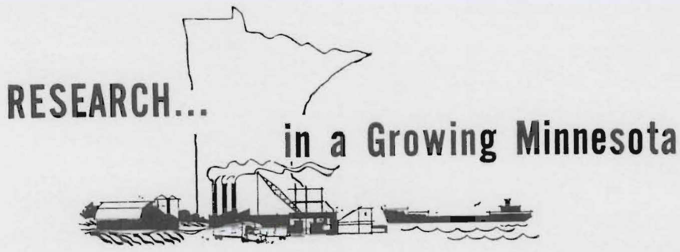
Volume 24, No. 4 Summer 1968

MINNESOTA SCIENCE

A publication of the University of Minnesota Agricultural Experiment Station

SOYBEAN RESEARCH

See page 4.



William F. Hueg, Jr., director of the Minnesota Agricultural Experiment Station, sees important roles ahead for public institutions, but with some interesting changes.

Public Agencies and Field Crop Development

Perhaps no single idea has done more to foster formal and informal discussion among research scientists in industries and public institutions than the prospect for the development of hybrid cereal grains other than corn. Traditionally, plant breeders in universities and the USDA have been responsible for improvement of grain varieties. But their roles have changed, and they will continue to change in the future.

This article emphasizes wheat development because the greatest commercial development activity has been in wheat, but other field crops are experiencing similar activity.

Six Roles of Public Institutions

In the improvement of field crops, public institutions have six distinct roles. The first is the development of new varieties with superior agronomic characteristics and superior quality. At public institutions, however, few breeding projects list the development of new varieties as the major program goal. More likely the goal is to discover more about the mechanisms of the crop plant — its genetics, physiology, resistance to insects and disease, and other characteristics. It is also important to find how these characteristics can be incorporated into existing crop lines to improve them, or to determine whether it would be better to develop entirely new materials. Whether this work is done by public or private breeders probably is of less concern today than in the past.

A second role of the public institutions is to provide new genetic materials. The main concern is to get the improved germ plasm used in a wider base and to make it available to growers. New genetic materials should be available to all breeders who can make good use of them. Generally the materials are not suited for immediate increase and release programs; therefore they should be used as a base for general improvement of the germ plasm.

The Germ Plasm Committee of the National Council of Commercial Plant Breeders needs to be informed about germ plasm that is available from public agencies. This group, in return, has the responsibility of making this information available to all in industry who can make good use of the genetic stocks.

A third role is the variety increase program. In some states the state university has not been affiliated with a foundation seed organization for years. Some universities make the breeder seed available to commercial companies which then are responsible for increasing and distributing it. The combined goal of the public agency and industry should be to get new and improved varieties into the hands of growers and processors as soon as possible.

Some people have criticized public agencies as slow in increasing seed, but the more conservative approach enables a variety to prove its worth before too many acres are planted. At public institutions the decisions on the release of a variety may be made on the basis of its performance for 3 years or more at 40 to 60 locations. Sometimes the final place of a variety in commercial production can be learned only from thorough field experience.

A fourth role of the public agencies is to determine how to produce each new variety profitably. To evaluate a variety by comparison with other varieties is not enough. Research must determine each new variety's total interaction with the fertility level, row spacing, planting dates, planting rates, harvest procedure, and economic value. A new variety should be evaluated at management levels as used in the commercial production of the crop.

Public research should do more on cultural practices than it has in recent years. This, however, will require shifts in attitudes within public agencies about the importance of this type of research to the producer, the processor, the eventual consumer, and the research worker.

A fifth role has been variety recommendation. We need to give a critical look at the 3-year test and its implications for the future. Today most producers base their decisions on research information from several sources. They are willing to take risks; in fact, if they are not they probably will not be farming 10 years later.

Stemming from the preceding roles is the sixth — the training of scientists to meet the needs of the future. The demand for trained research workers is increasing and seemingly insatiable. And whether the graduating scientists go into industry or into public research, the demand is for people with a higher level of training than ever before. Today's graduate must produce new plant materials and new understanding for more sophisticated consumers on the farm and in industry.

Education will always be a major function of the State Experiment Stations and the Land Grant Colleges. These institutions will further the total research effort by providing highly skilled scientists and technicians to be employed by federal and state agencies and private industry.

Inform Industry and Farmers

Public agencies have to become less protective and devote more time to presentation of facts based on principle as a basis in decision making. Industry must curb its zeal for the immediate short-run impact so as to capitalize on the substantial long-run impact of new genetic materials and varieties.

The public institution must indicate to industry how much material and at what level of development it is willing and able to evaluate. However, it appears that we should look at this material in early generations rather than when a variety is ready for release or has been released.

By working more closely, breeders in industry and public agencies should be able to keep one another informed on developments. If this does not happen, we are bound to cause confusion among the clientele we both serve.

Those of us in public agencies need to let farmers and industry know sooner what our research has available. But in releasing information earlier we will have to add extra qualifications and cautions. That is, we must emphasize the preliminary nature of the information and make clear that later information based on more years of experience may be more exact. Farmers need to realize fully the risk in variety selection with only 1 or 2 years of information.

Public agencies must concentrate their efforts more. I am convinced that not all states should have a major breeding effort in each crop grown in that state.

Universities need continuing support to carry on the training program to meet the needs for trained manpower, and also to reduce the problems of the future.

Funds for graduate assistantships and operation of the research program can be made individually by companies. It might be useful to have a group of companies make grants available to universities on a competitive basis. This could encourage concentration.

State and federal institutions will continue to make great contributions to the development of wheat and other crops. The time of their sole responsibility is over, however, and now industry and the public institutions must deal more effectively with those problems that are their joint responsibility.

I see no time in the immediate future when the public agency will not be a part of the research program in field crop development, but its role in variety development will probably diminish in the years ahead.

William F. Hueg, Jr.

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A publication of the University of Minnesota Agricultural Experiment Station

Minnesota Science is published by the University of Minnesota Agricultural Experiment Station, Institute of Agriculture, St. Paul, Minnesota 55101

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Editorial Committee — R. E. Turner, chairman; Huai Chiang; Harold Dzuik; Joan Gordon; James Houck; Jean Lambert; A. J. Linck; Harold Swanson; and C. W. Young.

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Growing Rapidly in Importance ---

Soybeans Serve Everybody

Above and on the front cover, a scientist makes an experimental cross by hand. The soybean flower just above the tip of the forceps will be emasculated, then fertilized with pollen from another soybean variety.

J. W. Lambert

Two hundred soybeans weigh only an ounce, but each soybean is a neat little package of nutrition. Tightly enclosed in a thin cellulose wrapper, a soybean is one part edible oil, two parts high-quality protein, and two parts carbohydrate. No wonder this immigrant from the Orient has risen in America from a minor forage crop 40 years ago to the number two crop in Minnesota and in the nation today.

The phenomenal rise of the soybean in America has not taken place automatically. Many hands have helped along the way. Farmers, merchandizers, processors, machinery manufacturers, researchers — all have made their contribution. Important among these are the federal and state workers who have cooperated in the introduction and adaptation of soybeans to American agriculture.

Agronomists at the Minnesota Agricultural Experiment Station have been important members of the soybean research team. They have selected high-yielding, early-maturing varieties to fit the short, intensive summers here in the North; they have also worked out the best planting dates, the best planting rates, the best row spacings, the best weed-control methods, and the best fertility practices for this region.

Since soybeans are rarely consumed as beans, you probably have never eaten a helping of soybeans. The so-called garden varieties have never become popular. How, then, do soybeans affect you as a consumer?

J. W. Lambert is a professor, Department of Agronomy and Plant Genetics.

Soybean oil products

Directly or indirectly, you probably eat soybeans every day, for the American kitchen that does not contain several foods containing soy products is rare indeed. Most soy products consumed by Americans are forms of soybean oil. Whenever you use salad oil, when you fry foods, when you eat cake or pie, or when you spread margarine on your bread, there's a good chance that you are using soybean oil in some form.

Of the 18 to 20 billion pounds of fats and oils of all kinds produced annually in the United States, over half now come from soybeans. About two-thirds of this soybean oil is consumed in the United States; the remainder is exported.

In this country, 90 percent of the soybean oil used goes into foods, principally shortening, margarine, and salad-cooking oil. But lecithin, an important byproduct of soybean oil refining, also is used in a great variety of foods. So, perhaps without being aware of it, nearly every housewife in the country is on intimate terms with the soybean. In addition, her husband may be hobnobbing with the bean whenever he spreads paint, for "drying oil" products contain a large proportion of the remaining 10 percent of the soybean oil used in this country.

Soybean protein concentrates

We use 20 million tons of protein concentrates in the United States every year, and of this huge amount some 13 million tons are soybean meal. That's the part of the soybean that remains after the oil has been extracted.

Soybean meal is high in protein — 44 percent or more — and it is high-quality protein if the meal has been processed properly. From this meal come soy flours of various sorts that have been used in the baking and meat-processing industries for many years, and in producing special low-cost foods for peoples of underdeveloped areas.

Ways have been found recently to isolate soybean protein and texturize it to make foods that resemble chicken, fish, ham, bacon, and hamburger in appearance, flavor, texture, color, and nutritional value. Although few of these simulated products are available now, it seems likely that within a few years they will be common on the shelves of supermarkets at prices considerably below the prices of the genuine articles.

Interesting as it may be to speculate on the future of soy protein in human foods, 99 percent of the soybean meal used in the United States today goes into livestock feeds, poultry feeds, and pet foods. That is, although human beings do not eat much soybean protein directly, they do eat it indirectly whenever they consume meat, poultry, eggs, or milk and milk products. And the milk, ice cream, eggs, broilers, turkeys, pork, and other animal products that we use are low-priced because of the great quantity of nutritious, economical soybean meal in feeds. A small proportion of soybean meal also goes into non-feed, non-food products such as adhesives, paper sizings, and printing inks.

The author takes notes on disease resistance in soybeans strains growing in breeding plots at the Minnesota Agricultural Experimental Station.

Consumers in America and in many foreign countries benefit from the low-cost oil and protein produced in American soybean fields. At the same time, soybean processing benefits the general economy. Of course, the basic value lies in the soybean itself, a renewable gift from nature; but the additions to its value made by many persons along the way also deserve recognition.

Soybeans benefit the economy

Let us trace the sequence of events from farm to factory to food shelf. The soybean plant with the aid of the sun's energy draws together ingredients from the soil and air to formulate, over a period of about four months, the "neat little packages" of protein, oil, and carbohydrates. With repeated encouragement from the soybean farmer, this process takes place summer after summer. For his contributions of land, labor, management, and other inputs, the farmer receives the market price for his beans. In 1966 this amounted to 233 million dollars for the farmers of Minnesota and over 2.6 billion dollars for the farmers of the United States.

After the farmer sells his soybeans at the local elevator, they still have a long way to go, and they must undergo much handling, processing, and transporting before they reach the housewife's shelf. Many beans go directly from the collection point to one or another of the processing plants of this country. There the oil is separated from the meal, refined, and shipped to various manufacturers of secondary products such as shortening, margarine, salad oil, paint, or varnish. The meal is also moved into feed and other industries.

A sizable quantity of American soybeans moves into the export market. Many of these beans are processed at their foreign destination much as they might be here. Other beans may be made into specialized food products that are not common in the United States. Whatever route the beans take, however, services must be performed at each step along the way. Compensation for these services, in salaries, wages, and dividends — whether to the processor, the margarine manufacturer, the feed mixer, or the operator of a supermarket — represent contributions to the overall economy. Of special significance to the national economy are the soybeans and soybean products shipped abroad. They have been the most important foreign dollar-earners among our agricultural products in recent years.

Thus we see the soybean as another of our important natural resources, one that serves nearly everyone of us in terms of good, well balanced diets. At the same time it is the basis for numerous enterprises that are important sectors of the economies of our state and nation. And the best part of it all is that the soybean is a resource that can go on and on without being diminished or depleted; in fact, with proper management it can be expanded.

Experiment Station research

Recognizing the importance of soybeans to the agricultural and agribusiness economies of Minnesota, the 1961 State Legislature appropriated a special fund for soybean research. This fund has been continued and increased in succeeding legislative bienniums to the point where, with supplemental federal and industrial support, the Minnesota Agricultural Experiment Station now has a plant breeder, a geneticist, a plant pathologist, a plant physiologist, a weed control specialist, and a soil scientist giving their entire research efforts to solving soybean problems. In addition, several other persons are devoting part of their research time to the soybean plant or its products. They will have plenty to do, for they know that their work will make the soybean an even greater crop than it is.

Improved Bromegrass Variety from Minnesota Station

Fox, a new variety of bromegrass developed at the Minnesota Agricultural Experiment Station, has better seedling vigor than other available varieties, and it also resists leaf spot better. Tests in Minnesota show it to be similar to Lincoln in yield and maturity.

William F. Hueg, director of the Minnesota Station, announced recently that foundation seed of Fox has been released to Minnesota seed growers and dealers, to other state experiment stations, and to foundation seed programs in other north central states. At present the seed is available only for further seed increase, not for forage production. Limited quantities should be available for forage seeding by the spring of 1971.

H. L. Thomas, associate professor, Department of Agronomy and Plant Genetics, University of Minnesota, conducted the breeding program that produced Fox. According to Thomas, Fox is a synthetic variety produced from five clones.

Improving the Serviceability of Wood

John R. Neetzel

"Penny wise, pound foolish" is just as true today as it was in 1621 when written by Robert Burton. The old saying certainly applies when we use untreated poles, posts, and lumber in contact with the soil or other moist conditions.

Each year an estimated 50,000 buildings (not including homes, apartments and commercial structures) are built in Minnesota — also many hundreds of miles of farm fences and right-of-way fences, and an even greater length of decorative fences. Until a few years ago nearly all of this construction was with wood — chiefly untreated wood.

During the past 20 or 30 years treated wood has become more readily available and has contributed much to the expansion and development of many facilities which are important parts of our everyday lives. Most lake, river and ocean docks and many small bridges on highways and railroads are now being built with treated wood piling, timbers, and planks.

Treated wood piling is used in or beneath the foundations of many large and small buildings now being constructed. Ties of treated wood support the steel rails that carry the railroad traffic. Most utility lines are hung on treated wood poles and cross-arms. Many highway and advertising signs are attached to treated posts and poles. Most farm fences, right-of-way fences, and decorative fences are built with treated wood posts.

John R. Neetzel is a research associate, University of Minnesota School of Forestry

A relatively new concept of inexpensive pole-frame building construction uses treated wood poles for both the foundation and the framing. Under the sponsorship of the Minnesota Agricultural Experiment Station, the School of Forestry has had a part in this fencing and pole-frame construction research and development. The findings from these studies can also be helpful in the future to assure that wood is properly used in our extensive new programs to develop buildings that will provide better surroundings for animals and poultry.

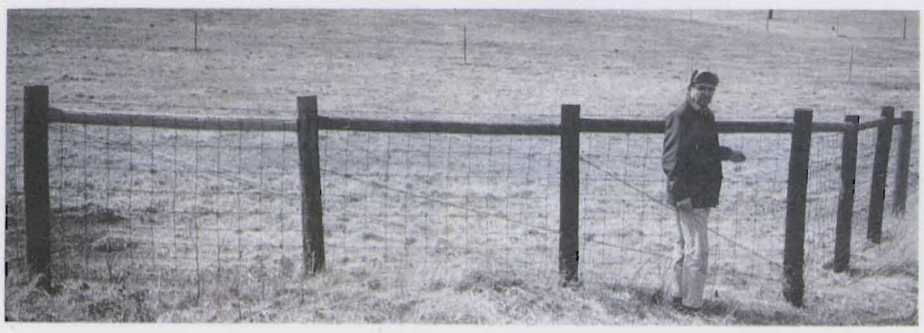
Better fences

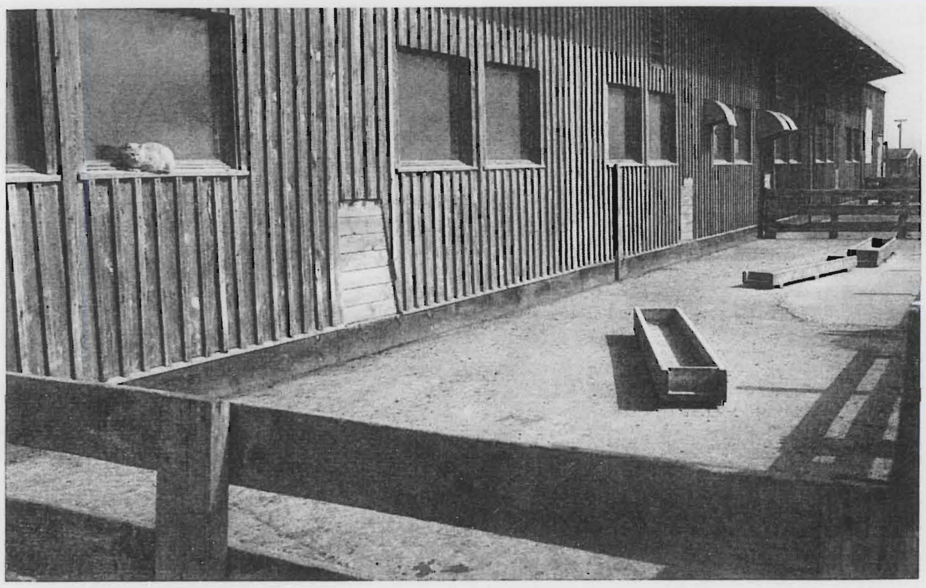
The early studies were in farm fencing, where the short service life of untreated posts required frequent replacement and expensive and time-consuming fence maintenance. Thousands of treated and untreated wood fence posts, set many years ago in test plots, are being examined each year. In addition, many miles of experimental farm fences have been built to test kinds, sizes, spacing, and methods of setting posts in fences actually being used to control farm animals.

The 25-year service record of seven Minnesota-grown post species indicates that 2 to 3 pounds per cubic foot of a 5 percent penta treatment for jack pine and black ash will give these posts a 30-year or longer average service life. This compares with an average service life of only a few years when the same species are used untreated. The average annual cost of the untreated post in the farm fence is at least ten cents. The comparable annual cost for a treated pine post is three cents or less. In other words, treated wood posts are about ⅓ as expensive to use as untreated wood posts. These estimates are based on the initial cost and serviceability tests during the past 25 years.

Contacts with users indicate durability of treated posts is not the only consideration when choosing a fence post. Labor costs for setting the post are of great concern. Unfortunately, the mechanization of the farm fencing operation has been slower in developing than the mechanization of most other farm operations. Power driving of wood posts, which has been carefully analyzed in the School of Forestry fencing study, indicates that post-setting costs can be reduced 60 to 80

Built in 1952 of treated, power-driven posts, this Rosemount fence corner looks as if it will give good service for 25 years more.





Afte a dozen years this insulated pole-frame hog farrowing house made of treated lumber is essentially as good as new.

percent compared to hand digging and tamping. Pointed, power-driven wood posts are also more firmly set in the soil, and with less physical labor.

Our development of the power-driven, multiple-post Rosemount Corner has given the farm fence an economical foundation seldom previously built into farm and right-of-way fences. This corner and much of the design and material specifications developed under this project are being used by many farmers. These standards have been adopted by the highway departments of many states for right-of-way fences.

Long-Lasting Buildings

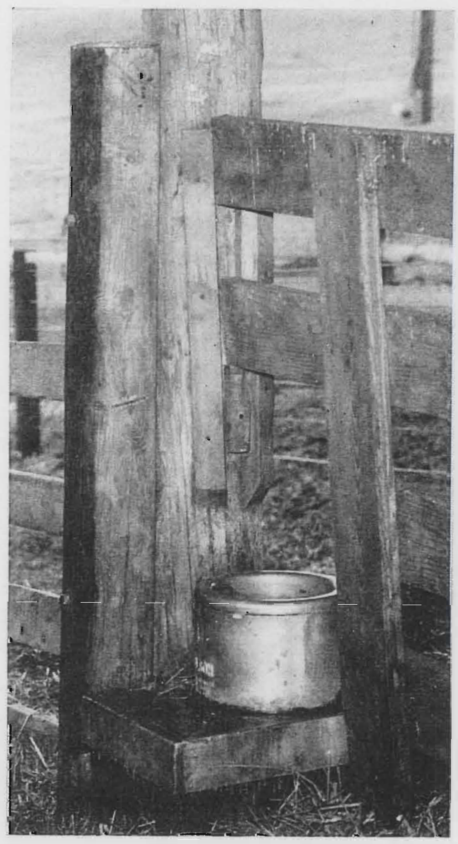
There is also a need to use adequately treated poles and other wood products in all farm buildings. Lessons learned from the many farm structures built during the past 15 years can be applied to the environmental animal and poultry factories which will produce the eggs, milk, and meat of the future.

Cattle, hogs, and poultry all create conditions of high relative humidity. Consequently, every effort is being made to control both the air moisture and the temperature in animal buildings to create conditions more favorable for the growth and development of the animals and poultry. Such control will enable animals to produce more meat, milk, and eggs from a given amount of feed. Fans and other ventilation are helpful, and so is proper structural design of the buildings. No matter how carefully design is considered, however, conditions of excessive moisture favorable for decay and deterioration of the structural material will often develop. Treated wood, which is a good insulator against both heat and cold, will continue to be one of the important building materials used in these farm factories.

During the past 15 years several experimental farm buildings have been built at the University of Minnesota Agricultural Experiment Stations to test new ideas to facilitatae this ever-changing pattern of farming. Preservative-treated wood has been incorporated into these structures, which are under continuous use for both poultry and livestock production.

In 1952 a 52-by-132-foot, pole-frame, Doane-plan cattle shed was built with sound western red cedar poles that had been previously used untreated for a few years in a utility line. Western red cedar is considered to be a naturally durable wood. These poles were cut off at the previous ground line. Eleven of the poles were set without any treatment. Six poles were brush-treated on the bottom 6-foot section with a 5-percent penta solution in no. 2 fuel oil for a solvent. The remaining 44 poles were given a brush treatment of penta on the bottom 6-foot section plus a 5 percent penta grease treatment about 6 inches above to 2 feet below the anticipated ground line.

Some of the poles were in the feed-storage area and some on outside walls, where they remained reasonably dry. Others were in the animal pen areas, where they were in direct contact with the manure pack. A few were adjacent to automatic water fountains. The 15-year pole service examination found all the untreated poles, except those in the dry feed-storage area, were badly decayed at the ground line; several were completely rotted off. The poles with only the brush-on treatment were little or no better than the untreated poles. Most of the poles with the penta-grease treatment were, after 15 years, in fairly good condition, although those next to the waterers and one where the manure pack had been above the treated area were badly decayed.



Original untreated pole near cattle waterer rotted off at ground. Repaired by splicing.

In all, 12 of the 61 poles were decayed so badly they had to be either replaced or stubbed. A large number of the other poles were partly decayed, but they had enough sound heartwood so the decayed area was cut away and a new coat of 10-percent-penta grease, which is now available, applied. Excavating, cleaning the poles, adding new grease, and digging for replacement poles was a difficult and time-consuming operation—much more costly than the initial digging of the holes and setting of the poles.

Pine poles treated to recommended standards would have remained sound after 15 years of service. The creosote-pressure-treated splash boards used above and below ground around the ends and closed side of this shed are still sound after 15 years of service. Using untreated or poorly treated poles, even of a naturally durable species like western red cedar, was certainly "penny wise, pound foolish."

Horizontal silo made of treated posts and lumber.

Durable Horizontal Silos

A somewhat similar experience with two experimental horizontal silos (built in 1955 and torn down in 1967) also points out the need to use well-treated poles and other wood products when they will be in contact with the soil or other moist conditions favorable for decay.

Part of the red pine poles were treated immediately after cutting and peeling when they were too wet to take the standard treatment. The penetration of the 5-percent penta solution was shallow, and the total absorption was about 0.6 pound per cubic foot. This is about a tenth of the recommended standard. Air-drying the remainder of the poles for 10 days permitted the absorption of about 2 pounds of the preservative solution per cubic foot, and ¼-inch penetration of the preservative. This treatment was still only about ⅓ of the recommended standard. Most of these poles were incised to the butt six-foot section. When setting the poles for the silo, a 5-percent penta grease was applied in a 2½-foot band at ground line on most of the poles.

The 1- and 2-inch pine lumber used to line the silos was air-dry when treated with the 5-percent penta solution. Many of the boards were heavily blue stained. Penetration in the boards was nearly 100 percent, and the absorption was from 6 to 8 pounds of the preservative solution per cubic foot of wood.

The silos were used for 12 consecutive years prior to being torn down in 1967 to make room for other structures. At that time the lumber was all free of decay. Some of the 1-inch boards had warped and checked. The 2-inch planks were as sound as when the silos were built. Four of the poles which had not been incised had completely failed. Sixteen other poles showed some decay at ground line. The remaining 46 poles and braces were still sound after 12 years of service. The structures could safely have been used several more years without major repairs or replacements.

Pine poles treated to standard specification with 4 to 6 pounds of the preservative have remained sound for 15 years in similar farm structures. There is no reason to believe their service life will be less than 30 or more years, which is the experience with utility poles treated to accepted standards. Untreated pine poles could not be expected to last much longer than untreated pine fence posts — certainly not more than five years.

Inspection of these and other experimental buildings conclusively shows the need to use adequately treated wood in all farm structures. This need will be even greater in the environmental farm buildings of the future.

There is no reason that "penny wise, pound foolish" should continue to be applicable to wood used in construction, even where it comes in contact with the soil or other moist conditions favorable for decay. Adequate preservative treatment, adequate design, and adequate construction will assure wood structures with a long service life with a minimum of maintenance.

Plot for testing service life of treated and untreated posts.

Newly Discovered in Minnesota —

Phytophthora Root Rot of Alfalfa

F. I. Frosheiser

In July, 1965 my attention was called to an alfalfa field in Carver County that had suffered considerable stand loss since early spring. The symptoms on the surviving plants in the affected areas of the field suggested a root rot caused by a fungus, *Phytophthora megasperma,* which had been reported previously to occur in California, Ohio, and Illinois. I isolated this fungus from the diseased roots, and reproduced the disease in the greenhouse.

Several other fields in this area, mostly new seedings, suffered considerable stand loss during the 1965 season following a rainy period in late May and early June. The rainfall in June amounted to about 8 inches that year. The stand in a field in Pine County was also greatly reduced by this disease.

Usually the first evidence seen of Phytophthora root rot is wilting of the plants and thinning of the stand. Sometime before this happens the roots become infected, and dark lesions (rotted areas) appear on the roots, followed by rotting of the tap roots (figure 1). The tissue above and below the rotted areas is usually yellow.

High soil moisture is necessary for the progress of the disease, and if wet conditions prevail the rot continues until the tap root is rotted off and the plant dies. When the soil moisture decreases, progress of the rot stops. If enough of the tap root remains, the plant produces smaller replacement roots and recovers. These adventitious roots of the recovered plants are shallow, and the plants are more subject to damage by drought.

In an area where the stand has been thinned, when the tap roots of surviving plant show evidence of having been rotted off, very likely Phytophthora root rot caused the stand loss. Figure 2 shows roots of plants dug in September in areas where the stand had been thinned by the fungus early in the summer. The length of healthy tap roots varied from 3 to 14 inches. The plants with the shorter tap roots were generally less vigorous.

Since high soil moisture is necessary for development of this disease, therefore, it is a problem only in poorly drained soils during periods of excessive rainfall. Low areas in the field where water tends to collect are often affected, but the condition also occurs on slopes where the water does not readily penetrate the subsoil. Here the surface soil remains saturated in periods of continuous rainfall — during the two weeks in June 1967 for example. Rainfall for that month totaled 8 to 10 inches in many parts of Minnesota.

F. I. Frosheiser is a research plant pathologist, USDA, and an associate professor, Department of Plant Pathology, University of Minnesota.

Figure 1. Phytophthora root rot on alfalfa roots.

A striking example of stand loss on a poorly drained hillside occurred in a first-year stand in Carver County. The alfalfa on the crest of the ridge along one edge of the field was unaffected. The stand was almost completely wiped out on the slope, but the alfalfa in the lowest-lying portion of the field was unaffected. This part of the field was tile drained.

The disease was observed in Carver and Pine Counties in 1965, but a more extensive survey probably would have revealed a wider distribution. Evidence of the disease was found in a wet area of only one field in 1966, a season of limited rainfall. In 1967, following the copious rain in June, Phytophthora root rot was observed in alfalfa fields in Carver, Cottonwood, Murray, Sibley, Waseca, Chisago, and Pine Counties.

The fungus, which appears to be present in most of the heavier soils in Minnesota, will damage alfalfa during prolonged periods of rainfal in poorly drained soils. The fungus does little or no damage in soil that is adequately drained.

Figure 2. Alfalfa roots rotted off at various depths by Phytophthora.

Hybrid Sorghums As Forage

A. R. Schmid

The sorghums may be considered as four types: 1) sweet sorghums (sorgos), 2) grass sorghums, 3) grain sorghums, and 4) broom-corns.

The sweet sorghums (sometimes called "forage sorghums" or "canes") have long been used for silage and fodder in Minnesota. They have sweet, juicy stems, and so some are used for production of sorghum syrup.

The grass sorghums include sudangrass and Johnsongrass. Sudangrass and the sorghum-sudan hybrids have been recognized as useful crops for green chop and emergency or supplementary pasture and hay.

The grain sorghums and broom corn are seldom used for forage.

A. R. Schmid is an associate professor, Department of Agronomy and Plant Genetics.

The use of male-sterile lines has made it possible to produce hybrid sorghums, sudans, and sorghum-sudans at reasonable cost. The question is: How much better are they? Will they substitute completely for corn as silage? Will the hybrid sudans and sorghum-sudans replace alfalfa or alfalfa-grass mixtures for hay, pasture, and green chop? These and other questions have been partially answered by recent research at Minnesota Agricultural Experiment Stations.

Sorghums for Silage

A wide range of sweet sorghum hybrids developed by seed companies and experiment stations are available. Many are late in maturity for production of good silage in Minnesota. Sorghum is a warm weather crop, having originated in tropical countries, and so most of the

Figure 1. Forage sorghum variety trial at Rosemount. Note the variability in maturity.

Table 1. Average yields per acre, digestibility in vitro and composition of corn and forage sorghum at the silage stage at Rosemount 1967.

Crop	Tons dry matter per acre	In vitro digestibility of dry matter in %	Tons digestible dry matter per acre	Percent of dry matter composed of heads or ears
Corn — Average of 3 hybrids	6.80	63.1	4.26	52
Sorghum hybrids				
Average of 3 high yielding, early maturing	5.46	61.1	3.33	21
Average of 3 high yielding, late maturing	6.96	57.3	3.61	9

hybrids are best adapted to the warmer climate of the southern Great Plains states. Some hybrids mature early enough to attain the dough stage before frost in the St. Paul area.

Trials of these silage sorghums in comparison with corn have been carried out at Rosemount and Lamberton over the past few years (see figure 1). In table 1 are shown yield digestibility (determined by a laboratory method) and composition data from the corn and sorghum trial at Rosemount in 1967. These plots received adequate amounts of P and K fertilizer (shown by soil test) and 100 pounds of N per acre. The data are averages of four replications of three-row plots. Corn was planted in early May and the sorghum in late May. The digestibility was determined by a test tube method, using rumen fluid from a dairy cow, peptic acid, artificial saliva, and urea. The percentage composition of the plants was determined by hand separation.

The data show that the average of the three high-yields (late-maturing sorghum hybrids compare favorably with the average of the three corn hybrids in yield of dry matter. However, the digestibility of the dry matter as determined in the laboratory was almost 6 percent lower than that of corn. The high-yielding, early-maturing sorghum hybrids were 2 percent lower in digestibility. As a result, the yield of digestible dry matter for corn was 4.26 tons, early sorghums 3.33 tons, and the late sorghums 3.61 tons per acre. The grain, the most nutritive part of the plant, helps to explain the difference in digestibility. In corn the ears were 52 percent of the dry matter. In the early sorghums, heads were 21 percent of the dry matter, but in the late sorghums only 9 percent. These data are similar to other data obtained in Minnesota, and they indicate that corn is still "king of the silage crops."

If sweet sorghums are used for silage, select the varieties that will give a good yield, mature early, and give a high percentage of the yield composed of sorghum

Figure 2. Sudangrass grazed when about 30 inches tall. Note the excessive waste.

heads. Data from variety trials in Minnesota are reported in Minnesota Miscellaneous Report 24, available from your county agent.

Sorghum-sudan and Sudan Hybrids for Green-chop

Acreages of sorghum-sudan and sudan hybrids greatly increased up to 1965, due to publicity. Also in 1965, with considerable winter-kill on legumes, an emergency crop was needed, and sorghum-sudan and sudan hybrids reached a peak of use in Minnesota. In 1965, with a cool season, these crops did not perform as well as normal, and publicity had dropped off, so the acreage has since declined.

The best use of sorghum-sudan and hybrid sudans is as a green-chop crop. Production comes during July and August when forage production from perennial grasses and legumes can be quite low. However, they are not "miracle crops." When harvested at about four feet in height before heading, digestibility is 65-70 percent and protein content is about 14 percent — excellent green chop feed at this stage. These crops grow rapidly, and as they head out and approach maturity the digestibility drops below 60 percent; then they are no longer top quality for high-producing dairy cows. The costs of production of these annuals run higher than for perennials such as alfalfa or alfalfa-brome, due to the annual costs of seedbed preparation, nitrogen fertilizer (not needed for alfala), seed, and seeding.

Table 2. Average dry matter yields of sudans and sorghum-sudan hybrids at a green chop stage (about 4 feet) at Rosemount and Morris, 1965-1967.

Crop	Tons dry matter per acre 1965	1966	1967	Avg.
Sudan				
Piper	1.96	3.79	2.28	2.68
Trudan II	2.13	4.22	2.10	2.82
Sorghum-sudan				
Average of 4 highest yielding	2.40	4.77	4.95	4.04
Average of 4 lowest yielding	1.75	3.96	2.28	2.66

The dry matter yields of Piper sudan, Trudan II (a sudan hybrid), and sorghum-sudan hybrids at the Experiment Stations at Morris and Rosemount over a period of 3 years are shown in table 2. These data are from plots drilled at 30 pounds of seed per acre with adequate P and K, plus 100 pounds of N per acre. At green chop stage (about 4 feet high), the hybrids on the average outyield Piper sudan. However, the four lowest-yielding sorghum-sudan hybrids yielded about the same as Piper sudan (2.7 tons of dry matter per acre) as an average of the two stations and three years. The four highest-yielding sorghum-sudans yielded 4 tons per acre. In comparison, alfalfa (with modest fertilization and a three-cut system) will yield about 3½ tons of dry matter as hay containing about 16 percent crude protein. Yields of 5 tons per acre of alfalfa with optimum fertilization and using a three-cut system is possible in many areas of Minnesota. Alfalfa is still "queen of the forages;" however sudans and sorghum-sudan hybrids can provide another crop to help the green-chop man fill that midsummer need.

Sorghum-sudan and Sudan Hybrids for Pasture

Sorghum-sudans and sudan can at times be disappointing for pasture because of the waste (see figure 2). It is recommended that Piper sudan, which is low in prussic acid (HCN), be grazed after it is about 18 inches tall. The sorghum-sudan hybrids generally are a bit higher in HCN and should not be grazed until they are about 24 to 30 inches in height. At this height the waste from pasturing can be excessive. At St. Paul in 1967, Trudan II was drilled in at 30 pounds per acre alongside a seeding in 40-inch rows. When it was 36 to 40 inches tall at the first round of grazing and 24-30 inches tall at the second round of grazing, the average percent waste of dry matter from tramping and fouling was 79 percent for the drilled and 43 percent for rows. These measurements were made by taking yield samples before and after grazing and using a period of only 3 days to graze it down. The cattle tend to walk down the rows and therefore cause less waste than when drilled solid. Some farmers have reported good results with rows 18 inches apart. Tests of 18-inch rows will be made at St. Paul in 1968.

Summary

On the basis of yield of digestible dry matter per acre, hybrid forage sorghums are worth about 80 percent as much per acre as good corn hybrids for silage, according to the Rosemount test. For best results in Minnesota the early-maturing, high-yielding hybrids should be selected.

The sorghum-sudans and hybrid sudans should be considered as supplementary or emergency crops and should not be considered replacements for alfalfa or alfalfa-grass. Their best use is as green-chop crops. For pasture the waste can be considerable from tramping and fouling. Growing these crops in narrow-rows for pasturing may be the answer to reducing the waste.

Whatever you can not understand, you can not possess. GOETHE

Urea-Corn Silage for Dairy Cattle

The microbes in a cow's paunch can use the nitrogen in urea — a cheap synthetic chemical — to make protein. Eventually the cow uses this protein. One way to feed urea is to mix it with silage.

D. E. Otterby, J. D. Donker and V. G. Pursel

Livestock people are reducing costs for supplemental protein by using urea in the dairy cow ration. Feed grade urea is a synthetic product that contains 45 percent nitrogen. The nitrogen in one pound of urea is equivalent to the nitrogen in 2.81 pounds of natural protein. The cow is able to utilize urea because the microorganisms in the cow's rumen (paunch) can convert the nitrogen from urea into a high-quality microbial protein. The cow in turn uses the microbial protein for her body needs. Urea is usually cheaper per pound of protein equivalent than supplemental soybean meal.

The addition of urea to corn silage at silage making time is becoming increasingly popular. There are some real advantages for this procedure. First of all, urea can be added to the silage in one operation. Second, the protein level of corn silage is normally quite low but is raised substantially when urea is added. The latter is particularly advantageous when large amounts of corn silage are fed with little or no alfalfa hay. When urea-corn silage is fed to dairy cattle, the protein content of the grain mix does not have to be as high as it otherwise would.

We were interested in feeding urea-corn silage to cows receiving no supplemental protein other than that offered naturally in the feed. In addition, we wanted to limit the amount of alfalfa hay fed. As you know, alfalfa hay is quite a good source of protein as well as other nutrients. Accordingly, two 14-by-40-foot concrete stave silos at the Morris Experiment Station were filled with corn silage. Silage in one silo was mixed with urea at

D. E. Otterby is an associate professor and J. D. Donker is a professor, Department of Animal Science, University of Minnesota. In that department V. G. Pursel recently completed his doctoral studies. He is now with the USDA, Beltsville, Md.

the rate of 10 pounds per ton of silage. The other silo was filled with corn silage only. All corn for silage was grown on the same field. Each load of silage was weighed as it was brought in from the field, and the appropriate amount of urea was spread over the top of the material going into the urea silo. Mixing of the urea with the corn silage was facilitated by the process of unloading the wagons and filling the silo.

The two silages were compared during the early spring of 1967 in a 90-day feeding trial with milking Holstein cows. We used twenty-six cows, paired according to stage of lactation, production, and age; in each pair, one cow ate urea silage and the other ate regular corn silage. Both silages were fed on a free-choice basis. In addition, we offered each cow five pounds of alfalfa hay and a grain mixture as shown in the table, fed at the rate of 1 pound for every 2 pounds of milk over 20 pounds daily. First-calf heifers received 3 pounds of extra grain per day to take care of the requirements for growth. Grain and silage were fed twice daily. Cows fed the urea-corn silage received no supplemental protein in their grain mixture, while the cows on regular corn silage were given a gram mixture containing soybean meal. Both groups of cows received similar daily amounts of protein.

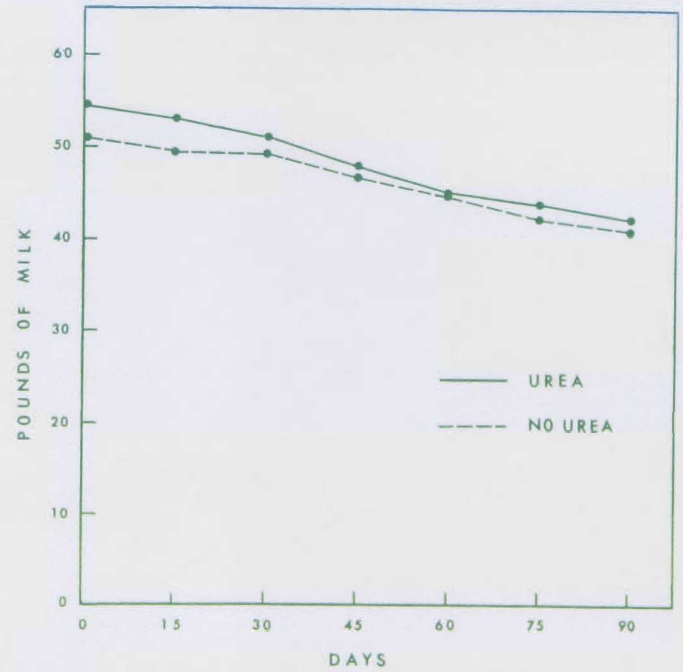
Table. Composition of grain mixtures

	Forage	
	Regular Corn Silage	Urea-Corn Silage
Ground Shelled Corn	69.7	74.4
Ground Oats	22.2	23.6
Soybean Meal (44%)	6.1	—
Salt	1.0	1.0
Dicalcium Phosphate	1.0	1.0

During the 90-day trial, silages and hay were sampled daily and composited by 2-week periods for chemical analyses. Each batch of grain was sampled, similarly. Cows were weighed once every 2 weeks. Daily milk production was recorded, and milk fat percentage and production were determined at the regular DHIA testing period.

The urea-silage tested 10.4 percent crude protein on a dry basis and 32.3 percent dry matter, while the regular silage contained 7.7 percent crude protein on a dry basis and 31.9 percent dry matter. Consumption of silage averaged 58.8 and 65.2 pounds daily for cows on urea and no urea, respectively. The urea cows ate about 1.5 pounds more grain per day.

As the graph shows, there was very little difference in production between groups over the 90-day period. Average milk production for cows fed urea-corn silage was 47.1 pounds per day, while that for the group fed regular silage was 46.0 pounds. Milk of both groups averaged 3.7 percent fat. When we calculated the percentage decline in milk production over the 90-day period, the results were again very similar — the urea-silage cows decreased an average of 19.5 percent, and the regular silage cows decreased 17.1 percent. The cows fed the regular silage gained slightly more body weight: 62 versus 36 pounds for the 90-day experimental period.



Cows in a group fed urea-corn silage produced about the same amount of milk as cows in a similar group fed regular silage.

The results of this trial, which are similar to results of similar trials at other experiment stations throughout the country, indicate that urea-corn silage can be used successfully in the dairy cattle ration with little or no difference in milk production. In this trial the nitrogen from urea provided the equivalent of 0.41 pounds of protein daily. This was only about 10 percent of the total protein intake.

It should be kept in mind that urea in corn silage or urea used in any other manner will be of no benefit either nutritionally or economically if protein is already adequate in the ration. Our current recommendations include:

Use 0.5 percent urea, or 10 pounds urea per ton of silage.

Be sure the urea is mixed well with the silage during the filling process.

Be sure the dairy ration is adequate in energy, minerals, and vitamins.

Give the cows 2 to 3 weeks to adjust to the urea.

Do not blow large amounts of urea (such as that from spills or accumulations around the blower) into silo at one time. The concentration of urea in the silage will be too high.

Loss of Crop Nutrients Through Runoff

D. R. Timmons, R. E. Burwell, and R. F. Holt

When the concentration of nutrient minerals in lakes and rivers becomes too high, growth of water plants usually becomes excessive. The water may then become undesirable for domestic and recreational uses. This too-great nutrient enrichment (eutrophication) of surface waters has been widely publicized recently, and the chemicals in runoff from agricultural lands have been blamed as one of the prime contributors.

Few quantitative data are available for evaluating the amounts and sources of agriculture's contribution to this eutrophication problem. It is true that fertilizers are being applied at higher rates because they are cheaper now and because of the economic necessity to get the largest crop returns per acre. This could increase the concentrations of chemicals in agricultural runoff. Also, the runoff from feedlots is of concern because livestock and poultry production is being concentrated into larger, confinement-type operations.

Nitrogen and phosphorous are generally considered the main elements causing aquatic plant growth, and these minerals are also major components of agricultural fertilizer. Therefore, the amounts of these elements in agricultural runoff need to be determined, and their critical limits need to be established so that methods can be developed and used to reduce these elements below critical levels in the runoff water.

This report summarizes 2 years' results of chemical analyses of runoff from the natural-rainfall erosion plots at the Barnes-Aastad Soil and Water Conservation Research Association Farm near Morris, Minnesota.

The Experiments

Nutrient content of runoff material was determined in 1966 and 1967 for a Barnes loam soil on a 6-percent slope. We made these measurements on experimental plots established in 1961 to determine the annual runoff and soil losses caused by natural rainfall in the west central Minnesota soil-climatic area. Five soil-cover cropping conditions were studied: (1) continuous corn; (2) continuous, clean-cultivated fallow; (3) corn in rotation; (4) oats in rotation; and (5) hay in rotation. Each of these soil-cover conditions was repeated three times on plots 13.3 feet wide and 72.6 feet long. We used standard equipment and procedures to determine soil and water losses. Weather records were maintained at the plot site to aid in interpreting data on runoff and soil loss.

Instead of using recommended, erosion-preventing planting methods, we planted crops up-and-down-slope to study the effects of cover without the added effect of perfect contouring. The fall plowing practice prevailing in the area was used. Weeds were controlled by mechanical cultivation without the use of herbicides. Crop residues remained on the plots after harvest, except for two hay cuttings. Fertilizer was broadcast and disked into the soil annually to supply sufficient amounts of plant nutrients to maintain a high level of crop produc-

Table 1. Annual nutrient loss for two seasons for the natural-rainfall erosion plots.

Cropping treatments	Avg annual tons per acre soil loss	Avg annual inches runoff	Avg lb per acre nutrient loss: Total N*	NH₄-N	NO₃-N	P	K
		1966					
Fallow	3.80	3.80	26.0	0.3	0.8	0.2	1.8
Corn-continuous	0.36	0.91	4.0	0.1	0.1	0.1	0.5
Corn-rotation	0.19	2.05	2.2	<0.1	0.3	0.1	0.6
Oats-rotation	0.01	0.20	0.1	0	<0.1	0	<0.1
Hay-rotation	0	3.41	0.3	0	0.1	0.1	0.8
		1967					
Fallow	10.28	4.63	89.9	0.8	2.6	0.5	4.6
Corn-continuous	3.14	2.98	19.2	0.3	0.8	0.2	1.2
Corn-rotation	0.62	2.35	6.7	0.1	0.4	0.1	0.6
Oats-rotation	1.02	2.09	9.4	0.1	0.9	0.1	0.6
Hay-rotation	0	3.83	5.7	0	0.2	0.3	5.2

* Excludes NH_4- and No_3-N.

At the North Central Soil Conservation Research Center, SWC, ARS, USDA, Morris, Minnesota, D. R. Timmons and R. E. Burwell are soil scientists. R. F. Holt is director there as well as a professor of soil science, University of Minnesota. The USDA and the Minnesota Agricultural Experiment Station cooperated in this research.

Table 2. Annual nitrogen loss (lb per acre) in runoff water and sediment from snowmelt and rainfall for two seasons.*

Cropping treatments	Total N†				NH_4-N				NO_3-N			
	Snowmelt		Rainfall		Snowmelt		Rainfall		Snowmelt		Rainfall	
	H_2O	Sediment	H_2O	Sediment	H_2O	Sediment	H_2O	Sediment	H_2O	Sediment	H_2O	Sediment
						1966						
Fallow	0.40	1.29	0.25	24.03	0	0.01	0	0.27	0.38	0	0.28	0.13
Corn-continuous	.03	0	.28	3.65	0	0	0	.10	.02	0	.04	.01
Corn-rotation	.50	0	.17	1.55	0	0	0	.02	.30	0	.02	.01
Oats-rotation	.04	0	.07	0	0	0	0	0	.03	0	.01	0
Hay-rotation	.30	0	0	0	0	0	0	0	.10	0	0	0
						1967						
Fallow	3.20	1.03	.21	85.46	0	.04	0	.75	.99	.02	1.24	.35
Corn-continuous	.31	0	0	18.92	0	0	0	.25	.29	0	.43	.07
Corn-rotation	.66	0	.12	5.90	0	0	0	.08	.34	0	.05	.02
Oats-rotation	.29	2.67	.01	6.44	0	.03	0	.06	.66	.01	.22	.02
Hay-rotation	5.62	0	.02	.03	0	0	0	0	.13	0	.03	0

* Values are given to two places to indicate the small concentrations measured for nutrient loss but not to indicate absolute values.
† Excludes NH_4- and NO_3-N.

tion. The annual nutrient applications per acre were:

(1) Continuous corn: 100 lb N as 33.-0-0, 26 lb P as 0-46-0.

(2) Rotation corn: 50 lb N as 33.5-0-0, 26 lb P as 0-46-0.

(3) Oats: 16 lb N as 33.5-0-0, 27 lb P as 0-46-0.

The fallow plots were fertilized with 300 pounds of 16-20-0 per acre in 1961 only.

Runoff samples collected after each runoff-producing storm were filtered to separate the water and sediment in the runoff. The sediment and water samples were then analyzed for total nitrogen, nitrate and ammonium nitrogen, phosphorus, and potassium.

Results and Discussion

The annual nutrient losses from the natural-rainfall erosion plots for 1966 and 1967 are shown in table 1. The 1966 nutrient losses were lower because four of the five runoff-producing storms occurred when crop cover was fairly complete; but four of the five runoff-producing storms in 1967 occurred during the critical erosion period when crop cover was lacking or negligible. Fallow plots and continuous corn plots generally had the highest nutrient losses of the five cropping treatments.

Nutrient losses determined in the water and sediment portions from snowmelt and rainfall runoff are presented in tables 2 and 3. For all crop-

Table 3. Annual phosphorous and potassium losses (lb per acre) in runoff water and sediment from snowmelt and rainfall for two seasons.*

Cropping treatments	P				K			
	Snowmelt		Rainfall		Snowmelt		Rainfall	
	H_2O	Sediment	H_2O	Sediment	H_2O	Sediment	H_2O	Sediment
				1966				
Fallow	0.03	0.01	0.03	0.14	0.19	0.08	0.19	1.30
Corn-continuous	0	0	.05	.03	.02	0	.28	.20
Corn-rotation	.03	0	.03	.02	.35	0	.16	.10
Oats-rotation	0	0	0	0	.02	0	.02	0
Hay-rotation	.06	0	0	0	.82	0	0	0
				1967				
Fallow	.01	.03	.02	.42	.50	.19	.12	3.78
Corn-continuous	.01	0	.06	.16	.14	0	.11	1.00
Corn-rotation	.04	0	.02	.05	.33	0	.07	.24
Oats-rotation	.01	.01	.01	.05	.17	.09	.03	.33
Hay-rotation	.34	0	.01	0	5.10	0	.01	0

* Values are given to two places to indicate the small concentrations measured for nutrient loss but not to indicate absolute values.

Table 4. Annual and accumulative nutrient losses based on 1961-67 soil losses and 1966-67 nutrient losses.

Cropping treatments	Avg annual tons per acre soil loss (1961-67)	Avg annual lb nutrient loss per ton soil loss (1966-67)	Avg annual lb per acre nutrient loss	7-year cumulative lb per acre nutrient loss
		N*		
Fallow	21.37	8.57	183.1	1282.0
Corn-continuous	9.44	7.03	66.4	465.0
C-O-H rotation	2.21	14.26	31.5	220.0
		P		
Fallow	21.37	.05	1.07	7.49
Corn-continuous	9.44	.09	.85	5.95
C-O-H rotation	2.21	.39	.86	6.02
		K		
Fallow	21.37	.45	9.62	67.3
Corn-continuous	9.44	.50	4.72	33.0
C-O-H rotation	2.21	3.81	8.42	58.9

* Includes Kjeldahl N, NO_3-N, and NH_4-N.

crop were much less than the rspecest loss of total nitrogen occurred in the sediment portion of the rainfall runoff; but the water from snowmelt runoff contained most total nitrogen for the hay plots. All the ammonium nitrogen occurred in the sediment from the rainfall runoff, but the nitrate nitrogen losses were highest in the water portions of snowmelt and rainfall runoff. The amounts of ammonium and nitrate losses from each crop were much less than the respective total nitrogen losses.

For the 2-year period, both phosphorus and potassium losses in sediment were highest from fallow plots, but losses of these elements in runoff water were highest from rotation corn and hay plots. It appears that snowmelt leaching of grain stubble preceding the hay cropping season is the main factor causing nutrient losses from hay plots. Only negligible nutrient losses were measured in rainfall water runoff from the hay plots.

Estimates of the annual nutrient loss per acre and of the accumulative 7-year losses for the natural-rainfall erosion plots were made by averaging the total amounts of each nutrient in the water and sediment from snowmelt and rainfall runoff for the two years and calculating the pounds of nutrient loss per ton of soil loss (table 4). This 7-year average was used because complete runoff and soil loss measurements have been made on the natural-rainfall erosion plots for this period.

Erosion studies at other locations have shown that soil losses from 300-foot slope lengths may be twice the losses obtained from 75-foot slope lengths. If field and cropping conditions are similar to those of the small plot studies, the nutrient loss data can be projected to larger areas. Based on the average nutrient loss for 1966-67, a continuous corn field with a 300-foot slope length and one-fourth mile long (9.3 acres) could lose 228 pounds of nitrogen, 3 pounds of phosphorus, and 17 pounds of potassium annually when conservation practices are not used. These nutrients not only contribute to eutrophication of lakes and rivers, but also represent a fertility loss of about $2.50 per acre per year for the farmer.

Conservation practices such as contouring, strip-cropping, mulching, and minimum tillage will reduce soil losses by 25 to 75 percent. The close relationship between soil and nutrient losses obtained from the 72.6-foot slope length natural-rainfall erosion plots farmed up and down the slope indicate that factors which increase or decrease soil losses will also result in a corresponding change in losses of nutrients from sediments. The amounts of runoff water, however, are not closely related to erosion factors, and erosion control practices involving crop residue management may not reduce nutrient losses in the runoff water if leaching of the residue occurs.

Nitrogen and phosphorus losses attributable to runoff and soil loss from agricultural watersheds are influenced by many factors. These include cultural and conservation practices, soil characteristics that affect infiltration and percolation, length and steepness of slope, seepage of ground water, amount and distribution of precipitation, water and sediment pondage areas, and size of watershed. Additional information is needed on these factors to better understand nutrient losses from agricultural lands.

New Dairy Topping Has Only Half As Much Fat

Food scientists at the University of Minnesota have developed a dairy topping that resembles whipped cream but contains only half as much fat. According to S. T. Coulter, M. A. Nielsen, and E. L. Thomas, their new product is 15 percent fat and contains only 23 calories per ounce. Regular whipped cream is 30 percent fat and contains 48 calories per ounce.

Made principally of cream, milk solids, sugar, emulsifiers, and stabilizers blended together and homogenized, the new topping stays whipped better and withstands storage at low temperatures better than whipping cream. Unlike regular whipping cream, it can be frozen and stored successfully for months. Freezable foods such as cakes and pies may be frozen and stored after the new topping has been added.

Test marketing at the Department of Food Science and Industries indicates that consumers like the new dairy topping.

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Titles of Articles

Those without authors are short items.

Authors of Articles

New Minnesota Field Crop Varieties

Carl Borgeson

Minnesota farmers will benefit from the release of three new field crop varieities — *Nored* flax, *Clay* soybeans, and *Polk* hard red spring wheat — which have been developed at the Univeristy of Minnesota Agricultural Experiment Station.

Nored flax is a medium to late maturing variety that is considered to be a replacement for Redwood and B-5128. When sown early, Nored is superior to other recommended varieties in yield of seed. Also, it is outstanding in its tolerance to pasmo disease and in its resistance to rust and wilt. It resists lodging and is high in oil.

Nored flax first seed increase.

Nored is medium in height, has blue flowers, and has average-size brown seed.

North Dakota, South Dakota, and Wisconsin are also releasing Nored flax. Two men at the University of Minnesota cooperated in its development: V. E. Comstock, USDA agronomist and associate professor of agronomy and plant genetics, and Harlan Ford, research agronomist for the USDA.

Clay is an early soybean. It matures 6 to 8 days earlier than Merit and 3 days later than Flambeau. Clay has better standing ability than either of these varieties, but it is shorter. In spite of its shortness, Clay has outyielded Merit and Flambeau in test fields harvested by combine.

Clay has dense, dark green foliage, purple flowers, and gray pubescence. Its seeds are medium size, shiny, and yellow, with colorless hila. Oil content of seeds is high.

Carl Borgeson is an associate professor, Department of Agronomy and Plant Genetics.

We expect Clay soybeans to be used most in a small area in northeastern South Dakota and in the Red River Valley counties of Minnesota and North Dakota. North Dakota and South Dakota have joined Minnesota in releasing Clay.

J. W. Lambert, professor of agronomy and plant genetics at the University of Minnesota, selected Clay soybeans from a cross between Renville and Capital.

Polk hard red spring wheat was developed under the direction of Robert E. Heiner, USDA geneticist and assistant professor of agronomy and plant genetics at this university. Polk is a bearded wheat of medium height and maturity. It has moderately stiff straw. It is superior to Chris in resisting the common types of stem and leaf rust. It is also resistant to black chaff and bunt.

One of the outstanding characteristics of Polk is its test weight, which averages about 3 percent higher than the weight of Chris. In the 1967 regional field trials, Polk yielded 6 percent more than Chris; but over a 3-year period the two varieties averaged the same in yield.

The milling and baking characteristics of Polk are satisfactory. In this way it is higher in quality than Chris.

North Dakota, South Dakota, and Montana will be participating with Minnesota in the release of Polk.

We distributed foundation seed and registered seed of Nored flax, Clay soybeans, and Polk wheat in cooperation with three groups: the Minnesota Crop Improvement Association (to registered and approved member growers), the Minnesota Seed Dealers Association, and the Minnesota Approved Seed Processors Association. In all, 1415 bushels of Nored, 557 bushels of Clay, and 7129 bushels of Polk were distributed to growers in the three organizations. These growers will be listed in the seed directory published by the Minnesota Crop Improvement Association and usually avilable about October first .

Nored flax, Clay soybeans, and Polk hard red spring wheat were developed as a team effort between the Department of Agronomy and Plant Genetics and the Department of Plant Pathology at the University of Minnesota in cooperation with the Agricultural Research Service, U.S. Department of Agriculture.

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