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MINNESOTA FARM AND HOME Science

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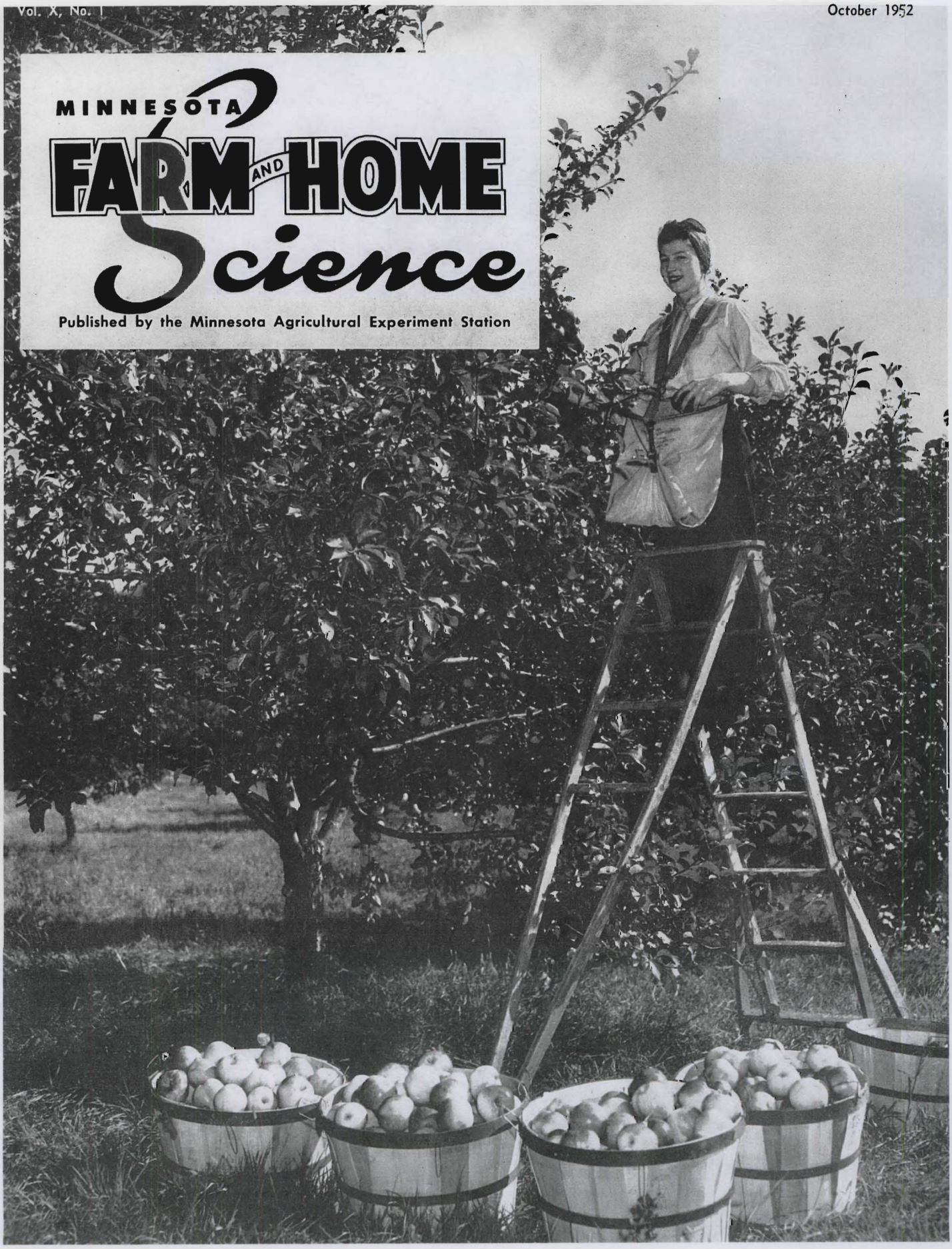

MINNESOTA FARM AND HOME Science

Published by the University of Minnesota Agricultural Experiment Station, University Farm, St. Paul 1, Minnesota

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October, 1952

Apples For Every Day

One of the pleasures much enjoyed by farm youngsters—and adults as well—is eating one's way through the apple season. Each month brings with it new taste delights and new eating pleasures. Late in July come the "harvest" apples and the crabs. Later other apples, each seemingly more delicious than the one before, come into season until finally those hard winter apples are picked and stored away for long blustery winter evenings.

Many of the apples that add to the appeal and usefulness of your orchard probably were developed at the University of Minnesota's Fruit Breeding Farm at Excelsior. Located about 25 miles west of Minneapolis and 5 miles southwest of Excelsior, the Farm is the center of the University's fruit breeding work. Our cover shows a familiar scene at our Farm during the fall apple-picking season.

The Fruit Breeding Farm was established back in 1907. Today it consists of 230 acres in two units 1½ miles apart. Its primary function, of course, is to produce varieties of fruit that will fit Minnesota conditions. Thus far 62 such varieties have been introduced, and several others are about ready to make their "debut" in Minnesota orchards.

Naturally it takes a lot of experimentation and hard work to develop a new fruit variety. A new apple may be 30 years in the making. Thousands of crosses and selections are tried. Right now, for example, there are about 40,000 "first test seedlings" and two thousand selections in advanced tests at the Farm.

Minnesota's Men of Science

Editor's Note—This is the ninth in a series of articles introducing scientists of the University of Minnesota's Department of Agriculture. Here we present Mark Thompson, superintendent, Northeast Experiment Station, Duluth.

Friends of Mark Thompson tell this story of his boundless energy and determination to make the Northeast Experiment Station a vital part of Minnesota's Arrowhead Region. Many years ago, in the days of the horse and buggy, members of the Board of Regents of the University notified Mr. Thompson they would visit the Station on a certain day. They arrived but could find Mr. Thompson nowhere. Finally they were directed out into the fields where land clearing was taking place.

There they found the superintendent busy grubbing out stumps with his fellow staff members. Dusty and disheveled, he gave the members of the Board of Regents a "running" visit of the Experiment Station, explaining his lack of formality with, "After all, they hired me to build this farm."

And Mark Thompson did literally carve the Station out of wilderness. Now, just a few months before his scheduled retirement, the Northeast Experiment Station is a modern farm, conducting experimental work on most of the problems that intimately concern farmers.

Mr. Thompson was born on a farm near Winsted, Minnesota and studied agriculture at the University of Minnesota where he received his bachelor of science degree in 1911 and his master of science degree in 1912. He was the first recipient of the Shevlin fellowship in agriculture. After graduation he was employed by the United States Department of Agriculture and was sent to western Michigan to organize county agent work in that area.

He was called back to the University of Minnesota in 1913 to establish the Northeast Experiment Station. When he arrived there, the place was covered with balsam, fir trees, and birches so his first big project was land clearing.

By 1918 the farm had begun to develop well. Then came the big forest fire which wiped out everything. The entire Station was burned, and Thompson saved his wife and two children only by taking them underneath a bridge.

Thompson rebuilt through the years. Working with scientists from University Farm and on his own projects, he developed a broad experimental program. Today the Station includes nearly 300 acres of land and 15 well-kept buildings with attractive landscaping.

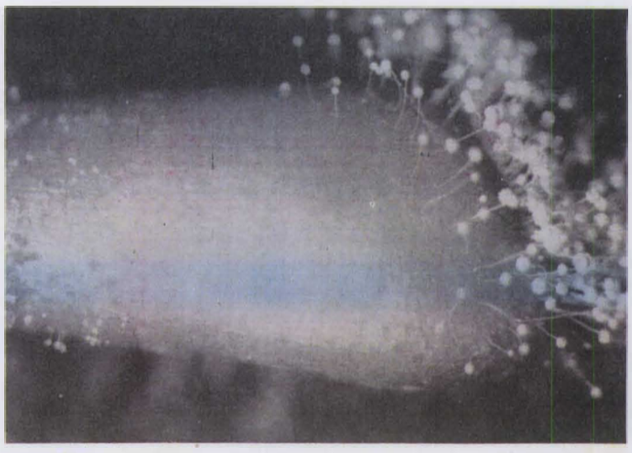
Experimental work under Mr. Thompson at the Station has included projects on the use of manure, improved crop varieties, potato variety and fertilizer testing. The Arrowhead rutabaga and the Arrowhead dwarf sunflower originated at the Duluth Station.

A man of boundless energy, more active than men half his age, Thompson has not limited his work entirely to the farm. His columns in "Stock and Dairy" and in the "Cooperative Builder" reach thousands of homes each week and he has a regular radio program every week.

He is a member of many honorary and professional groups including Sigma Xi, Gamma Sigma Delta, Alpha Zeta, and is a fellow in the American Society of Agronomy.

Sick Wheat

It caused a loss of several millions of dollars in the wheat belt last year. While sick wheat is a major problem to those who ship, store, or process large quantities of wheat, it is by no means their problem alone.



Storage mold growing from the germ of sick wheat.

CLYDE M. CHRISTENSEN

WHAT IS sick wheat? Essentially it is seed whose germ or embryo is off-color and either greatly weakened or dead. Sick wheat is not readily detected by anyone but an expert, and usually its presence in a lot of grain is first discovered when the grain is inspected as it arrives at the terminal. Even though it's hard to see, sick wheat is a very real and actual trouble. A carload of wheat that contains more than a small percentage of sick seeds will not make high class flour, and the poor flour made from it will make even worse bread.

Sick wheat probably has been with us ever since wheat first was grown, thousands of years ago. Apparently it has been increasing in the last 10 or 15 years. Why? Some say that it is because of the more moist harvest seasons. Others claim that we merely are beginning to be aware of a condition that always was present, but has been accentuated by the more moist harvest seasons. Others maintain that harvesting by combines has made a previously minor problem into a major one. It may well be a combination of all three.

What Makes Wheat Sick

What causes sick wheat? Our studies during the last 10 years, indicate that various conditions may contribute to changing wheat that presumably is sound at harvest into wheat that becomes sick in storage or transit. Molds are one of the principal causes—molds that are present on and within the wheat seed when it is harvested. Given the right conditions, these molds invade and kill the germ of the wheat and grow into other portions of the seed. In so doing, they produce or contribute greatly to the complex biochemical changes that convert sound wheat into sick wheat.

Clyde M. Christensen is professor of plant pathology.

The major factors that determine whether wheat, once harvested, will remain sound or become sick are:

1. The moisture content of the grain when harvested and during storage.

2. The temperature of the stored grain.

3. The length of time the grain is stored.

Surprisingly enough, it is not always easy to determine even so simple a thing as moisture content of grain. As wheat is brought to a country elevator, or as carload lots come to the terminals, or as the grain is stored in terminal bins, an average sample of the grain from the truck or grain car or bin is taken. The moisture content of this sample is determined with an electric moisture meter.

Considerable care is taken to get a sample that represents the entire lot. But we have evidence to indicate that such an "average" sample may be misleading. From a bin of wheat whose average moisture content was 13.2 per cent, we have obtained samples with a moisture content of 16.0 per cent. Sick wheat had developed in this bin, although the figure on the "average" moisture content indicated that the grain was well within the limits for safe storage.

If the moisture content exceeds 14.5 per cent in any portion of the bulk, as it did in this case, there is danger of spoilage. Obviously, then, it is important to know the highest moisture content in any portion of the bulk grain, since this is what determines whether molds will grow, and whether the grain will keep well or spoil.

How much does the moisture content vary in different portions of a single truckload of wheat brought to the country elevator by the farmer? We do not know, but we are going to find out. Certainly our evidence at present indicates that the "average" moisture content is a rather risky basis on which to buy, ship, and store large quantities of wheat.

Moisture Content Changes

Even when wheat is stored at a uniform and safe moisture content—below 14 per cent—it is not necessarily safe from deterioration. When grain is stored in bulk—several hundred to many thousands of bushels in one bin—the moisture content does not remain uniform throughout the mass of grain.

Tests by us and others of grain stored in bins prove that moisture moves slowly and gradually from one part of the bulk to another. It is virtually impossible to prevent this slow shifting of water. If, after some weeks or months of storage, this movement of water results in part of the grain accumulating a moisture content in excess of 14.5 per cent, that portion of the grain will gradually mold and spoil, and this may lead to spoilage of a much greater portion.

As stated earlier, moisture is only one of the chief things that determine whether molds will grow on and spoil stored wheat. Temperature and time are important too. We have stored wheat at 16 per cent moisture for 18 months, with only a slight drop in germination. But we stored at at 23° F.—well below freezing.

Also, wheat at 14.5 to 15.0 per cent moisture can be stored safely for some weeks at a temperature of 70° F., but if stored for several months it will mold and spoil. If the temperature of the stored grain is between 35 and 40° F., it can be kept safely for some months at a moisture content close to 15 per cent.

Keep Moisture Content Low

Our present knowledge indicates that excess moisture of the grain when harvested and stored is principally responsible for the acuteness of the sick wheat problem over the last decade. Moisture above 14.5 per cent in any con-

(Continued on page 19)

Good Crop Rotation *Boosts Corn Yields*

A. R. SCHMID, R. F. CRIM, and C. O. ROST

YOU CAN take the word of at least eight Minnesota farmers that a good crop rotation boosts corn yields! There are many others, too, who will swear by crop rotations.

But let's have these eight farmers tell their story. These men cooperated with the University of Minnesota and their local county agents in a series of 2¼-acre field trials.

The farmers who cooperated were: Arnold Losleben, Brown County; Vern Immer, Cottonwood; Robert Keller, Murray; Charles V. Simpson, Le Sueur; George Fausch, Rice; Arne Stenlund, Goodhue; Nicholas Weyrens, Grant; and Alfred T. Putnam, West Ottertail.

To make these tests fair, their land received no special treatment. In other words, the results they obtained can be expected on representative farms throughout the state.

We know of course that legumes and legume-grass mixtures—as hay, silage, or pasture—give high returns in livestock and livestock products. At the same time they build the soil.

Legumes add nitrogen to the soil and both legumes and grasses add organic matter. This organic matter holds reserve supplies of plant nutrients, provides food for necessary soil microorganisms, improves tilth, increases intake and movement of water in the soil, and prevents erosion.

One-Year Meadow Trials

Since 1949 we've conducted experiments on Minnesota farms to find out how different types of legumes, legume-grass mixtures, and grasses affect yields of corn which follow. Table 1 shows corn yields in 1951 on land which was in different hay crops in 1950 and on one field of sweet clover which was plowed under at the hay stage. The legumes and grasses were seeded with oats in 1949.

The big increases in corn yields following the various one-year sod crops is striking when compared with the check which was in oats. Increases ranged from 33 to 69 per cent. Figure 1 shows how much more corn grew on the George Fausch farm at Morristown following one year of alfalfa hay than following oats. Corn planted following brome-timothy (no legume) showed the smallest increase—33 per cent over the check field where oats had been grown in 1950.

Table 1. Corn Yields in 1951 Following One Year of Hay
(Averages of three farms)

Hay crop in 1950	Bushels of corn per acre			
	Fertilized*	Not fertilized	Average	Per cent increase over check
Check (oats in 1950)	33.9	29.4	31.7	....
Alfalfa	54.9	51.3	53.1	67
Alfalfa, brome, timothy	55.9	51.3	53.6	69
Brome, timothy	44.3	40.2	42.2	33
Medium red clover	49.9	46.5	48.2	52
Medium red clover, timothy	52.7	50.1	51.4	65
Sweet clover (plowed at hay stage)	51.7	48.4	50.1	58

* Fertilizer = 200 pounds per acre 0-20-20, applied to oats and legumes in 1949.

The plots which had sweet clover plowed down at the hay stage showed some advantage over medium red clover, but no particular advantage over the other legume alone or legume-grass plots where the hay was removed.

From these data, it appears that it may not be practical to lose a year of crop production by plowing under a sweet clover crop in the hay stage, especially in areas where moisture is plentiful.

We are working on experiments now to determine the effect on corn of leaving sod crops down two years before plowing. Data from other states indicate that during the second year that a sod crop is left down, the improvement in soil productivity is only one-fifth as great as during the first year. During the third year that a sod crop is left down, there is no additional improvement in soil productivity.

For this reason, we may get the greatest increase in soil productivity on a farm by growing legumes and legume-grass mixtures only one year, but putting them into the rotation more often. Cheap, southern-grown Ranger alfalfa may be available in the near future to cut down the cost of more frequent seedings of one-year legumes.

Using Legume Catch Crops for Green Manures

On many farms in Minnesota, particularly in the southwestern and western areas, it is difficult to grow enough one-year and two-year meadows in the rotation to build up the soil. The main reasons for this are the large size of the farms and insufficient livestock. The deficiency in acreage of legumes can be made up to some extent by growing legumes in the grain which precedes corn. Table 2 shows corn yields following such legume catch crops compared with grain with no legume.

Again, the legumes gave quite an increase in corn yields compared with the check with no legume. The increases in yield are rather astonishing when you consider the limited amount of growth made by a small-seeded leg-

FIG. 1. Left—Corn following oats. Right—Corn following one year of alfalfa. Both pictures were taken on the George Fausch Farm near Morristown, Minnesota.

A. R. Schmid is associate professor of agronomy and plant genetics; R. F. Crim is associate professor of agronomy; C. O. Rost is professor and chief, Division of Soils.

ume during the seeding year when grown with a companion crop.

The increases in yield of corn following the grain with various legumes was 7.1 to 12.8 bushels per acre or 21 to 31 per cent. Our figure 2 shows the growth of oats in the third year of the oats (with alfalfa)-corn-oats sequence compared with oats (without alfalfa)-corn-oats.

In this experiment, medium red clover and alfalfa appeared to be somewhat superior to biennial sweet clover and Hubam sweet clover in boosting corn yields. However, sweet clover weevil had damaged some of the sweet clover stands. Hubam sweet clover has consistently produced a rather nonvigorous growth. Also because it is an annual, it does not produce as heavy a root system as the biennial sweet clover.

Biennial sweet clover has been a cheap and effective legume to grow as a catch crop in grain to be plowed under for corn. However, more and more difficulty is being encountered in getting stands of sweet clover because of the sweet clover weevil. Experiments are under way to find out the best way to control this insect using various insecticides. Some progress is being made in these studies.

The crop rotation results reported here indicate that medium red clover and cheap, common southern alfalfa should make good substitutes for sweet clover. Lack of winter hardiness in common southern alfalfa is not an important consideration because only the growth made during the seeding year is used.

Table 2. Corn Yields in 1951 Following Oats Planted to Legume Catch Crop for Green Manure

(Averages of five farms)

Legume catch crop in oats in 1950	Bushels of corn per acre			
	Fertilized*	Not fertilized	Average	Per cent increase over check
Check (no legume)	40.0	38.6	39.3	.....
Medium red clover	52.8	50.6	51.7	31
Kansas common alfalfa	50.0	50.9	50.4	28
Biennial sweet clover	47.1	49.0	48.1	22
Hubam sweet clover	47.7	47.1	47.4	21

*Fertilizer = 200 pounds per acre 0-20-20 applied to oats and legume.

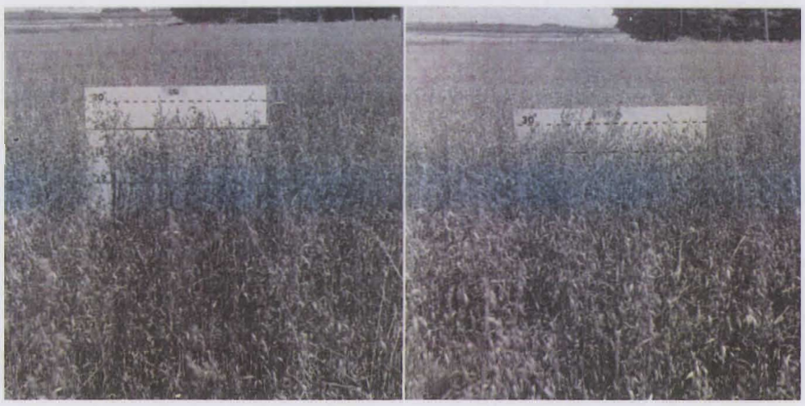


FIG. 2. Left—Oats in the third year of an oats-corn-oats sequence where no legume was grown with the oats for green manure.

Right—Oats in the third year of an oats-corn-oats sequence where alfalfa was grown with the oats for green manure.

Table 3. Dry Matter Yields of Tops and Roots in Late Fall of Legume Catch Crops Grown for Green Manure in Oats Preceding Corn

(Averages of two fields)

Fertilizer treatment	Dry weight yield per acre			Per cent increase
	Tops	Roots	Total	
	lbs.	lbs.	lbs.	
	Biennial White Sweet Clover			
0-0-0	597	956	1553	.....
0-60-0	631	987	1618	4
0-60-60	722	1188	1910	23
	Alfalfa			
0-0-0	347	371	718	.....
0-60-0	498	512	1010	40
0-60-60	612	632	1244	75
	Medium Red Clover			
0-0-0	426	390	816	.....
0-60-0	790	635	1425	75
0-60-60	685	634	1319	62

Although no striking differences in corn yields were obtained from the fertilizer treatments on the legume catch crops for green manure in this experiment, two other experiments where yields of tops and roots of the legumes were taken showed quite a response to fertilization. These data are shown in table 3.

Three fertilizer treatments were used: (1) None, (2) 300 pounds per acre of 0-20-0 and (3) 300 pounds per acre of 0-20-20. The fertilizers increased the dry matter produced by each of the legumes.

For biennial sweet clover and alfalfa, the phosphate-potash combination produced the largest increases and was effective on both top and root production. This indicates the importance of potash for these two legumes. Phosphate was the important constituent for red clover and the gain in yield of both tops and roots was primarily due to it.

It is apparent that through the use of fertilizer, both top and root production of legumes can be increased. This means a corresponding increase in organic matter and nitrogen. The added organic matter not only carries available nitrogen but additional mineral elements which are released for the succeeding corn crop.

Here is How to Increase Your Corn Yields

1. **Try to grow a legume or legume-grass meadow crop once every three to five years on each tillable acre. This can be done most easily by leaving the sod only one year. Where soil erosion is a serious problem, it may be necessary to leave sod for more than one year or include a sod crop in the rotation more often.**
2. **Grow a legume catch crop in every acre of grain which precedes corn. This practice is particularly desirable on large farms where there isn't enough livestock available to use efficiently all the forage from adequate acreage of one-year and two-year meadows.**
3. **Have the soil tested and provide sufficient lime, phosphate, and potash to attain a high fertility level and provide for nutrients used by crops.**

Frost-Free Stock Watering Tank

ARNOLD M. FLIKKE

ICE-FREE WATER for livestock has always been a problem in northern climates, especially in pen barns and feed lots. Water is the cheapest part of the dairy ration, yet during cold weather it is difficult to supply in adequate amounts.

Many types of tank heaters are now on the market. Although these heaters usually perform satisfactorily, they are costly to operate and need considerable attention during long, cold spells. That's why we're studying ways to improve present tank-heating methods.

We want to determine the requirements of a frost-free tank and also investigate sources of heat. We do know the amount of heat lost from large water tanks kept at constant temperatures. Since these conditions do not apply to farm tanks, we built a unit and placed it in a cold room where we could study how much, and in what way, heat was lost.

From our data and other information, it is apparent that heat is lost from the surface of the water and through the walls of the tank. These losses are affected by air and water temperatures, wind velocity over the tank surface, type of tank used, and number of livestock using the tank.

As as result of these studies, the following principles of design have been determined:

1. The tank should have a small surface area in order to reduce the amount of heat lost to the atmosphere. If cattle can get to the water at all times, drinking space for two animals at a time is sufficient.

2. The volume of the tank should be small. This reduces the amount of heat needed to prevent freezing and also provides fresher drinking water.

3. The walls of the tank must be insulated to reduce heat losses.

4. The tank should be installed in an area protected from the weather. This reduces the heat loss and provides greater comfort for the livestock.

We also found that the behavior of water as it cools and freezes can help in keeping the tank ice-free. The density of the water changes with temperature, being most dense at 39.2° F. Therefore, as the water in the tank cools, there is a continuous circulation, until all the water is at 39.2° F. Upon further cooling, the cold water remains on top and will freeze. Conversely, if the water is warmed, any water warmer than 39.2° F. will remain on top of the tank.

From this it is apparent that if water at 39° F. is suitable for livestock, it is necessary to heat only the top 2 or 3 inches of water in a tank to keep it from freezing on the surface.

Feeding trials with livestock show that they do not particularly prefer warm water. It has been shown that livestock will drink most water if the temperature is between 35°-50° F. The important fact is that open water should be available at all times to the livestock.

An experimental tank was then built in which the cold water on the surface was drained off and "wasted" and replaced by warmer water from the well. This is illustrated below. A solenoid valve in the overflow, operated by a thermostat, controls the amount of water wasted. This method takes advantage of the changing density of the water and also uses a cheap source of heat. The expense of keeping the tank open comes from pumping fresh water into the tank..

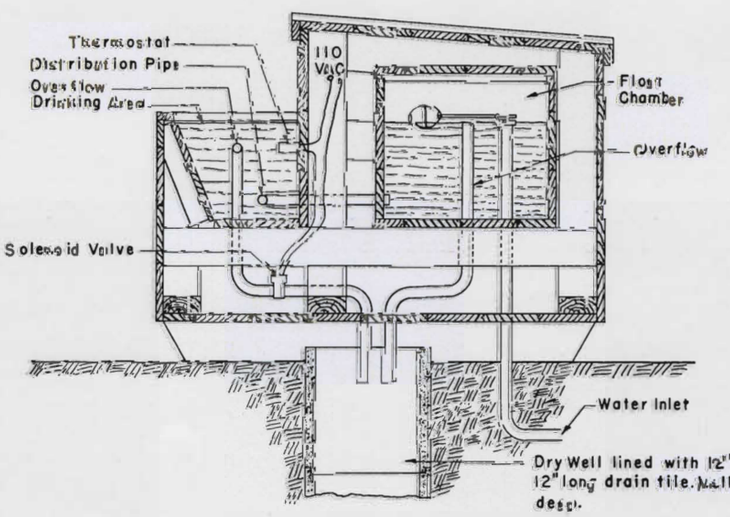
Units of this type have been used under various conditions. A unit located in a pasture away from livestock wasted 420 gallons of water on a day when the temperature averaged 16 below zero F. Tank units operated in feed lots with cattle drinking from them have wasted a maximum of 270 gallons per day under similar temperature conditions. In terms of cost these tanks can be kept open using two kilowatts or less of electricity per day for pumping, which is considerably less than cost of operating conventional tank heaters. The two main requirements for this type of tank are water under pressure and adequate drainage facilities for the waste water.

Other Sources of Heat

Further work is being done to find other heat sources. One method is to circulate the cold water through coils buried in the ground. Tests carried on in sandy soils indicate no apparent advantage to this method as pumping costs are too high. Another source being studied is the manure pack in pen barns in which temperatures of over 90° F. have been measured.

Another phase of the work is to eliminate the float valve and its insulated chamber. To do this, a solenoid valve is installed in the water supply line. It is controlled either by a thermostat or an electronic water level control. An overflow is provided for the waste water. The liquid-level control mechanism, except for the probes, can be installed away from the tank thus simplifying construction. There are many other improvements in livestock watering methods to be tried and we hope to develop a watering unit that is low in initial cost, easy to construct, foolproof, and low in operating cost.

Pipe line arrangement for frost-free stock watering tank.



Arnold M. Flikke is assistant professor of agricultural engineering.

Fifty Years of Farm Records

The Minnesota Agricultural Experiment Station has the distinction of being the pioneer in the field of farm management research in the United States. Here's the story of this research on its golden anniversary.

GEORGE POND

FIFTY YEARS ago two pioneer farm leaders, W. M. Hays and Andrew Boss, wanted to know if crop rotations might increase farm profits. This curiosity in 1902 led them to establish cost accounting in three areas of Minnesota. At first they had dreamed of getting cost figures from their experimental plots. Practical men, they soon realized that costs had to be based on actual farm operations to be of any value.

To get this information they first had to sell the idea to farmers. This they did so well that on January 1, 1902, groups of farmers in three important type-of-farming areas began supplying information to a fieldman who made daily visits to each farm.

First Study of Crop Costs

During the first two years attention was centered on crop costs. It soon became apparent that livestock was too important to be ignored. So in 1904 the study was expanded to cover the entire farm business.

At first Hays and Boss emphasized cost of production. Results were published in money costs per acre of crops or per head of livestock. But constantly changing prices of labor, feed, and other commodities used in farm production made money costs computed for one year mean little a year or two later.

This led to expressing costs in terms of physical quantities as hours of labor, pounds of feed, and the like. Thus by applying current prices to them, cost and profit computations could be adjusted as prices changed. As time went on more attention was paid to farm earnings as a whole and less to the cost or income for specific crops and classes of livestock. Interest centered on the farm as a business unit and the adjustment needed from year to year as prices and other conditions change.

Farm Picture Changes

The importance of a steady flow of information on factors affecting farm success is obvious when one recalls the revolutionary changes in the farm picture during the past 50 years.

Most farms today have more money invested in tractors alone than the average Minnesota farm needed for all machinery in 1902. Electricity has come to the farm. The combine, corn picker, windrow baler, and field chopper have revolutionized harvesting operations. Fertilizer, lime, and weed sprays are new crop costs. Livestock production has changed drastically with the purchase of baby chicks, criss-cross breeding of hogs, artificial breeding, dairy herd improvement associations, litter testing, the use of protein concentrates and antibiotics, and many other new developments. Farms are becoming larger; farm prices have fluctuated violently.

Fifty years of farm records have enabled the experiment station worker to keep abreast of the changes in the farm picture as they occurred and to keep his research adjusted to meet new problems as they arose. They have also served as a beacon light to guide farmers in adjusting their operations more accurately.

Methods of Record Keeping Change Too

Through the 50 years that these farm records have served as a guide to agriculture, significant changes took place in the records project itself. The work has been rotated over the state to cover different types of farming and different farm problems. At first the fieldman kept all records for the farmer. Later, seeing the value of the records, the farmer assumed more and more of the responsibility for keeping them. This made it possible to increase the number of records supervised by one fieldman.

However, even with this change, the number of cost accounting records that could be supervised was so small it was decided in 1928 to experiment with somewhat simpler records kept by larger groups of farmers. Daily labor reports and some other details were eliminated, and the farmer kept his own record with little supervision. This plan worked so well that by 1930 one fieldman was able to supervise some 180 farmers as compared with 25 to 30 previously.

The withdrawal of federal funds from this expanded study in 1930 threatened its discontinuance. However, by this time the farmers had found these records and their analysis so valuable that they paid to keep the project in operation.

One study, centered on dairy farms in southeastern Minnesota, is now in its twenty-fifth year, and farmers bear a major share of the cost, paying annual fees from $34 to over $60 per year. A similar study set up in 1940 in southwestern Minnesota is also in operation. These cooperative studies enable both the farmers and the Experiment Station to obtain valuable information at much less cost than either could get it alone.

Some idea of the scope of these farm record studies over the 50-year period is shown in the table. They are divided into two groups: (1) regular continuing studies giving an over-all picture of agriculture in different parts of the state and (2) special studies of particular problem farms or areas.

The latter included groups of starting farmers in various parts of the state, cooperators in soil conservation and in Tennessee Valley Authority phosphate demonstration projects, and Rural Rehabilitation (now Farmers Home Administration) clients.

(Continued on page 8)

Farm Records Used for Research Purposes Per Year and Total by Periods, 1902-1951

Years covered	Number of records per year: Regular projects, Cost accounts	Regular projects, With feed records	Special projects, With feed records	Special projects, Without feed records	Total per year	Grand total
1902-17	27	.....	.....	.....	27	433
1918-19	0	.....	.....	.....	.....	0
1920-27	44	.....	.....	.....	44	348
1928-30	23	159	.....	.....	182	546
1931-39	20	146	.....	280	446	4,019
1940-45	19	234	.....	197	450	3,300
1946	0	320	.....	118	438	438
1947-50	0	321	378	.....	699	2,796
1951	33	279	260	.....	572	572
Average or total	24	113	35	77	249	12,453

George Pond is professor of agricultural economics.

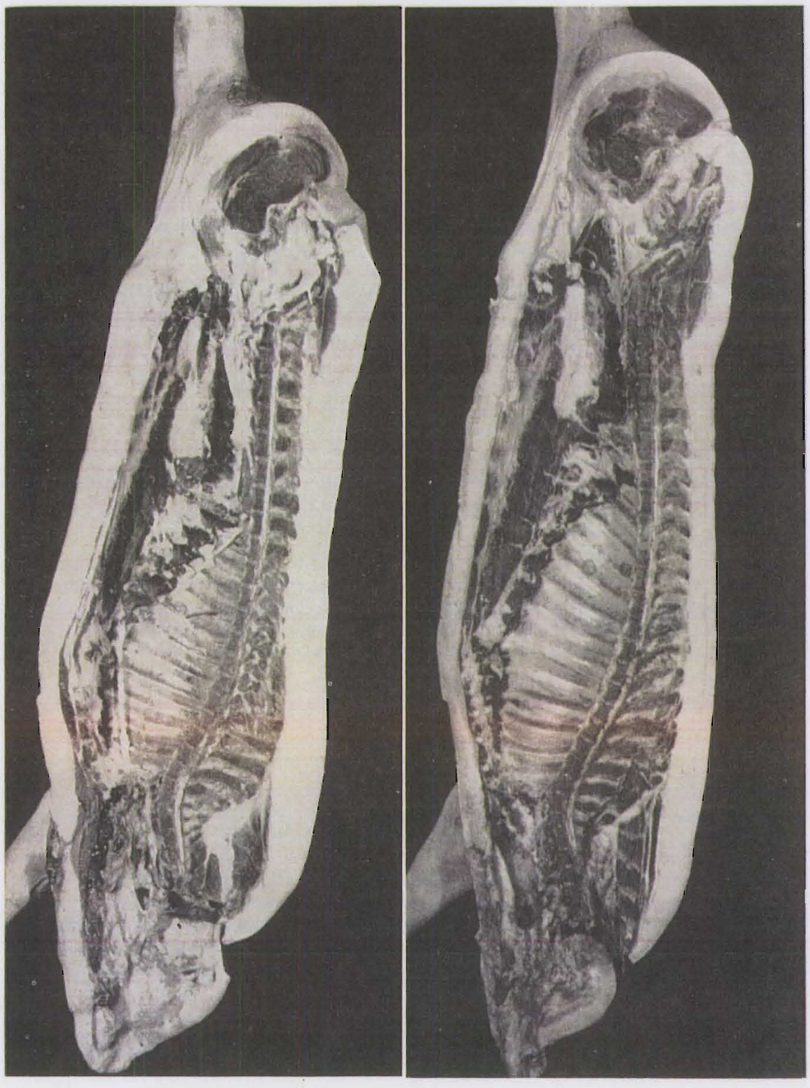
PRICING HOGS On Foot and On The Rail

ROBERT E. OLSON and
AUSTIN A. DOWELL

HOG PRODUCERS should be paid according to the value of the hogs they deliver to market. And value depends upon the total value consumers place on the various cuts, trimming, and by-products.

Since the true value of a hog depends upon its cut-out value, why aren't hogs sold on this basis? The answer is that this is not practicable either for individual hogs or for separate lots of hogs. The time and expense involved is too great.

However, the accuracy of pricing a particular hog or lot of hogs can be determined by comparing the price paid with the value of the products. The relative accuracy of pricing hogs by various on-foot methods and by carcass weight and grade also can be determined by comparing the prices paid with the actual cut-out values.



The very fat carcass on the left weighed 169 pounds, measured 2.30 inches of backfat, and would be expected to yield 44.4 per cent lean cuts (hams, loins, picnics, and Boston butts). The more desirable carcass on the right weighed 143 pounds, measured 1.53 inches of backfat, and would be expected to yield 51.0 per cent lean cuts.

Check 219 Hogs

To obtain information on the relative accuracy of pricing hogs by different methods, 32 lots of five to ten hogs each were selected at random from hogs delivered at the Geo. A. Hormel & Company plant, Austin, Minnesota, by farmers within 25 miles of the plant. Detailed on-foot, carcass, and cut-out information was obtained on each of the 219 hogs in the 32 lots. The results are shown in our table.

The figures in the first line in the table measure the pricing errors under each marketing method. The smaller the figure, the more accurate is the pricing method.

The second line shows the percentage reduction in pricing error compared with the usual method of selling hogs on the basis of a flat price according to weight for several different methods of marketing. The greater the reduction in pricing error, the greater the improvement in pricing accuracy.

Test Six Methods

The last line in the table gives the rank in pricing accuracy of the different methods.

Column 1 shows the results under the rather common method of marketing hogs in the United States, by liveweight in lots at a flat price by weight groups. This is the least accurate of any of the methods shown.

Some lots of butcher hogs contain individuals that weigh more than the upper limit or less than the lower limit of the range of the weight group in which they are sold. For example, the seven hogs in one of the lots in this study ranged in weight from 184 to 239 pounds with an average of 216 pounds for the lot. This lot was priced at the market top of the day because the average weight fell in the 200-220 pound range. However, only one hog was in the 200-220 pound range.

Column 2 shows the reduction in pricing error accomplished by weighing each hog individually and pricing it by weight. This resulted in only a slight improvement over the usual

Robert E. Olson was formerly research fellow in agricultural economics, University of Minnesota; he is now agricultural economist, Bureau of Agricultural Economics, Washington, D.C. Austin A. Dowell is professor of agricultural economics.

method of marketing hogs as shown in column 1.

Column 3 shows the reduction in pricing error accomplished when an experienced hog buyer estimated the carcass yield and average backfat thickness, which is a measure of carcass merit, of each individual hog. This had about the same accuracy as pricing by individual liveweight (column 2).

The buyer overestimated the value of the entire sample of 219 hogs by 21 cents per 100 pounds liveweight. This resulted from an overestimate of average yield and an underestimate of average backfat thickness. Since it is likely that with more practice the buyer would be able to make a closer estimate of the average value of a large number of hogs, the figures were adjusted so that the total estimated value of the 219 hogs was the same as the total cut-out value. When this was done, the pricing error was reduced considerably (column 4).

It is possible that more experience in estimating backfat thickness will lead to greater accuracy in estimating grade in live hogs. Hence in column 5 it was assumed that the buyer could place each hog in its proper carcass class or grade. This resulted in a slight improvement in pricing accuracy over the method reported in column 4. A few packers at the present time estimate the backfat thickness and use this estimate to pick out premium hogs alive.

The last method was to price each carcass on the basis of its weight and average backfat thickness. This is quite similar to the method used in Canada, the United Kingdom, Denmark, Sweden, and a few other countries. This was by far the most accurate of any of the pricing methods studied. Under the carcass weight and grade method of marketing, errors in estimating yield are eliminated and the quality of the carcass can be determined more accurately on the rail than in the live hog.

Carcass Method Most Accurate

The carcass method of marketing permits pricing hogs individually. This is important because most farmers' lots of hogs contain hogs of more than one grade. In this study, 17 of the 32 lots delivered from 32 different farms included hogs that produced carcasses of two grades and the remaining 15 lots contained hogs that produced carcasses of three grades. No lot contained hogs of only one grade. The farmer needs to know which hogs are sold in each grade so that he can take steps to improve the quality of the hogs he produces.

The greater relative accuracy of the carcass weight and grade method of pricing over any of the on-foot methods suggests a need for studies directed at the problems involved in the carcass method of marketing. More accurate pricing of hogs is desirable from the standpoint both of hog producers and consumers of pork. It would make possible more effective research in animal genetics, animal nutrition, and consumer preferences.

Relative Accuracy of Six Methods of Pricing Slaughter Hogs, 219 Butcher Hogs in 32 Lots of Five to Ten Hogs Each

	On-foot pricing method					
	Liveweight only		Liveweight and grade			
	Average weight of lot	Individual weight of hogs	Estimated yield and grade of each hog		Assumed correct grading	Carcass weight and grade
			Original estimate	Adjusted estimate		
	(1)	(2)	(3)	(4)	(5)	(6)
Measure of pricing error*	22.3	18.8	19.0	13.9	10.6	4.0
Percentage reduction in pricing error (based on column 1)		16	15	38	53	82
Rank in pricing accuracy	Sixth	Fourth	Fifth	Third	Second	First

* Variance.

Farm Management Research . . .

(Continued from page 7)

Records were classified into three groups according to the amount of detail in the records and analysis: (1) cost accounts or cost of production studies covering the whole farm business, (2) financial accounts supplemented with feed records for all classes of livestock, and (3) simple financial accounts. Altogether 12,453 annual farm records have been collected and analyzed over the 50 years.

How Results Are Used

The results of these 50 years of farm records have furnished the main source of information for 28 experiment station bulletins, 2 technical bulletins, 11 extension bulletins, 193 mimeographed reports, a number of circulars and pamphlets, and a steady flow of articles in *Minnesota Farm and Home Science*, *Minnesota Farm Business Notes*, and the farm press generally. These studies have provided the answers for thousands of inquiries addressed to the experiment station from all over the state covering farm management, costs of farm production and tractor and machine operation, farm leasing arrangements, and the like.

For 50 years they have supplied basic information and illustrations for classroom and extension teaching. They provide the chief and practically sole source of information on the personal and household expenses of farm families.

During World War II farm record data were an important source of information for setting production goals. More recently they have been used in planning production programs for the state and preparing farm outlook reports from time to time.

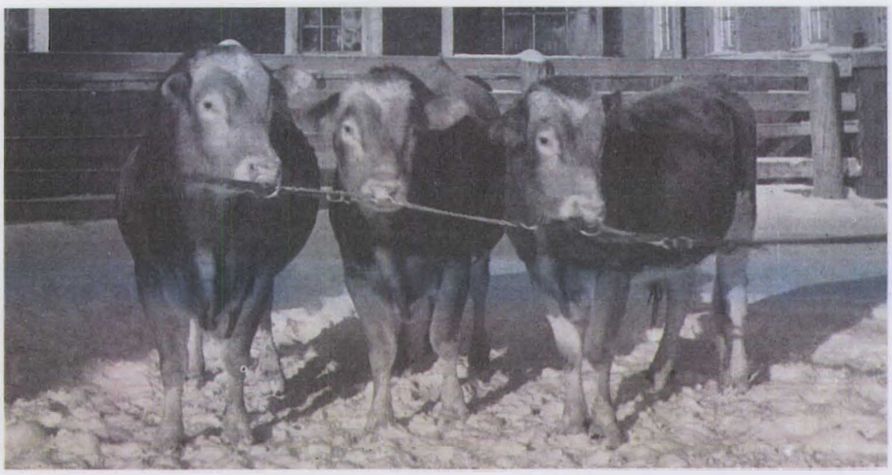
Perhaps the most striking evidence of the value the farmer has come to see in these records is indicated by the fact that when he was first asked to keep the record of his receipts and expenses in 1904 it was necessary to pay him for his services. Today he is very glad not only to keep the records himself but also to pay a substantial part of the cost of supervising and analyzing them.

Only New York and Illinois have a wealth of farm management research data comparable with that available from the farm records projects in Minnesota. Both have long-time farm record studies going back some 40 years.

Problems Are Changing

Farming is a highly dynamic business. Its economic problems are never completely solved because new ones are constantly replacing the old ones. The most profitable crop or combination of crops today may be decidedly unprofitable a year or two hence. The combinations of labor, capital, and other resources of the farmer must be changed with changing prices and changing technologies if farmer's earnings are to be maintained.

Both the farmer and the research worker need a continuing flow of accurate farm record data to keep our farm business adjusted to the changes it faces.



Triplets and

Triplet bulls—Harry, Dick, and Tom (from left to right)—are being used to test the effect of nutrition on semen production. Harry gets the most food, Dick the next, and Tom the least.

M. C. HERVEY

IT ISN'T EVERY Tom, Dick, and Harry in our dairy world that can be placed on a pedestal for their contributions to dairy science. But where nature plays a trick and makes these Toms, Dicks, and Harrys identical twins or triplets, they become real servants of Minnesota's dairymen through the work of the University's Agricultural Experiment Station.

With 30 sets of twins and 5 sets of triplets now on hand, the University has the largest collection of identical twins and triplets in the United States and one of the largest collections in the world. Since the start of the work with identical twins in 1947, 47 sets of twins and 7 sets of triplets have been used in our dairy research work.

Why Are Identical Twins So Important?

Except for identical twins, there are no two animals in the world that have exactly the same inheritance. Individuals differ greatly in their appearance, and in their inherent capacity to grow, to use feed, to produce milk, etc.

Because there are such great differences in the inherited capacities of different individuals, research workers ordinarily use large numbers of animals in an experiment where one feed or one type of management is being compared with another. When they use a large number of animals, variations because of inheritance are minimized in comparing the various experimental groups. Scientists also have tried many other procedures in an effort to eliminate the effect of different inherited potentialities in different individuals.

One of the best procedures, however, is to use identical twins. Since identical twins do have exactly the same inheritance, one animal can be placed on one treatment with its identical twin mate on another. Thus we know that any differences in the performance of the animals is due to the treatments or the environment rather than due to any differences in the genetic composition of the animals.

M. C. Hervey is associate professor of dairy husbandry.

Identical Twins Rare

Twins occur about once in 50 calvings in dairy cattle. However, only a small proportion of these twins in cattle are identical. More than 90 per cent of twins in dairy cattle are fraternal twins and no more alike in their inheritance than ordinary full sisters, full brothers, or a full brother and sister.

Identical twins not only look very much alike but when fed and managed under similar conditions grow and produce alike. To check growth we studied 22 sets of identical twins, managing and feeding them alike until they came into production. Within a pair of twins the average growth varied only .07 pound per day. The small variations found within sets of identical twins means that one set of identical twins is as efficient as from 6 to 24 pairs of unrelated animals when results are measured in terms of body weight and from 14 to 43 pairs of unrelated animals when results are measured by height at withers. Researchers at the Animal Breeding Institute at Wiad, Sweden and the Ruakura Experiment Station in New Zealand reached similar conclusions in their work.

Although we have very little data yet on the milk and butterfat production of the identical twins when fed and managed alike, there is remarkable similarity in those sets that have completed lactations. Results to date indicate that the value of identical twins for experiments in which results are measured by milk or butterfat production is much greater than in the case of growth. When managed and fed the same, identical twins averaged only 6 pounds difference in butterfat production during their first lactation. This is especially remarkable because we had very good and very poor producing pairs under test. Researchers at Ruakura, New Zealand found that one set of identical twins was as efficient as from 22 to 54 pairs of unrelated animals for milk and butterfat production studies.

These and other studies convinced us we could use identical twins and triplets effectively in our research.

University Experiments

The identical twins at the University of Minnesota have been used during the past few years in a great many different kinds of experiments that have involved different types of management. Following is a report on some of our results.

Importance of Hay Quality—Two sets of identical twins were used in which U.S. No. 1 extra leafy alfalfa hay was compared with U.S. No. 3 leafy brown alfalfa hay. We found that the U.S. No. 1 hay was more palatable and that it produced more rapid gains in body weight and height at withers. The U.S. No. 1 alfalfa hay contained slightly more digestible protein and total digestible nutrients and nearly five times as much carotene as the U.S. No. 3 hay.

Effect of Grain in Calf Rations—One member of each of six sets of twins on this experiment was fed whole milk for about two weeks after birth and then skim milk until 180 days. Whole and skim milk were fed at the rate of 1 pound of milk to 8 pounds of body weight of the calf up to a maximum of 16 pounds daily. In addition, these calves received as much as they would eat of high quality alfalfa hay and a 14 per cent digestible protein grain mixture.

Their identical twin mates were fed exactly the same except that they received no grain.

In this experiment we found that the calves on the no-grain rations could be raised satisfactorily and that they made nearly as rapid growth as their identical twin mates that were receiving all the

Identical Twins Speed Dairy Research

grain they would eat, an average of approximately 4 pounds per head per day. The calves raised on the no-grain ration made their gains at much less cost and were in satisfactory condition. It should be emphasized that very high quality alfalfa was used throughout the experiment and that the amount of grain consumed by the calves would probably have been much higher if poorer quality hay had been used.

Effect of Nutrition on Semen Production—Studies on the effects of nutrition upon semen production are being made on a long-time basis with two sets of identical triplet bulls—Tom, Dick, and Harry as well as Ike, Mike, and Spike. One member of each set of triplets is fed 100 per cent of his total digestible nutrient requirements, another 70 per cent of this amount, and the third 130 per cent. One set of these triplet bulls is now six years old and the other set, three years old. To date we have found that the bulls on the highest planes of nutrition have produced more semen of higher quality than those on lower planes of nutrition. In other words, the old belief that thin bulls are the best breeders is not true. Of course, we don't know yet whether these same differences will continue as the bulls become older.

Effect of Mastitis—In a number of instances, one member of a set of twins has developed mastitis in a lactation and her identical twin mate has not. These cases have indicated the effect of mastitis on production. This is the first time that it has been possible really to estimate accurately the losses in production which occur.

For example, take the case of T-1 and T-2. T-1 went through her first lactation rather uneventfully to produce 6,293 pounds of milk and 260 pounds of butterfat in 305 days. T-2, her identical twin mate, however, had four attacks of mastitis and suffered from repeated injuries to the teats. All the attacks were mild and she responded well to prompt treatments each time but produced only 6,080 pounds of milk and 247 pounds of fat in her 305-day lactation, a loss of 213 pounds of milk and 13 pounds of butterfat compared with her identical twin mate. T-2 in her second lactation, however, showed a complete recovery and produced slightly more than T-1.

The case of T-9 and T-10 furnish an example of a more severe case. T-10 lost one quarter from mastitis in her first lactation. She produced 1,554 pounds less milk and 63 pounds less fat in her first lactation than her unaffected mate. In the second lactation T-10, on three quarters, produced 2,772 pounds less milk and 103 pounds less butterfat than T-9.

These losses in production which occur in spite of prompt treatment emphasize the necessity of taking care to prevent injuries to the udder and to reduce the incidence of mastitis as much as possible.

Value of Rotational Grazing—Four sets of twins have been used on an experiment to determine the value of rotational grazing. One member of each set was placed on an alfalfa-brome pasture of 4.8 acres with access to the entire area. The other members of each set were placed on a comparable pasture but permitted to have access to only the amount that they would graze each day. By means of an electric fence they were given a new allotment each day. The twins got all of their nutrients from the pasture; they received no supplementary feed.

The first year of this trial was a wet year with frequent showers throughout the entire summer. The growth of the pasture was good during the entire season. Both types of pasture provided an adequate source of nutrients, and there was little difference in growth or milk production between the two groups, although the animals on the rotationally grazed pasture were slightly ahead. However, it was necessary to use only 1.8 acres of the rotationally grazed area for pasture. The remainder was cut for hay.

The continuously grazed pasture yielded 5,681 pounds of TND (total digestible nutrients), and the rotationally grazed pasture yielded 5,930 pounds of TDN plus more than 8 tons of hay.

Rotational grazing thus makes for much better use of the land and is a much more flexible system of management. Furthermore, it was possible to turn the cattle onto the rotationally grazed pasture when it had reached the proper stage of maturity. We noted, too, that the plant growth on this pasture was more dense and more vigorous.

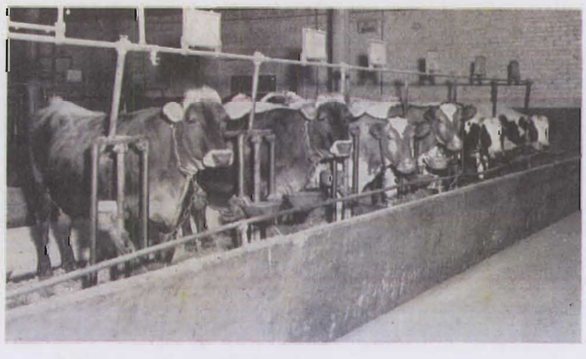
Other Tests—Identical twins have been or are being used on many other types of experiments in dairy production. Some involve hormonal control of lactation in which one animal calves normally while the other is brought into milk production by use of various hormones.

In the case of one set of triplet cows, one animal is milked once a day, one twice a day, and another three times a day to determine the effect of the frequency of milking upon production.

Studies on the effect of different intervals between milkings are being made with several sets of twins, one of each set being milked every 12 hours while her identical twin mate is milked at alternate 10- and 14-hour intervals.

We don't have enough information to draw conclusions concerning these different intervals at various levels of production, but it may be possible sometime to determine how much it costs the dairyman to lie abed an extra hour or so in the morning.

Other twins are being used on studies on different feeds and on various other experiments. It is obvious that these identical twins may be used to great advantage to answer many different problems for the dairyman and the Dairy Division of the University of Minnesota is constantly adding identical twins to its research program.



Three of the 36 sets of twins the University is now using in dairy research. We can learn as much from studying one set of identical twins as from 6 to 24 pairs of unrelated animals.

Minnesota Is Becoming An Urban State

You may well be startled by the Census takers' 1950 results here in Minnesota. Changes have occurred that will have a marked effect on all of us—young and old. Here Dr. Nelson tells of these startling changes.

LOWRY NELSON

• Our population is growing but at a declining rate.

During Minnesota's first 50 years, our population increased very rapidly to 1,750,000 people. In the second 50 years the population has grown more slowly, adding only 1,232,000.

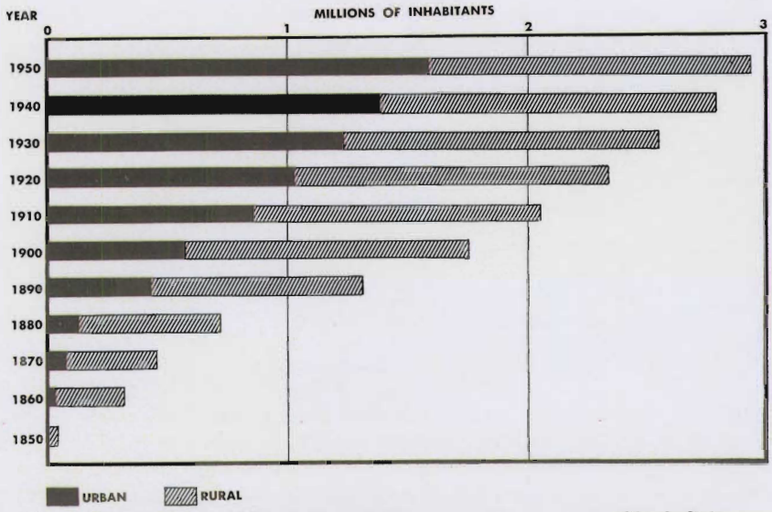


Fig. 1. The proportion of Minnesota's population in rural areas is steadily declining.

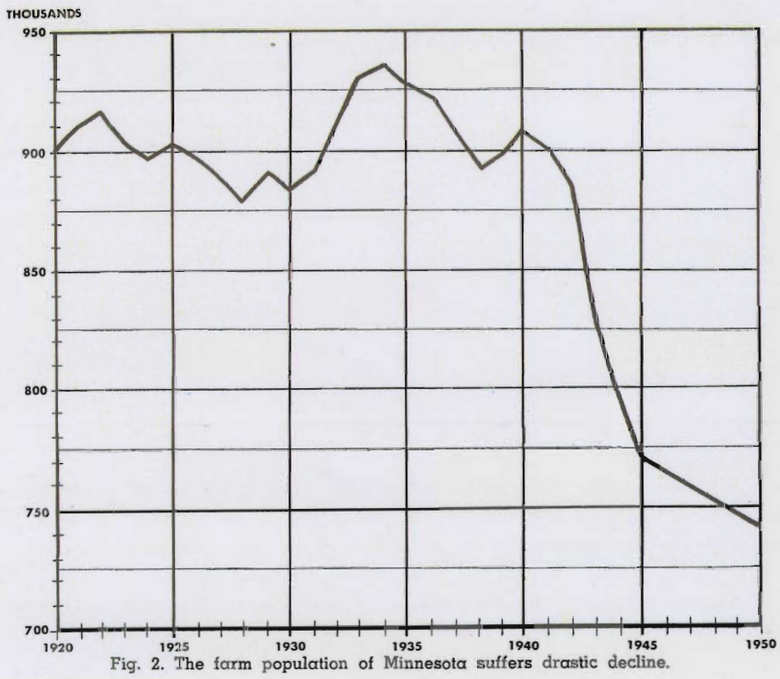


Fig. 2. The farm population of Minnesota suffers drastic decline.

This is not due to failure on the part of the population to reproduce, but rather to the tendency for a large part of the natural increase to migrate out of the state. For example, from 1940-50 our total population increased by around 190,000. However, in this same period, births exceeded deaths by 365,000. If all people born in the state had remained here, the 1950 Census would have totalled 175,000 more persons. This represents the number who have left the state during the decade.

• Our population is steadily becoming more urban.

In 1950 for the first time, more than half of Minnesota's people lived in urban places. Only 46.1 per cent lived in rural territory (defined as incorporated places of less than 2,500 people and all unincorporated territory).

Actually, while the state was growing by 190,000, the population of rural territory was decreasing by some 27,000. This is a rather remarkable shift in population from rural to urban. Figure 1 presents this change graphically.

• Our farm population is tumbling.

The decline in our rural population occurred among the people living *on farms*—a decrease of 165,000. Although about one-third of this decrease is due to a change in the census definition of a farm, even the remaining two-thirds represents the most drastic reduction in the farm population which the state has ever known (figure 2).

At the same time, rural *nonfarm* people, that is, those living in hamlets and villages of under 2,500, increased by one-fourth during the decade, but this increase in villagers was not enough to equal the decline in farmers, and was due in part to the change in definition.

These figures emphasize the remarkable evolution that has taken place in the country in the relatively short span of a century—a transition from an alalmost exclusively farm population to one predominately urban. The social significance of the decline in farm population is a matter of increasing concern to rural leaders. Many schools have already reorganized and some churches, cooperatives, and other social institutions are considering it.

As farms grow larger in response to mechanization, farm families are more

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Lowry Nelson is professor of rural sociology.

widely separated than formerly, and more dependent for social contacts upon motor transportation. In all likelihood more activities will be village-centered.

• Some counties lose population while others gain.

From the foregoing, the reader will anticipate that many counties in the state have declined while others have gained. Clearly those that are predominately rural would be likely to lose, while those in which urban centers are located would inevitably increase. During the decade, 48 of the 87 counties lost people. This was similar to the experience of most of these counties during the prosperous 1920's when they also declined in size. Then, in the decade of the '30's they "filled up" again. The story of losses and gains is shown in figure 3.

• The old and the young are becoming more numerous.

Everyone knows that the birth rates increased rapidly during the 1940's. However, it may be surprising to learn that the number of children under 5 during this period increased by *over 44 per cent* (figure 4). On the other hand, the number in the age group 15-24 declined one-sixth. Population in other age groups usually included in the labor force increased, but by a very small number.

At the other end of the age pyramid, there was a one-fourth increase among persons 55 years of age and over. Actually, this increase in Minnesota's older population is considerably smaller than that for the nation as a whole and would indicate that some of these persons migrate out of the state. Even so, in 1950 we had 57,000 more people of age 65 and over than we had a decade earlier.

All of this increase was among urbanites and villagers, because the rural farm population had fewer persons 65 and over in 1950 than in 1940—a result of the general decline in farm population. Older people tend to congregate in small towns and they constitute a higher percentage of small town than of either city or farm populations.

This changing age composition of our population, of course, causes a number of social problems. The rapid increase among children necessitates construction of new school buildings, employment of more teachers, and investments in more school-bus and other facilities.

On the other hand, the increase among the aged increases the need for facilities to care for them. Meanwhile, **the number of people in the working age range has actually declined.** A relatively greater burden is now carried by people in the working age group.

This fact has serious implications for policies regarding social security, veterans benefits, and special interest legislation, which cannot be discussed in this article.

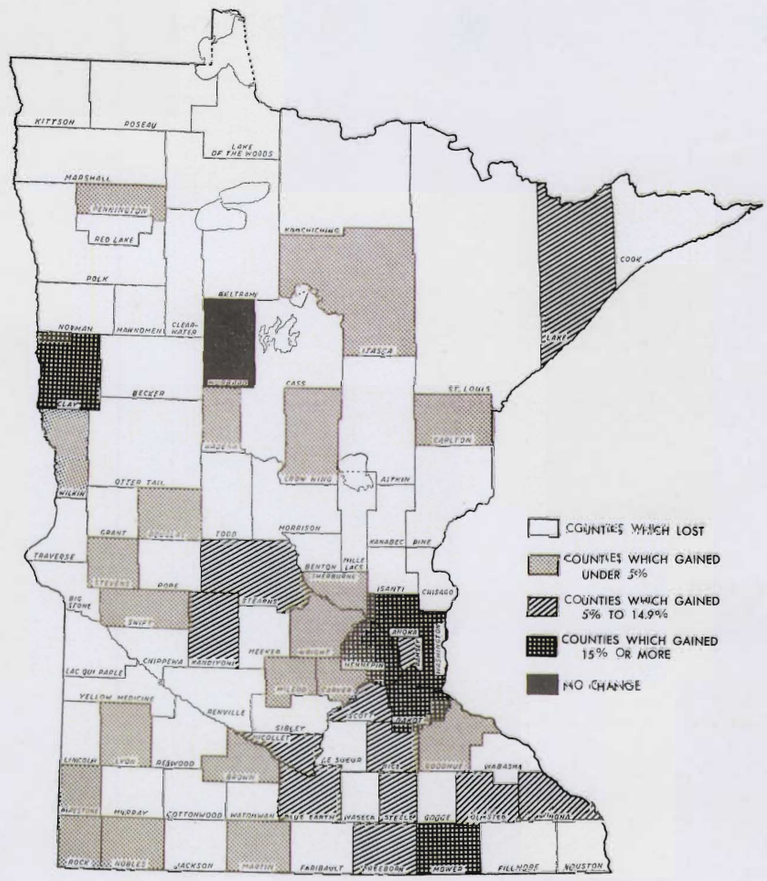


Fig. 3. Percentage change in total population by counties for period 1940-50.

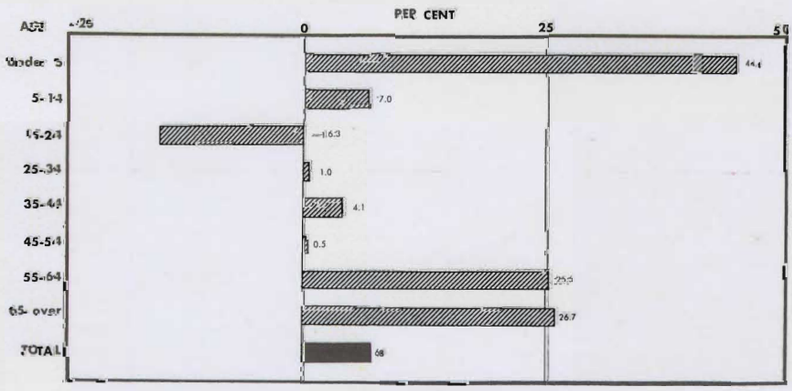


Fig. 4. Percentage increase in population of Minnesota by age groups, 1940-50.

Pollination of Our Agricultural Crops

ROLAND L. FISCHER

DID YOU EVER CONSIDER that the lowly bee might mean the difference between a good or a poor crop? That's right, for many of our farm crops depend on the job these friends do in pollinating our crops. Without proper pollination there might be no seed or fruit.

And what is pollination? It is nothing more than the transfer of the male portion of the flower (the pollen) to the female portion (the stigma). Once this is done the pollen grain germinates and sends down a germ tube to the ovule (the potential seed). Then fertilization (the union of the nucleus in the germ tube with the female nucleus in the ovule) takes place. After this, the seed or fruit may then develop.

Many plants must be *cross-pollinated* to increase the vigor of the fruit and to insure fertilization. Cross-pollination occurs when the pollen from one flower is transferred to the stigma of another.

This is in contrast to *self-pollination* in which the pollen of a flower is transferred to the stigma of the same flower. We call a flower, which is self-pollinated and which is able to produce mature fruit and viable seed, self-fruitful or self-fertile.

On the other hand, a self-unfruitful or self-sterile plant is one which cannot set fruit and mature it with its own pollen. Many plants, even though self-fruitful, produce better crops when cross-pollinated.

Pollen Transferred by Wind, Water, and Insects

Pollen may be transferred by wind, water, insects, or experimentally by hand. Certain plants are pollinated by each of these natural methods.

In *Elodea*, one of the pondweeds, the pollen floats to the surface of the water. Then movement of the surface water eventually brings it into contact with the stigma of the female.

Most grass crops including oats, wheat, barley, and corn are wind-pollinated. Wind-pollinated plants usually produce more pollen than insect-pollinated plants. In some forests the production of pollen by the wind-pollinated pines and birches may be so great that the air is filled with "golden showers" of pollen.

Many of our farm crops are insect-pollinated. With few exceptions, bees are our most efficient friends in doing this job. More than 50 farm crops depend upon bees for their production or yield better when bees visit their flowers. Bees collect both pollen and nectar when they visit these flowers. In doing this they transfer enough pollen to bring about cross-pollination.

Bees Aid Pollination

Bees are thus one of the farmer's greatest assets. Naturally, we must protect and preserve both our honeybees and our native bees. Here in Minnesota alone it is estimated that we have more than 300 kinds of native bees. Generally speaking we have three kinds of native bees—(1) **bumblebees**, (2) **leafcutter bees** which use portions of leaves to construct a nest, and (3) **digger bees** which burrow into the earth to construct their nests.

The fruit grower has a pollination problem with apples, pears, cherries, and plums. In general, apricots and peaches are self-fertile and will set fruit with their own pollen. Many varieties of apples and pears and the majority of cherries, however, are self-unfruitful. Consequently many growers interplant an orchard with other varieties of the same crop to insure adequate pollination. In general, the honeybee is a very effective pollinator of orchard crops. The value of honeybees is increased because they may be moved into an orchard after spraying is done and then be moved out when their pollination activities have come to an end.

The honeybee is also an important pollinator of raspberries, cranberries, some varieties of grapes and strawberries, and many of the cucurbit crops such as squash, pumpkins, watermelons, and muskmelons. Many of the vegetable seed crops must also be cross-pollinated.

Legumes Must Be Cross-Pollinated

Legumes, too, are largely self-unfruitful and must be cross-pollinated to produce a seed crop. Bees are thus a necessity. The honeybee does a good job of pollinating alsike and sweet clover and possibly red clover. Bumblebees and a species of *Lasioglossum*, one of the small digger bees, also pollinate alsike.

Leafcutter bees do the best job of pollinating alfalfa, but bumblebees also play an important part. We still do not know what role the honeybee may play in the pollination of alfalfa in Minnesota. The Minnesota Agricultural Experiment Station is now studying this and many other legume seed problems.

Even though bees may be plentiful in an area, their presence does not guarantee the production of a crop. Many things may hamper the bees from doing their work. Bad weather at blossoming time may keep many "grounded" and thus stop their pollinating activities. To avoid this, many orchardists use an excess of honeybees in their orchards during the blossom period.

Protect Bees from Insecticides

The presence of injurious insects may also cut crop production. The farmer, in many instances, must use insecticides to control these harmful insects. But many insecticides are as injurious to bees as they are to other insects. To avoid killing bees, apply the insecticides at the bud stage before the bees are foraging in the crop.

If spraying of legumes is necessary when in bloom (with heavy infestations this may be necessary), use toxaphene. Toxaphene controls the majority of the harmful insects except the pea aphid. Even though toxaphene is not as toxic to bees as many other insecticides, apply it late in the evening or at night when the bees are not working in the field to lessen the possibility of killing bees.

Crops Compete

The competition of other crops or weeds more attractive to bees for pollen and nectar may also cut the chances of a crop being adequately pollinated. This is particularly important in alfalfa seed production. Many of the leafcutter bees visit sow thistle and fireweed in preference to alfalfa. Alfalfa fields left for seed should be as free of weeds as possible and should be segregated from competing crops such as sweet clover.

All this points to the importance of farmers doing everything to protect and preserve our bees. It's good business to protect our good friends, the bees.

Roland L. Fischer is research fellow in entomology.

Aerial Photos Aid Forest Management

STEPHEN H. SPURR

AERIAL PHOTOGRAPHS have become essential tools in forest management since 1945. Much of present-day forest mapping, timber cruising, and actual forest administration is carried on by foresters who either use aerial photographs to obtain the essential information, or who plan their field activities with the aid of either aerial photographs or maps made from the photographs.

In Minnesota, most of the forested region of the state has recently been photographed from the air through the the cooperative efforts of various public agencies and wood-using industries. We may well pause to summarize the present status of the use of aerial photographs in woodland management.

Type of Photos Needed

First, we should recognize that every craftsman needs tools particularly fitted to the needs of his profession. For example, the highway engineer wants aerial photographs showing the ground at large scale through leafless trees taken during late fall or winter when no snow is on the ground. But the forester needs photographs taken when broad-leaved trees still have their leaves to get information about the forest cover.

Economy requires that the photographic scale be 1,000 feet to the inch or smaller, but the photos are easier to interpret if the scale is 2,000 feet to the inch or larger. The scale most commonly used in Minnesota is 1,320 feet to the inch. At this scale, a section is 4 inches square and a forty, 1 inch square.

When leaves are in autumn color, forestry photographs are taken with panchromatic film, the common black and white film used for everyday photography. In the summer, infrared photographs are used in Minnesota to distinguish the softwoods from the hardwoods. On either, most of the common tree species can be distinguished.

In all cases, the photographs are taken with the camera pointed straight down in such a way that each successive exposure overlaps the previous one by 60 per cent. This permits the use of the photographs in mapping triangulation and permits stereoscopic study. The three-dimensional image, obtained by examining any two adjoining photographs in the same flight strip under a small pocket stereoscope, is indispensable if tree species are to be identified, stand sizes are to be estimated, and detail on the ground is to to be discerned.

Most Tree Species Can Be Distinguished

If the aerial photographs are taken to proper forestry specifications and the leaves are out, most of the important Minnesota trees can be identified in the stereoscopic view. There are many pitfalls, however, and frequent ground-checking is necessary. In fact, the best photo-interpretation is done by a forester thoroughly acquainted with the woods, not by a specialist in aerial photographs.

Old-growth pines are readily picked out, down to a single isolated tree. It is frequently difficult to determine, however, whether a given tree is white pine or red pine. Jack pine in pure stands on sandy soils are readily identified. The stand is usually relatively homogeneous, and the tree crowns are small, rather indistinct, and lighter in tone than spruce and fir.

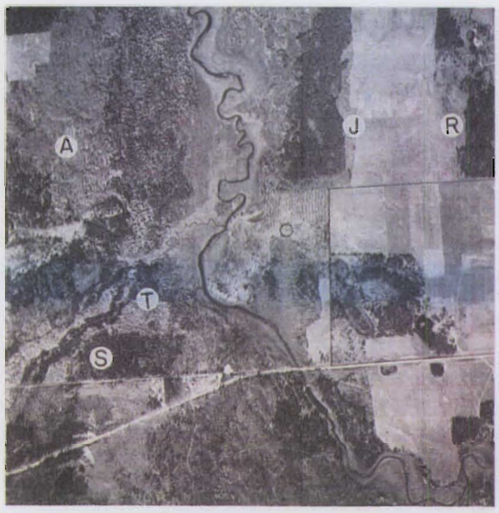
Spruce in swamps and spruce-fir mixtures on flats and low slopes are also readily separated. Mixtures of spruce-fir and jack pine, or pure stands of either type on intermediate sites give much trouble and usually should be ground-checked.

Tamarack photographs pure white on fall panchromatic photographs and stands out in sharp contrast to adjacent spruce and fir stands. It can also be identified on summer infrared with little difficulty. Cedar stands, unfortunately, cannot be easily found on airphotos.

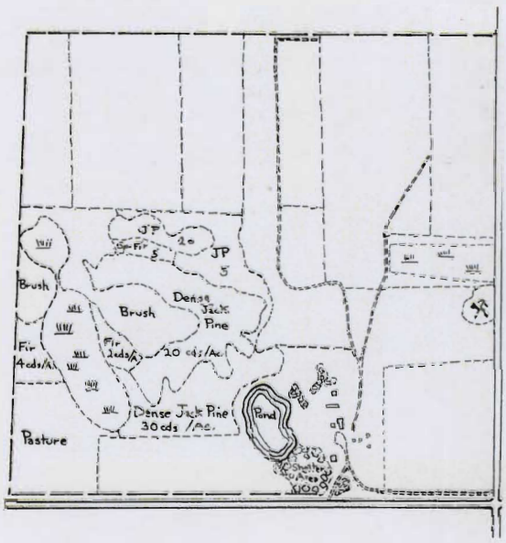
In contrast with the softwoods, all of which except tamarack photograph in dark grey tones on special forestry photographs, the hardwoods usually appear in light gray or even in white tones. Aspen and paper birch stands are light in tone and look alike in the stereoscopic picture. They are characterized by small crowns and short

(Continued on page 17)

Stephen H. Spurr was formerly associate professor of forestry, University of Minnesota; he is now professor of forestry, University of Michigan.



A portion of the aerial photograph above is used to make the timber map below, which shows a quarter section on the Mississippi River near Lake Itasca. Various timber types outside this quarter section are identified, including jack pine (J), red pine (R), black spruce (S), tamarack (T), and aspen (A).



Mapping with the multiscope. With this instrument, the three-dimensional image from the aerial photographs is projected at any desired scale on the mapping surface.

What Is the Best Ration for GROWING TURKEYS?

H. J. SLOAN, A. M. PILKEY, and G. M. BRIGGS

SHOULD GRANULATED MASH for starting pullets followed by pellets during the growing season be substituted for regular mash in feeding turkeys? That's one of the many questions our University is studying at the Northwest Agricultural Experiment Station at Crookston, where some of our turkey feeding trials are conducted.

Last year we looked into this question. We used the same formula (table 1) for the growing mash as for the granules and pellets. We divided our turkeys into four groups. Here are the four feeding plans we used:

1. Standard mash.
2. Granules for six weeks, small pellets for two weeks, and range pellets for the rest of the feeding period. These were made with the standard mash formula.
3. Standard mash fed in the form of mash except that 3 per cent dried whey product was added to replace an equal amount of corn. We used this formula because some of our laboratory experiments at University Farm suggested that a small amount of whey product in certain combinations seems to give some increase in growth weight up to four weeks of age.
4. Standard mash but the range which was used after eight weeks was kept cultivated so that there would be no pasture.

The other three lots all had millet and rape pasture mixture available although a dry July resulted in poor pasture after the first few weeks.

All birds were Broad Breasted Bronze and all lots were started about the middle of May in groups of approximately 120 turkeys per lot. While the bad weather during the last two or three weeks of the trial influenced the rate of growth somewhat, all the lots were affected about the same.

Table 2 gives the essential results of our experiments. The percentage of loss was not high in any lot and could not be related to any particular system of feeding.

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Table 1. Formula of Standard Mash (in pounds)

Ground yellow corn	440
Pulverized oats	50
Alfalfa meal	50
Meat and bone scrap	100
Fish meal	30
Soybean oil meal	300
Bone meal	10
Oyster shell	10
Salt, iodized	5
Riboflavon concentrate	5
B_{12} antibiotic supplement	½
Dry D_3 (680,000) I.C.U./lb.	½
Manganese sulfate	¼
Feeding oil 300D-2250A pints	2
Total	1,003¼

The females were ready for market at about 24 weeks and therefore sold. The males, however, were not sufficiently finished especially from the standpoint of feathering. Consequently they were sold at 28 weeks.

The differences in weight loss in dressing favored neither group. Our figures indicate, as is usually found, that females have a somewhat higher dressing loss than the males. Remember though that in this trial the males were dressed four weeks later, and therefore the results are not strictly comparable. The figures do show, however, that these birds lost somewhat less weight in dressing than is commonly found.

The feed consumed per turkey could not be divided between males and females since the sexes were grown together. But our average feed consumption of approximately 4.5 pounds per pound of gain indicates a fairly economical conversion of feed to meat. Because of bad weather, feed consumption during the last four-week period was much higher than would be expected. This increased the efficiency figure to a somewhat higher level than would probably have been obtained under more normal conditions.

Granules and Pellets

Although they had a slight advantage in obtaining greater weight, the granules and pellets produced slightly less efficient gains. With the additional cost allowed for making the granules and pellets from the mash, the feed cost per pound of gain was nearly two cents higher per pound of turkey produced to 24 weeks.

Turkey growers commonly believe that granules and pellets result in heavier consumption, which seemed to be true in our trials. But our results indicate that greater consumption and even slightly greater growth might not be the most economical production. It was also true that the pellet group ate a higher proportion of pellets and less oats than the birds on standard mash which would increase costs somewhat.

It is true, of course, that granules and pellets have other advantages, such as ease of handling and probably less wind loss. However, the amount of standard mash used in this trial does not suggest that there was much waste.

Standard Mash Plus Dried Whey Product

The addition of 3 per cent dried whey product to the starting and growing mash did not result in any increased growth in males or females. The feed consumption was slightly greater.

With a slightly greater cost resulting from the addition of whey, the feed cost of producing a pound of turkey was slightly higher than for the stand-

(Continued on next page)

Table 2. Results of Type of Ration on Growth and Returns from Growing Turkeys

	Standard mash	Granules and pellets	Standard mash + 3 per cent whey product	Standard mash + bare lot
Number of birds started	120	120	121	124
Number of birds at 24 weeks	115	108	112	109
Per cent loss from all causes	4.2	10	7.4	12.1
Average weight of females at 24 weeks, pounds	14.4	14.9	14.6	14.5
Average weight of males at 24 weeks, pounds	20.3	20.6	20.1	19.9
Per cent weight loss in dressing (ice chilled), females*	8.77	9.06	8.61	8.27
Per cent weight loss in dressing (ice chilled), males†	6.60	6.40	6.73	6.54
Feed consumed per turkey to 24 weeks,‡ pounds	75	78	78	78
Per cent mash or pellets consumed	64.5	66.3	64.0	59.5
Per cent corn consumed	21.6	20.1	21.6	24.4
Per cent oats consumed	13.8	13.7	14.3	16.1
Feed required per pound of gain to 24 weeks, pounds	4.34	4.50	4.73	4.68
Feed cost per pound turkey to 24 weeks, cents	16.0	17.8	17.8	17.5

* At 24 weeks of age.
† At 28 weeks of age.
‡ Both sexes.

Aerial Photos Used by Foresters . . .

(Continued on page 15)

heights. Paper birch has somewhat the larger crown and the lighter tone, but cannot be separated accurately except with much checking on the ground. Bottomland hardwood (ash, elm, balsam poplar), northern hardwood (maple, basswood), and oak types can generally be distinguished from one another, but the individual species cannot be recognized.

Feeding Turkeys . . .

(Continued from page 16)

ard mash and just the same as the pellet ration. The failure to show improvement under practical field conditions could possibly be explained by the fact that the materials that were supplied by the whey were present in the pasture.

Standard Mash Plus Dry Lot

The birds on bare lot did not show any great difference from the other three lots possibly because of the generally poor pasture quality. The results were about the same all the way through except that the birds ate slightly more and as a consequence the feed cost per pound of gain was somewhat higher than the standard mash.

The failure to experience high mortality in this lot could have been due to at least two things. One could be the fact that it was reasonably clean range to start with. The second could be that the lot was rather frequently cultivated to keep down all greens. This may have improved soil sanitation.

On the basis of this one year's work the use of granules and pellets for growing turkeys in addition to the feeding of whole corn and oats on range was not superior to the use of a standard mash of this same formula. The use of 3 per cent whey product did not show any advantage, and the raising of turkeys on a bare lot did not seem to have any disadvantage.

The lot fed standard mash had the most economical production from the standpoint of feed cost per pound of turkey. In none of the lots was there any noticeable superiority so far as the quality of feathering was concerned. Nor was there any important difference in the degree or quality of fleshing when the birds were dressed for market.

Photos Used to Measure Trees

Tree images in the stereoscopic view can be measured and these measurements may be used to estimate stand volume directly from the aerial photographs. The area of each forest stand can be computed quickly and accurately in a small fraction of the time that would be needed on the ground.

Actual tree-size measurements may also be made quickly, but with varying success. For example, students in the forest aerial photogrammetry class at Itasca State Park measured 17 forest stands. They used fall panchromatic photographs of the park taken at a scale of 1,000 feet per inch. Measurements of tree heights made on aerial photos were less than 5 feet lower than actual tree heights. Similar accuracy was obtained measuring crown diameters and density of stand. But the number of trees per acre was so much underestimated that the aerial estimates were of no value.

Photo-cruise tests show that the gross timber volume of a tract can usually be estimated within 15 per cent from the aerial photographs alone. Such an estimate, however, does not provide exact information on the distribution of volume by species. It gives no information on the per cent cull, the quality of the timber, and the growth rate of the forest. For these reasons, aerial photographs are generally used to determine forest areas and to plan the ground timber cruise, rather than to replace the cruise.

Checking the airphotos in the field. A pocket stereoscope is used here to check the accuracy of the mapping from aerial photographs in a 58-year-old jack pine stand.

How Foresters Use Aerial Photos

Here's how Minnesota foresters are using aerial photographs:

First, most of our new maps of forested areas are made from aerial photographs. We must have a limited amount of ground control (such as triangulation stations, railroad surveys, or highway surveys) with which to begin. By triangulation with the photographs themselves, the correct position of each photograph within the tract can be found. Then with modern transfer instruments such as the multiscope (shown at bottom of page 15), the detailed map can be compiled.

The final map showing the location of roads, streams, lakes, swamps, and timber types can be made from aerial photographs with only a minimum of ground checking for a few cents per acre. The new maps of the Chippewa and Superior National Forests are examples of this technique.

Second, the inventory of Minnesota's forest resources is primarily based on aerial photographs. The Lake States Forest Experiment Station of the U.S. Forest Service, the Iron Range Resources and Rehabilitation Commission, and other agencies interested in the location and amount of our forests, first study the aerial photographs to determine the forest acreage, and the size and location of the various timber types and forest stand classes.

The number of ground plots needed is then computed statistically. These plots are located and measured on the ground with the aid of the photographs. The forest resource of each county in the forested part of Minnesota is being accurately and economically obtained by the combined use of aerial photo-interpretation and ground cruising.

Third, the photographs are being increasingly used in actual woodland management. They have an important place in fixing cutting areas, locating logging roads, acquiring land or stumpage, assessing fire and insect damage, and maintaining forest records.

The intelligent use of good quality photographs by the forester on the ground should make him at least 25 per cent more efficient by saving unnecessary field trips, by reducing travel time, and by permitting quicker decisions based on more accurate information. The use of aerial photographs should go far toward introducing sound forest management on the ground in Minnesota's forests.

Thirty Years of *Windbreak Studies*

Early Interest in Tree Planting

Interest in tree planting developed early in Minnesota. Minnesota State Horticultural Society records in 1866 mention this interest and make recommendations on species and planting methods. As early as 1870, Colonel John Stevens emphasized the need for learning more about how to conduct tree planting saying, "We have no precedents to follow. That which is balm in New England is a poison here."

In 1882 in a paper "Evergreens for the Prairie," W. D. Fuller discussed the question of whether evergreens could be successfully grown on the prairie.

The idea of a shelterbelt on a grand scale, actually tried by the Federal Government in the 1930's, may have been first expressed by Clarence Wedge of Albert Lea who in 1888 contended that "Protecting, extending, and systematizing our forest is one of the police duties the state owes its people. We need protection from blizzards almost as much as we do from burglars. Great belts should be planted on the prairie districts . . . forming a network of barriers to our storms."

H. L. HANSEN and D. P. DUNCAN

MINNESOTA'S EARLY interest in tree planting led in 1919 to a large scale project designed to demonstrate desirable windbreak design and planting methods. Between 1919 and 1927, 300 windbreaks, concentrated largely in western and central Minnesota, were planted as a result of this project.

The University Division of Forestry and Agricultural Extension and the Minnesota Forest Service worked together on the program. Trees were grown at the University's Cloquet Experimental Forest. Cooperating farmers did their own planting following instructions and a planting design prepared by the Division of Forestry.

Although the original purpose of this project was to provide field demonstrations over the prairie counties, these windbreaks have also served as an excellent source of research information. The University has made three systematic examinations of the windbreaks to check the relative hardiness of the species tried, their growth rate, freedom from serious disease and insect enemies, and factors influencing the success or failure of such plantings.

The first study, in 1926, showed poor cultivation slowed the growth of young windbreak trees. The effects of mulching as a substitute for cultivation were examined, and each of the 19 tree species under test were compared.

In 1936, a second survey was made. The trees then averaged about 14 years of age. It was found that most broad-leaved trees survived better on fine-textured than on sandy soils. The survival of the evergreens was distinctly better on sandy soils. Other data showed that thinning was becoming necessary on some belts and that some species such as Scotch pine, Siberian elm, and white pine are very susceptible to damage by rabbits.

In 1948, a third survey was made. Because the original detailed planting records and the record of re-examinations over a 25-year period were available, the project had become one of the most significant sources of windbreak planting information in this region. Comparative survival and growth data for 19 different species distributed over several hundred Minnesota prairie farms are now available (see table). In addition, the latest study of the windbreaks placed special emphasis on the interrelations of spacing, the need for thinnings, and the productivity of these windbreaks in terms of fence posts.

Other Windbreak Investigations

Although the demonstration windbreaks have provided the major source of information, other plantings have been studied over the past 30 years. In 1926 the University examined some of the older plantings in western Minnesota dating back to the "timber claim" days when farmers could acquire land from the public domain by meeting certain tree planting requirements. This investigation gave data on the influence of windbreaks on soil moisture, soil temperature, relative humidity of the air, and wind velocity.

In 1934 a general survey was made of old prairie plantings in Minnesota to discover the effects of the drouth years on tree survival. It was clear then that many were dying and that the rate of tree planting had to be stepped-up to replace existing windbreaks.

Present Investigation

Today studies are being made of specialized problems in establishing and maintaining windbreak and shelterbelt plantings. At the Agricultural Experiment Station, Rosemount, experimental windbreaks of several designs have been planted during the last five years to find the answers to such controversial questions as:

1. Is it necessary to separate the shrub row from the major windbreak by 40 to 60 feet in order to provide a snow trap, or can the shrub be placed within 12 to 15 feet of the adjacent row?

2. Should the major part of the windbreak be made up of fast-growing broad-leaved trees or should such species constitute only about one-fourth of the windbreak, the major part being composed of slower-growing but longer-lived broad-leaves and evergreens?

3. Can weeds be satisfactorily controlled in tree plantings by application of a mulch such as sawdust or wood chips or by treatment with chemicals?

On lands belonging to the Mayo Institute of Experimental Medicine, a large selection of poplars has been planted in an attempt to find hybrids or selections which reproduce well

A well-protected farmstead in Murray County.

H. L. Hansen is associate professor of forestry and D. P. Duncan is assistant professor of forestry.

This tree-planting machine can plant an 800-foot, seven-row farmstead windbreak in two or three hours.

from cuttings, grow rapidly, and are free of disease. To date, six or seven appear to be particularly promising for windbreak use. Similar work is underway there with elms.

Seed source studies also have a direct bearing upon the success of windbreak plantings. For instance, Colorado blue spruce is affected by *Cytospora* canker in Minnesota. To obtain canker-free trees, blue spruce of eight different origins from Colorado, Utah, and Wyoming were recently planted. Seed source studies are also being conducted with jack pine and green ash and are planned for ponderosa pine.

Development of tree planting machines during the past 12 years has greatly encouraged windbreak and shelterbelt planting. These machines can plant an 800-foot, seven-row farmstead windbreak in two or three hours without the physical labor of hand planting. About 40 machines are presently available in the state and more appear each year.

Field shelterbelt design is being investigated now. The objectives in these experimental plantings are twofold: (1) to learn which combination of species in two or three rows will most effectively protect soil from wind erosion, and (2) to determine the possible effect upon crop yields.

More Research Needed

Additional research is needed, especially along the following lines:

1. Testing of new species, varieties, strains, and seed sources.

Growth Rate and Survival of the Species Most Commonly Planted in the Demonstration Windbreaks

Species	Average survival during post-establishment period (1936-1948)	Average survival after 25 years	Average height after 25 years
	per cent	per cent	feet
Green ash	90	80	30
Boxelder	72	70	27
Caragana	70	69	10
American elm	69	68	30
Silver maple	75	53	30
Black Hills spruce	....	46	16
Russian olive	64	40	19
Jack pine	82	37	25
Scotch pine	84	36	28
Northwest poplar	61	36	39
Colorado blue spruce	68	31	20
White willow	60	30	27
Northern white-cedar	96	24	12
White spruce	74	23	19
Laurel-leaved willow	61	20	22
Red pine	80	14	24
Norway spruce	....	10	....
Northern white pine	63	8	23
Russian poplar	62	2	....

Sick Wheat . . .

(Continued from page 3)

siderable portion of the bulk, for any considerable length of time, permits molds to grow in the seed. Long before these molds have become visible to the naked eye they will have injured or killed the seed and will have reduced its quality for milling and baking.

At present we can see no single cure or control, nor can we hope for research to produce a miracle answer. The practical solution at present appears to be the common sense one of a more careful check than has been made in the past on moisture content all along the line—from the time the grain comes from the farmer's truck to the time it is milled.

And so far as we know now, the only ways of converting moist grain of poor storage risk into grain dry enough to be a good storage risk are to blend or mix it with dry grain, or to dry it artificially. Judging from recent tests, blending may occasionally involve some risk, because molds may grow on the moister portions of the grain before the moisture content can become equalized.

Once the grain is in the bin, the moisture content of different portions of the bulk should be determined at intervals. If there is an increase above 14.5 per cent anywhere in the bulk, the grain should be remixed or dried to achieve a uniform moisture content below 14 per cent, or preferably below 13.5 per cent, to give a margin of safety.

If moist harvest seasons continue in the wheat belt, we may need equipment and "know how" for accurate moisture determinations and for artificial drying if we are to harvest, sell, store, and process really choice grain consistently.

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2. Further emphasis on field shelterbelt studies. No work indicating the effects of shelterbelts on soil erosion and crop yield has been carried on in Minnesota, and the limited studies in the Great Plains may not be applicable here.

3. Expansion of the tests of chemicals and mulches for controlling weeds in the tree rows, particularly since weed control is the major factor affecting survival and growth of newly planted windbreaks and shelterbelts.

4. Testing of new repellents and other control measures to prevent rodent injury.

5. Testing to determine what species are best adapted to the "high lime" soils characteristic of sections of western Minnesota.

Mistletoes Don't All Mean Romance; Some Cause Witches Broom

RALPH L. ANDERSON

MISTLETOES aren't all romance. In fact, foresters and plant pathologists consider the mistletoes serious pests. They are parasitic seed plants that grow on trees, and some species cause serious damage.

The true mistletoes are leafy plants, which grow on broad-leaved trees in the southern states and are used as a Christmas decoration. The dwarf mistletoes are small, leafless plants, which grow on coniferous trees and cause serious damage. The only species found in Minnesota is a dwarf mistletoe that grows on black spruce in our swamps.

The black spruce, dwarf mistletoe is the smallest of the mistletoes. The flowers and berries are borne on shoots about half an inch long. They grow out through the bark of the twigs on infected parts of a tree. Each berry contains a sticky seed, which is shot out with considerable force. If a seed lands on a spruce twig, it germinates and produces a rootlike system in the bark and wood of the tree. The shoots develop from the "root" system.

Mistletoe Causes Witches Broom

Mistletoe is the cause of the most serious disease problem of black spruce. Growth of infected branches is abnormal, and dense, shrublike masses of distorted branches are formed. These are called witches brooms. The growth energies of the tree seem to be diverted into the infected parts, and the remainder of the tree declines in vigor and growth. Severe infection causes death of the tree.

When mistletoe invades a swamp, practically all of the spruce trees are eventually killed and replaced by younger trees. These in turn are deformed and killed. As a result, in an area heavily infected with mistletoe, very few trees grow large enough or free enough of deformation to produce good pulp wood.

Mistletoe is limited to specific areas in which most of the trees are infected, whereas the remainder of the swamps are free of infection. It is spread locally, from tree to tree, by the shooting of the seeds from the berries. New infection areas occasionally arise at considerable distance from old infections.

Ralph L. Anderson is research assistant in plant pathology.

Witches-brooms on black spruce.

We don't know how the mistletoe seeds are carried for long distances, but we suspect they are carried by birds or animals.

Infected areas frequently occur as patches or spots in otherwise healthy stands. We have found that these infected areas spread slowly outwards into the surrounding stand, killing most of the trees in the process.

Mistletoe could be wiped out from a spruce stand by cutting all of the infected trees. Usually this does not pay because many seedlings and small trees with no value would have to be cut, and an area would have to be reworked a few times to assure the removal of all infection.

Here's How to Reduce Damage

However, damage could be reduced markedly by practices which should be economically feasible. When infected areas are logged they should be clear cut of all spruce trees larger than saplings. This would eliminate all infections that are a considerable distance above the ground, where the seeds could be shot out over a wide area. When otherwise healthy stands contain patches of infection, the spread of the disease should be delayed appreciably if a strip of healthy spruce 60 to 100 feet wide is cut to create a break between the infected and healthy areas.

In This Issue