (fruit, roots, or grain) relatively free of metal enrichments.

And, interestingly, the researchers have also found that soil acidity is the major soil characteristic that affects trace metal uptake by growing plants. Metals that severely reduce yields when soil acidity is low cause little or no yield reduction at higher pH levels. When soil pH is above 6.2, only a very small percentage of sludge-borne metals are absorbed by a given crop and few heavy metals leach into groundwater.

The research is continuing to try and determine the economic value of the waste materials as a source of plant nutrients and to collect information on which to base recommendations for proper management of waste materials in agricultural production.

Science Notes

PEAT: A NEW ENERGY RESOURCE

One of Minnesota's newest energy resources may also be one of its oldest. Several thousands of years ago over 7 million acres of peatlands began to form throughout the state. Today, with threatening fuel shortages many people are taking an interest in this peat and are trying to find out if indeed it might be a potential source of fuel.

Among those studying peat is Rouse Farnham, of the Department of Soil Science at the University of Minnesota. Farnham, who is known internationally for his work with peat, estimates that one day Minnesota could produce as much as 10 percent of its energy from this fossil fuel. He is currently working on four different projects which are exploring applications of peat in energy, agriculture, and forestry.

During the past two years, Farnham and other UM researchers have worked closely with staff of the Minnesota Department of Natural Resources (DNR) in mapping the state's peat resources. This survey was the first comprehensive inventory of peatlands to be undertaken in Minnesota. Farnham's special role in this project has been helping to classify peat samples. A joint study of present and potential uses of peat is also being undertaken.

One of the future uses Farnham sees for peat is for energy. He believes there are four ways in which this can be accomplished. The first of these is gasification. Synthetic natural gas is currently being refined from coal. Since peat represents an early stage in coal formation, Farnham believes a similar process can be used to produce pipeline quality gas from peat. However, the technology for peat gasification has not been extensively developed yet and it is not clear whether such gas would be economically competitive with current fuel sources.

The second option, liquefaction of peat, involves burning biomass products, such as wood or cattails, to form a liquid fuel that can be refined into gasoline or light oils. However, this process is only beginning to be developed under laboratory conditions. Peat can also be changed into energy through direct combustion, as is done in Europe today. Farnham is looking into the possibility of burning peat directly as a fuel in municipal power and heating plants.

The final way peat can be used for energy is more speculative. In this process, which is called biomass production, peat would act as a soil nutrient for growing plants, such as cattails, which would be burned in direct combustion for energy. The U.S. Department of Energy has awarded Farnham a grant to research the possibility of producing biomass crops which could be used as energy sources on peatlands.

"Peat is a proven energy resource — one that European countries have burned for centuries in the form of compressed sod or briquettes," says Farnham. "But nowhere in the United States today is peat being used for such purposes."

The Minnesota Energy Agency predicts that the state of Minnesota will face an energy supply deficiency by 1985 if present energy usage trends continue. Farnham believes Minnesota peat reserves could help alleviate this shortage.

Peatlands, such as this one in Pine County, could one day provide as much as 10 percent of the energy for the people of Minnesota.

Royal Knight Chrysanthemums.

NEW MUMS FOR 1979

The University of Minnesota's Department of Horticultural Science and Landscape Architecture has introduced two new cultivars of garden chrysanthemums for the 1979 gardening season. Developed by horticultural researchers, Richard E. Widmer and Peter D. Ascher, the two new varieties have been named "Minnqueen" and "Royal Knight."

Minnqueen plants average 12 inches high and 24 inches wide. It has 3-inch flat, lively rose-pink blossoms. Royal Knight produces 3½-inch velvety maroon-purple or burgundy flowers with a silvery underside. The flowers have shown above average frost resistance. Royal Knight plants average 12 to 15 inches across and 20 inches high.

Both plants usually start flowering in mid-September and have shown disease tolerance in plant disease nursery tests.

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