MINNESOTA FARM AND HOME Science

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In This Issue . . .

ON THE COVER—

The drier section in new Dairy Industries Building. See the article on page 7.

MINNESOTA FARM AND HOME Science

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Minnesota's Men of Science

Editor's Note—This is the thirty-second in a series of articles introducing scientists of the University of Minnesota Institute of Agriculture.

S. T. "Sam" Coulter, the newest department head on the St. Paul Campus, is no stranger to Minnesota dairymen. In fact, his work has helped the dairymen of the state find new markets to improve old markets for many years.

Coulter has headed the Department of Dairy Industries, the newest unit on Campus, since it was established July 1, 1959. The department is responsible for the teaching, research, and public service in dairy manufacturing and dairy bacteriology. Previously this work had been done by the dairy husbandry department which was divided into the two separate units—dairy husbandry and dairy industries.

The new department Coulter heads is housed in the Campus' newest building. Our cover on Minnesota Farm and Home Science features one area of this modern research and teaching plant, the drier section.

Coulter, though, is a veteran. He has been on the University staff since 1925. A native of Weiser, Idaho, he received his undergraduate training at Oregon State College. He came to the University of Minnesota as a half-time assistant graduate student in 1925. He received his M.S. degree from the University in 1930 and his Ph.D. in 1933.

He became manager of the University's experimental creamery at Albert Lea in 1928. Two years later he returned to the St. Paul Campus as an instructor. Later he was promoted to assistant professor, associate professor, and finally professor in 1945.

Coulter is nationally known for research in dairy products, especially with processing butter and cheese, the development and production of dried milk.

In 1951 he received the Borden Gold Medal award, one of the highest honors that can come to an American scientist. He was honored for his "outstanding contributions to the fundamental knowledge of dairy products and the application of this knowledge to manufacturing dairy products." He had been previously honored for his work as coordinator of dairy production research by the Quartermaster's Department of the Armed Forces during World War II.

Coulter has served on many committees of scientific and professional organizations including the National Academy of Sciences, National Research Advisory Board, and the American Dry Milk Institute. He also served as consultant to national and United Nation's organizations.

Coulter belongs to Sigma Xi, Alpha Zeta, Gamma Sigma Delta, the American Dairy Science Association, and is a fellow of the American Association for the Advancement of Science.

Canoe Country Camping -- Who? Where? Why?

MARVIN TAVES and JAMES MORGAN

AMERICANS ARE "TAKING TO THE WOODS" in ever-increasing numbers. Last year visits to the national forests increased 19 percent. The number has risen steadily since 1945 with no evidence of slacking off.

A large part of the recent increase in forest recreation has been in undeveloped areas. Some of this is due to preference for wilderness experiences and getting off the beaten path. Some is caused by people seeking new areas because of lack of space at developed campsites. But unrestricted use damages and even destroys the forest environment these people are seeking.

Public lands in Minnesota and the other Lake States, for the most part, were not acquired for recreation areas and have not been managed for heavy public use. Managers of public land need to know more about their customers for forest recreation and what they want. Vacationers' wants alone should not determine the use of the land, but surely they must be considered. Land managers need to learn more about future recreation demands so they can estimate future needs and plan accordingly.

In 1958, a study was made on the Superior National Forest to contact those who travel by canoe and those who camp in established campgrounds. Of the 383 vacationers questioned, 263 were canoeists and 120 were campground campers.

Who Camps and Who Canoes?

Although there were more men, 40 percent of the campers and 20 percent of the canoeists were women.

Both camping and canoeing appeal to all but the oldest. Over a third of the campers and a fourth of the canoeists were at least 45 years of age; half were between 25 and 44 years old.

The majority of the vacationers was married. However, among the men, 25 percent of the campers and 42 percent of the canoeists were single; while among the women only 14 percent of each group was single.

As is true for vacationers in general, these vacationers included a somewhat larger proportion of higher socio-economic status groups than their number in the general population. Nevertheless, about 50 percent of the campers and 35 percent of the canoeists reported having had no more than a high school education. On the other hand, 19 percent of the campers and 22 percent of the canoeists had had more than 4 years of college.

Although canoeing and particularly camping are considered relatively inexpensive types of vacations, the reported median family income of respondents was approximately $7,500 per year or somewhat above the national median. While clerical, skilled, and semi-skilled workers predominated, professional, proprietorial, and managerial persons accounted for 38 percent of the campers and 50 percent of the canoeists.

Camping is a group-type vacation. About 10 percent of the groups in this study consisted of father-son combinations, while 1 in 6 consisted of parents with one or more children, and another 1 in 6 of husband and wife only. Other combinations of families and friends accounted for 18 percent so that a total of some 60 percent of all parties was some type of family group. The vacationing party most often included both men and women though about a third consisted of men only, while an occasional party was composed entirely of women.

When Do People Camp and Canoe?

Practically all of the camping and canoeing was done between May and September. Nevertheless, planning and preparation tends to continue throughout the year. The majority of those interviewed started planning their trip at least 2 months beforehand and continued to think and talk about it for months after returning home. About half of the interviewees had vacationed there at least once before.

Why Do They Vacation in Canoe Country?

When asked to indicate the relative importance of different advantages of a canoe country vacation, the responses most often given were, "it provides an opportunity to leave all of the cares of the work-a-day world behind" (48 percent); "helps one to gain experience in doing things by one's self" (32 percent); "helps develop foresight and ability to plan" (30 percent); "helps one to get close to the Creator" (29 percent); "it is something new and different" (25 percent); "it provides physical 'reconditioning' " (24 percent).

When asked some time after completing the trip, "Just what has this vacation done for you physically, mentally, and spiritually?" answers such as the following were received: "Felt better in every way. Better able to come back to the daily grind. Was pleased that we were able to take everything as well as we did. Brought our family closer together again. Had time to think out several problems. Came to a better spiritual understanding."

Although relatively few vacationers complained, those who did blamed insects (mainly mosquitoes and deer flies), inclement weather, and littered, dirty, or poorly maintained campsites. About 1 in 20 made reference to disappointment in fishing or to apprehension about bears.

The most common regret (expressed by 25 percent) was that they had not

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Marvin J. Taves is associate professor of sociology and supervisor of rural sociology. James Morgan is chief of forest economics research at the Lake States Forest Experiment Station. The study was cooperatively supported by Lake States Station, the Quetico-Superior Research Center, and the Agricultural Experiment Station.

A New Hybrid F_1 Tomato

T. M. CURRENCE

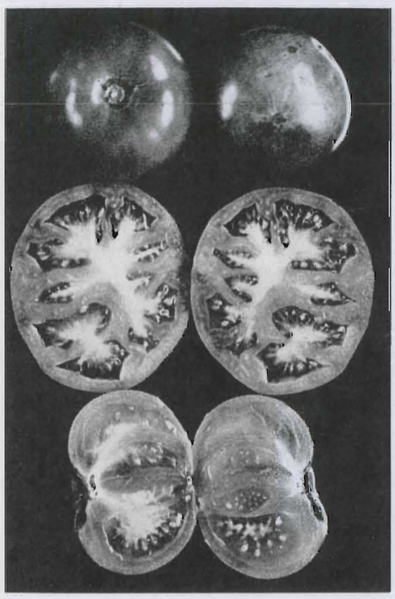
A PROMISING NEW HYBRID F_1 TOMATO, developed by the University, is on the market. It is a cross between the well-known varieties Bounty and Earliana. One commercial name is Hybrid EE but there may be others.

This is another example of using hybrid vigor to improve a food crop. Adapting hybrid vigor to tomatoes differs from corn in one important way. Tomato flowers are self-pollinated, whereas corn is cross-pollinated. This means that corn has to be artificially self-pollinated to develop the inbred lines that are the parents of commercial hybrids. With nature doing the selfing of tomato flowers, the common varieties are genetically inbred and comparable to corn inbred parental lines.

We're not implying that tomato improvement requires only crossing between existing varieties — inbred lines. Obviously superior hybrids or crosses can result only from crosses of superior parents. Breeding tomatoes for improved varieties, therefore, is equivalent to improving inbred lines of corn.

Another basic difference between the two crops is also apparent. Tomato inbreds are usually suitable for growing as field or garden varieties, but corn inbreds are too weak and unproductive to have direct use as varieties. This new introduction, therefore, is a cross between two well-recognized varieties that have been in the trade for many years.

The Minnesota Agricultural Experiment Station has experimented with hybrid tomatoes for several years. As crosses and varieties of definite promise appear, they are included in cooperative tests in four parts of the state. Our new hybrid has consistently made a good showing in this cooperative test. It produces uniform plants. The growth is not as sparse and open as Earliana, but it is not as compact and determinate as Bounty. For those who wish close spacing for maximum production, the plants probably will do well when unstaked and grown as close as 2 × 2 feet.



Different views showing fruit characteristics of Bounty by Earliana.

The outstanding characteristic of the hybrid is heavy production early in the season. The fruit begins to ripen as early as Earliana, but the vigor is much greater. Thus, in quantity of early crop, the hybrid is superior to its earlier parent. The fruit type is considerably more desirable than that of the Earliana type. Fruit of the Bounty parent is large and smooth and, to a lesser extent, these characteristics appear in the cross. Individual fruits are not as large as Bounty but they are essentially as smooth and attractive. The fruit may equal the better varieties in table quality, color, and general desirability.

In total production for the season you will find the hybrid superior to any inbred variety that is comparable in earliness (table). Here the Bounty × Earliana yield and fruit size are compared to the popular standard variety, Firesteel. Firesteel averages high in size of fruit and exceeded the cross in this characteristic at all locations. If the results were given in comparative weights, Firesteel would average about 5½ ounces per tomato or 3 per pound and the cross approximately 4½ ounces or about 4 per pound. Most gardeners consider an average of 4 ounces per fruit satisfactory for home or market use.

In earliness, total yield, and yield of superior quality fruits the hybrid was definitely better than Firesteel in all instances. The hybrid EE, over the 5-year period, averaged 3 times the early yield of Firesteel at Crookston and almost 4 times that at St. Paul. The minimum increase was at Grand Rapids where it was just slightly less than twice the early yield. The average at all locations was 270 percent and suggests a definite advantage in earliness. In total yield and yield of first-grade fruits, the superiority of the cross was very consistent but was not as great as it was for early yield.

Performance of Bounty × Earliana tomato hybrid as percentage of Firesteel variety*

Location	Early yield	Total yield	Grade 1 yield	Fruit size
St. Paul	387	117	141	63
Morris	200	145	208	88
Crookston	300	167	253	91
Grand Rapids	192	138	277	84
Average	270	142	220	81

* In this comparison, Firesteel rates as 100. The data exceeding 100 show superiority to Firesteel while those data below 100 show inferiority to Firesteel.

T. M. Currence is a professor in the Department of Horticulture.

CEREAL VIRUSES COMMON IN MINNESOTA

ERNEST E. BANTTARI

VIRUS DISEASES WERE DESTRUCTIVE to cereals in Minnesota in 1959. There are many viruses that attack cereals and four of these are common in Minnesota: barley yellow dwarf, oat blue dwarf, aster yellows, and barley stripe mosaic. Of these, the barley yellow dwarf virus —the cause of red leaf or yellow dwarf on oats, barley, and wheat— has been the most devastating and widespread. This disease is prevalent throughout the cereal-growing areas of the United States and has caused losses amounting to millions of dollars. Many fields in southern Minnesota were plowed down as the result of damage by this virus in 1949, 1953, and again in 1959.

Red Leaf or Yellow Dwarf

The red leaf or barley yellow dwarf virus stunts growth severely and causes blotching of leaves. The blotches combine to form general reddening or yellowing in oats or a bright yellowing in barley and wheat. These symptoms are very distinctive (figure 1). Infected plants frequently die without heading, or, if they head, the heads are severely blasted and seed production is reduced substantially.

Ernest E. Banttari is a research fellow in the Department of Plant Pathology and Botany.

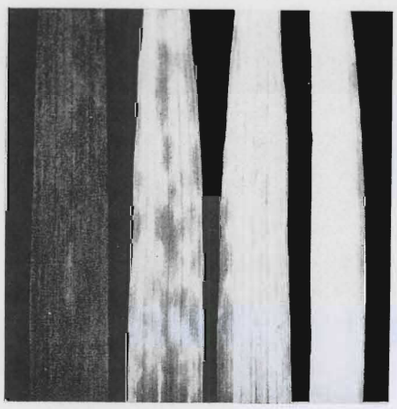


Fig. 1. Red leaf in oats showing the increasing development of mottling in the leaves.

This virus is transmitted by several species of aphids common in Minnesota. The severe and extensive epidemics in Minnesota have been associated with the heavy migration of one particular kind, the greenbug. These aphids acquire the virus by feeding on the sap of infected plants. Then they can spread the virus to large numbers of grain seedlings when they move about in feeding.

In April 1959, there was a marked "explosion" of the greenbug population in winter-sown grain in Oklahoma, Texas, Kansas, and several other south-central states. Moderate to strong winds from the south carried large numbers of these insects and distributed them northward. The first reports of greenbugs in Minnesota came about the first week of May. The damage from feeding by the heavy aphid population also caused extensive damage to grain. Two to three weeks following the first appearance of the greenbug, the damaging effects of the virus were evident in fields which survived the greenbug feeding injury. Losses from red leaf were accentuated by drought conditions which followed.

Insufficient evidence is available to recommend spraying the aphids over large acreages to control red leaf. Ordinarily, by the time greenbugs or other aphids are present in sufficient numbers to warrant spraying, they usually have had ample opportunity to infect a high proportion of the plants with virus.

The principal approach to control of red leaf has been the search for resistant varieties. Research at Minnesota and other agricultural experiment stations has shown that there are varietal differences in resistance to red leaf. Although all varieties of oats, barley, and wheat commonly grown in Minnesota become infected, some withstand the attack better than others. Of the recommended oat varieties for Minnesota, Andrew and Minton are moderately resistant, Ajax and Minhafer are moderately susceptible, Rodney and Garry are susceptible, and Burnett is very susceptible.

Fig. 2. Blue dwarf infected Sauk oats, 2 months old. Healthy, left; infected, right.

Blue Dwarf

Blue dwarf in oats and barley was first observed in oats fields in Minnesota in 1951. However, only recently research disclosed the cause to be a virus, and that another insect, the six-spotted leafhopper, was responsible for its spread. Up to 5 percent of infection of oats has been observed in fields in Minnesota. The extent of damage to barley has not been determined.

The name blue dwarf is descriptive of the symptoms in oats (figure 2), since affected plants are stunted, have a uniform blue-green color, and have an abnormally erect, sturdy appearance which makes them conspicuous among normal plants in the field. Yield from infected plants is low. The symptoms of this disease in barley are much like those in oats except that the plants do not have the striking blue color.

Because blue dwarf is spread by leafhoppers, the control is difficult.

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MINNESOTA AGRIBUSINESS

D. C. DAHL and D. F. FIENUP

MANY FARMERS HAVE QUIT farming because some **jobs** have left the farm. The jobs that have left farming have been the basis for the development of businesses related to agriculture. Farming itself plus businesses that supply farmers with the inputs they need in production and the firms that process and distribute farm products make up a part of our economy called "agribusiness."

Interestingly enough, the term "agribusiness" today corresponds to what agriculture meant 150 years ago. Early American farmers grew their own feed and seed, made much of their own farm machinery, and provided their own power and transportation with horses and oxen. They even hauled their extra products to town, where they sold them themselves. Most of these jobs are not a part of what we call agriculture today.

Over the past 150 years, the farmer has given up these tasks to specialize in the narrower, but all important, process of producing food and fiber. Such specialization has been made possible by continued technological advance.

As a result of specialization and these technological changes, output per worker in farming has risen greatly. In 1820, 1 farm worker provided enough food and fiber for 4 people including himself. By 1940 the same worker produced enough for 11, and today, only 20 years later, the production of 1 farm worker provides for 25 people.[1]

Because of this change in productivity, and the resulting shift of jobs away from the farm, fewer farmers are needed to provide the necessary farm output. In turn, a large number of farmers have left farming for industry.

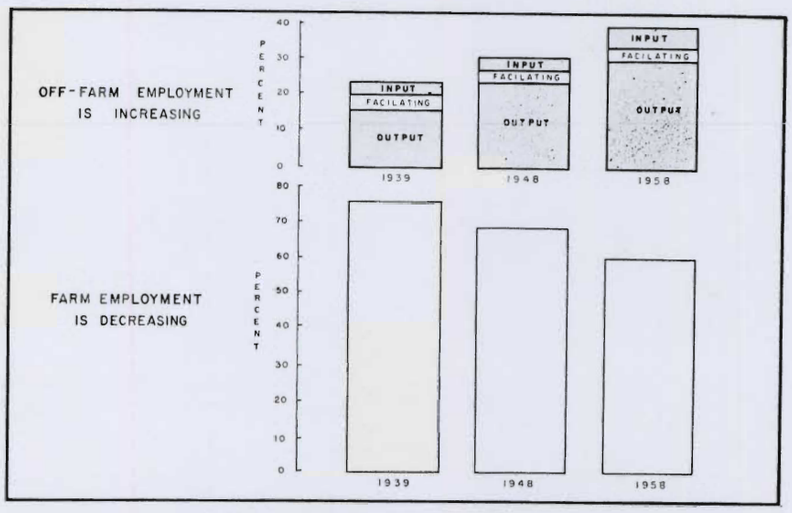


Fig. 1. New employment opportunities—agribusiness employment trends (expressed as a percent of total agribusiness employment).

But what has happened to the employment in businesses doing the jobs that farmers once did? Obviously it has increased, but how much? Is the increase enough to compensate for the decline in farm employment? Just how big is this agribusiness complex and what do changes in its size and composition mean?

Agribusiness Is Important

Agribusiness makes up a large segment of our national economy. About 40 percent of all consumer expenditures in 1954 were made for products originating in agriculture. Employment in agribusiness constituted 37 percent of the total labor force in the United States that year.[2] In 1954, nearly 40 percent of Minnesota's labor force was employed in some phase of agribusiness.

Over the past 20 years total agribusiness employment in Minnesota first increased and then declined. From 1939-1948, employment declines in farming were more than offset by increases in employment in the off-farm parts of Minnesota agribusiness. But from 1948 to 1958, the increases in employment in the businesses serving farmers and handling farm products were not large enough to compensate for the declines in farm laborers (both family and hired). This means that much of the labor leaving Minnesota farms today must find jobs outside agribusiness in this state.

The off-farm parts of agribusiness fall into three groups. One, the "input" group, includes those businesses that supply farmers with items they use in production, such as feed, seed, fertilizer, and farm machinery. The businesses that process and distribute farm products form the "output" group. A third group, called the "facilitating" group, includes such businesses as rail and truck transportation and government workers serving agriculture.

Employment in these three groups has increased in Minnesota over the past 20 years, but at varying rates. The most notable differences are in the input as opposed to the output group. Employment in the input

(Continued on page 21)

[1] "Change in Farm Production and Efficiency," USDA, Statistical Bul. No. 233, Sept., 1959, p. 27. 1960 figure estimated.

D. C. Dahl is a research assistant and D. F. Fienup is an assistant professor in the Department of Agricultural Economics.

[2] Davis and Goldburg, *A Concept of Agribusiness*, Alpine Press, Boston, 1957. p. 11.

Utilization Research in Dry Milk Products

S. T. COULTER and C. H. PYNE

Utilization research is an important phase of the work of the University of Minnesota's Agricultural Experiment Station. Here we tell about the efforts of researchers in 1 of the nearly 40 utilization-related studies. Here we deal with improving the market and finding new uses for dairy products through dry milk.

MINNESOTA has about 2 percent of the nation's population, but produces nearly 10 percent of its milk. Therefore, about 80 percent of the milk produced by Minnesota cows is shipped from the state in one form or another. Dry milk is the most economical way of shipping milk to distant markets.

Nonfat dry milk has been well received by housewives and is used by many to supplement locally produced fluid milk. No doubt, one of the reasons for the acceptance of nonfat dry milk is its availability in an easily reconstitutable form. Despite much research, an equally easily reconstitutable dry whole milk has not been produced.

A fundamental study has been made of the factors involved in the reconstitution characteristics of dry milk products. Production of "instant" nonfat dry milk was based upon the manufacture of products consisting of large individual particles. One method used is to process the powder so as to agglomerate several of the smaller particles into a large clump. Other methods also are used to secure large particles. The large pores or openings among the easily wettable nonfat dry milk particles readily permit the entrance of water into the powder mass.

Theoretical considerations and results of numerous trials suggest that an instant dry whole milk will not be produced in this manner. Dry whole milk contains fat which makes the particles nonwettable by cold water. Thus, even though the openings into the mass are large enough to admit water readily, flow is blocked by the nonwettability of the particles. We've come to the conclusion that a desirable structure would be one which has the greatest amount of surface in relation to its mass. Such a structure might be a hollow sphere like a ping pong ball.

The Eastern Utilization Research and Development Division, USDA, Philadelphia, Pennsylvania, has produced a "puff" dried whole milk powder. This is dried as a sponge. The sponge-like structure is crushed, yielding a powder with an extensive surface in comparison to its mass.

We have experimented with a product resembling the ping pong ball structure. This is made by spray drying a foamed or whipped condensed milk. Both products are much more readily dispersible than conventional products. Neither, in present form, appears to be completely satisfactory. Progress, however, is being made. There is sufficient research interest to bring hope for the solution of a difficult problem.

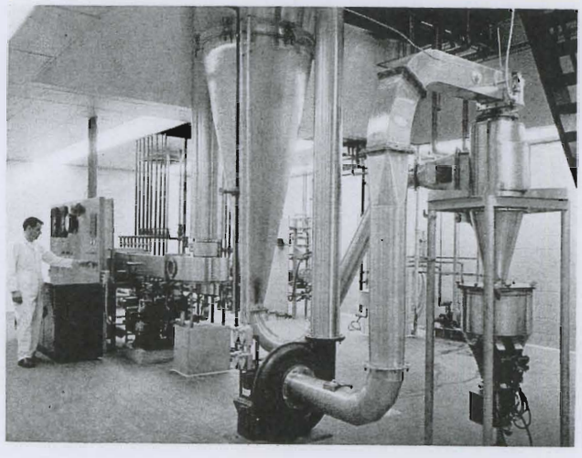
The flavor characteristics of nonfat dry milk are quite good. Properly made products, on reconstitution, can scarcely be distinguished from normal fluid skim milk. Nonfat dry milk is very stable in storage and requires only a vapor-proof package.

The flavor of dry whole milk, on the other hand, is a serious bar to its ready acceptance as a replacement for fluid milk. Even dry whole milk, fresh from the dryer, has a characteristic flavor and deteriorates rather rapidly during storage unless gas-packed to almost complete exclusion of oxygen. Obviously, the fat is the key to this problem.

We have in progress a long-range study of the method of fat oxidation in dry whole milk. Oxidation must be understood and controlled in the manufacture and storage of dry whole milk if the product is to attain extensive household use in this country.

Another commercial use for nonfat dry milk is developing. Such fluid dairy products as skim milk, buttermilk, and chocolate drink are commercially fortified by the addition of 1 to 2 percent of milk solids-not-fat. The consumer acceptance is increased by this addition.

Research at the University of Minnesota and at the University of Arizona has shown that most consumers prefer fluid milk containing 9.5 to 10 percent milk solids-not-fat. This is higher than the solids-not-fat content of most milks. Whipping cream, coffee cream, and half-and-half likewise are improved. There is much interest in this by the industry and, if certain legal obstacles can be overcome, this may provide an outlet for a large amount of Grade A nonfat dry milk.



Control and product collection centers, experimental spray drier.

S. T. Coulter is professor and head, and C. H. Pyne is a research fellow, Department of Dairy Industries.

Small Cubic Bales for Hay

John Strait, K. J. Albrecht, and A. M. Flikke

A GOOD HAY HARVESTING SYSTEM should allow the farm operator to put up high-quality hay with reasonable labor and equipment costs.

Mechanization has helped reduce the labor requirements in haying, with reasonable equipment costs. Little progress has been made, however, in quality control.

Research work was carried on during the past haying season at the Agricultural Experiment Station, Rosemount, on small, cubic-shaped bales. The bales are 12 inches wide, 12 inches thick, and approximately 12 inches long.

When dry, a 12-inch cubic bale of alfalfa weighs 10 to 12 pounds and is a "meal size" bale for the dairy cow. A 10-inch cube was also considered but discarded temporarily because of possible baling problems and higher twine costs.

To produce the cubes, engineers modified a baler originally designed to make a bale 18 inches wide and 14 inches thick. Experiments show that the maximum possible bale weight would be about 16 pounds with alfalfa, with the machine as presently constructed. The 10- to 12-pound bale would be better than a heavier bale for artificial drying.

John Strait is associate professor, K. J. Albrecht is a graduate student, and A. M. Flikke is associate professor, Department of Agricultural Engineering.

Hay Harvesting System with Cubic Bales

The 12-inch cubic bale is the basis for a harvesting system designed to produce high-quality hay and permit mechanical handling during the entire operation.

Steps in the haying system using the small cubic bale would be:

- Cut at the proper stage of maturity.
- Mechanically treat the freshly cut hay with a crusher or crimper.
- Rake at about 50-percent moisture content.
- Bale when the moisture content is 30 to 35 percent.
- Artificially dry the bales to a moisture content safe for bulk storage.

Hay Quality

Producing high-quality legume hay largely depends on cutting early, protecting the cut hay from weather, saving the leaves, and providing proper storage conditions.

Cutting at the proper stage of maturity is a management factor which can usually be controlled by the farm operator.

Weather in Minnesota and surrounding areas makes production of high-quality, field-dried hay rather difficult and uncertain. It takes a relatively long field drying time to dry the hay sufficiently for safe storage. During field drying, bad weather can reduce hay quality and even cause a total loss. Apparently the most practical way to protect the hay from weather damage is to reduce the time between cutting and storage. Both the hay conditioner and artificial drying can be used for this purpose.

Research at the University of Minnesota's Agricultural Experiment Station at Rosemount has shown the value of the hay conditioner in speeding up the field-drying rate of alfalfa cut for hay. With reasonably favor-

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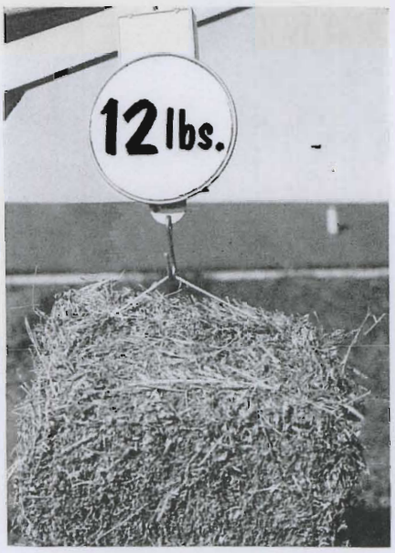

The 12-inch cubic bale of alfalfa weighs about 12 pounds.

Strait compares a small hay cube with a regular size bale.

Small bales are easy to unload mechanically and elevate into a drying structure.

Energy Needs of Young Adult Women

JANE M. LEICHSENRING and TORA HOVDE OTERHOLT

JUST HOW MUCH ENERGY—how many calories—does the average person need to maintain normal weight, carry on normal activities?

This seemingly simple question concerns many people who find increasing weight a problem. A clear-cut answer is not simple, however. Although there has been much research on the requirements for specific nutrients, such as vitamins and minerals, studies on energy needs have not been too numerous.

Recommended standards for caloric intake now are based to a considerable extent on broad dietary surveys rather than on detailed studies of the actual weights of foods which people eat. Furthermore, changes in the mode of living of the American people necessitate a re-evaluation of recommended energy intakes for maintaining body weight.

The School of Home Economics of the University of Minnesota has gathered information on the nutrient needs of college-age women during the past few years. During this research on various aspects of vitamin, mineral, and protein metabolism in women of this age group, detailed records were kept of the weights of foods eaten and of body weights. These records offer an excellent basis for calculating energy requirements.

Forty-three young women, between 18 and 22, took part in five studies between 1954 and 1958. These studies lasted 30 to 45 days—making a total of 201 days of observation. All of the girls were healthy and carried a normal program of classes and campus social activities.

During the experimental periods, the girls ate weighed amounts of food in carefully controlled diets which met the standards of nutritional adequacy set by the Food and Nutrition Board of the National Research Council. In addition to the basic diet, they were allowed certain specified foods in whatever amounts they desired to satisfy their energy needs. Accurate records were kept of the amounts of these supplementary foods consumed by each girl.

The caloric value of all the food eaten by each of the young women was calculated, using standard tables of food values. A record of their activities during the previous 24 hours also was kept each day, to get some assessment of the degree of activity of the girls.

The girls ranged in height from 57 inches to 68 inches, the average was 63 inches. Initial body weights ranged from 92 pounds to 166 pounds, with an average of 130 pounds. The average energy intake of all the girls in these studies was 2,210 calories, with a range from 2,085 to 2,400 calories.

In one of the five studies the girls were weighed each day and an immediate adjustment of the caloric intake was made in order to keep their weight constant. In the other four studies the girls were weighed at 5-day intervals. During these latter studies some of the girls gained weight, others lost. The overall picture, however, showed a tendency toward loss. The average daily weight loss for the different groups varied from ⅓ ounce to 1½ ounces, with an average daily loss for all the groups of ¾ ounce.

There are several explanations for these weight losses. Most important, probably, is that under the closely controlled conditions of these experiments, the girls did not "snack" as much as was their custom. Also, most of the studies were conducted just after the Christmas holidays, when extra food and decreased physical activity had resulted in weight gains for some of the girls. A return to more active college life, coupled with the controlled food intake, resulted in weight losses in some cases.

It is evident that the average intake of 2,210 calories was not quite adequate to maintain the body weight of these young women. It is possible, however, to calculate the additional

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This Sample Menu Will Provide Approximately 2,300 Calories . . .

Breakfast		Lunch		Dinner	
Food	Calories	Food	Calories	Food	Calories
½ c. orange juice	108	1 c. vegetable soup	82	3 oz. lean ground beef patty	197
1 egg, scrambled	106	1 cheese sandwich		1 medium potato, baked	97
2 strips bacon	97	2 slices whole wheat bread	110	2 pats butter	100
2 slices toast	126	1 oz. cheese	105	½ c. buttered carrots	34
2 pats butter	100	1 pat butter	50	Lettuce and tomato salad	29
	537	1 c. milk	166	1 tbsp. French dressing	59
		1 apple	75	Ice cream (1/7 qt.)	167
		2 cookies	110	2 tbsp. chocolate sauce	84
			698	1 c. milk	166
				1 roll	86
				1 pat butter	50
		Total	2,304		1,069

Jane M. Leichsenring is professor, and Tora Hovde Oterholt is a former research assistant, School of Home Economics.

Which Pastures Are Best for Dairy Cows?

WALTER F. WEDIN and JOHN D. DONKER

WHAT DO YOU HAVE TO DO to get best returns from pasture? Two closely related factors have great influence. They are economical high production and efficient use of the pasture legumes and grasses.

Control of these two factors is complex. Since it is hard to test both at the same time, the University carried on a grazing trial to study productivity of three widely varying forage mixtures under a weekly rotational grazing system. This trial was started at Rosemount in 1957.

The mixtures tested and seeding rate in pounds per acre were:

Simple Mixture of Legumes and Grasses

Alfalfa (Vernal)	6
Ladino clover	½
Bromegrass (Lincoln)	6
Orchardgrass (Common)	2
	14½

Simple mixture—alfalfa, Ladino clover, bromegrass, and orchardgrass (14½ lb./A) in first production year, Rosemount, August 11, 1958.

Walter F. Wedin is research agronomist, Crops Research Division, ARS, USDA, and assistant professor, Department of Agronomy and Plant Genetics and John D. Donker is associate professor, Department of Dairy Husbandry.

Grasses and nitrogen—bromegrass and orchardgrass (13 lb./A) fertilized with 134 pounds of nitrogen per acre in first production year, Rosemount, August 11, 1958.

Grasses + Nitrogen

Bromegrass (Lincoln)	10
Orchardgrass (Common)	3
	13

Complex Mixture of Legumes and Grasses

Alfalfa (Vernal)	8
Ladino clover	2
Alsike clover	2
Red clover	3
Bromegrass (Lincoln)	6
Orchardgrass (Common)	3
Meadow fescue	3
Reed canary grass	3
Timothy	2
	32

All mixtures were sown with a cultipacker seeder in early August 1957, following liberal fertilizer application according to soil tests. Pastures received 300 pounds per acre of 0-12-36 in the fall of 1958 as a maintenance application. In addition, the grass mixtures were fertilized with ammonium nitrate. The rates of actual nitrogen per acre were 134 pounds in three applications in 1958 and 105 pounds in two applications in 1959.

Holstein cows, all in the same stage of lactation, grazed the mixtures. The seasonal grazing period was from May 28 to August 25, 1958. In 1959, grass pastures were grazed from May 8 to September 10—the simple mixture from May 11 to August 31, and the complex mixture from May 15 to August 31.

Results

Stand and Species—Many people believe that increasing the recommended seeding rate, the number of species, or both will increase the number of plants and, therefore, productiveness and quality. Our results indicated a slight advantage in the first year only. However, plant counts were fairly uniform for all mixtures after 2 years of grazing. The number of plants per square foot were:

	Simple mixture	Grasses + N	Complex mixture
Spring, 1958	31	24	65
Fall, 1958	30	20	44
Fall, 1959	11	9	15

Even though many species were included in the complex mixtures, alfalfa and bromegrass added the most to the productiveness of all mixtures both years. This is shown by the percent of dry matter production in each mixture that follows:

	Simple mixture	Grasses + N	Complex mixture
1958 alfalfa	56	....	39
bromegrass	38	78	30
1959 alfalfa	28	....	34
bromegrass	67	98	56

However, other species helped production the first year. In the grass mixture, orchardgrass made up 10 percent of the dry matter. In the complex mixture, red clover made up 9 percent and alsike clover, timothy, and meadow fescue each 5 percent of the dry matter. Severe winterkilling essentially removed all of them before 1959 grazing.

Protein Content and Digestibility—Protein content has commonly been

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used to judge quality in forage crops. Samples taken before grazing in our trials indicate that grasses adequately fertilized with nitrogen, phosphorus, and potassium may rate as high as legume-grass mixtures in protein content. The crude protein percentage of dry matter was as follows:

	Simple mixture	Grasses + N	Complex mixture
1958	24.2	21.9	22.3
1959	17.5	19.7	17.9

In mixtures of legumes and grasses, the protein content was related to the percentage of legume. The smaller contribution of alfalfa due to winterkilling and weakened plants reduced the protein content in 1959. Protein contents of grasses receiving no nitrogen averaged 16.3 percent over the 2-year period.

High digestibility is of utmost importance in pasture crops. The results indicated no difference in the digestibility of the three mixtures tested. This is likely to be the case for legumes and grasses in general when taken at immature, pasture stage of growth under ideal management and fertility programs. Digestibility percentages determined on samples taken in 1958 were as follows: simple, 62.7; grasses + N, 64.6; complex, 63.1.

Milk Production—The pasture mixtures were grazed with high-producing cows. To keep production high, the cows were fed concentrates according to production, and pastures were not grazed closely. Under these conditions, approximately 60 percent of the energy required was supplied by pasture.

None of the mixtures reduced milk production or caused bloat. Daily milk production per cow averaged 43 pounds for two grazing seasons. Assuming no differences among mixtures and 60-percent contribution from pasture, pasture produced 26 pounds of milk per cow daily. Thus, the number of cow days that each mixture supplied became the important criterion to compare pastures and was as follows:

	Simple mixture	Grasses + N	Complex mixture
1958	156	148	154
1959	131	181	122

Extra days of grazing in May and September was the major advantage of grass in the second production year.

Pounds of milk produced per acre and attributable to pasture were as follows:

	Simple mixture	Grasses + N	Complex mixture
1958	4,056	3,848	4,004
1959	3,406	4,706	3,172

What This Means

Pasture improvement is one of the major areas for increasing efficiency on the farm. The pasture program must fit the farm and take into account all forage needs including hay and silage. Therefore, it will be necessary to improve and utilize several types of pasture with sound management. These may include:

(1) Improvement of unplowable grassland by fertilization and intensive management.

(2) Use of high-yielding mixtures in rotation pastures or on renovated, open pasture land.

(3) Supplementing with annual forage crops.

There has been considerable acclaim for using grasses with nitrogen fertilization. However, where a complete forage program is considered, it is unwise to assume that grasses plus nitrogen can economically replace legumes.

Where legumes are not suited, are difficult to establish, or have been severely depleted and weakened by winterkilling, a pasture fertility and management program for predominantly grass pastures is needed. This would increase the contribution of pasture to the entire forage program. Additional research is needed to determine if increased emphasis on grasses and nitrogen will benefit the hay or silage aspects of a forage program.

Nitrogen-fixing legumes in forage mixtures enhance the growth of associated grasses. Due to **severe winterkilling and weakening of legumes,** however, this was only true in the first year of our experiment. Under these circumstances, the economic return of different mixtures is interesting.

Assuming commercial nitrogen costs 15 cents per pound, the 134-pound application in 1958 would cost $20.10 per acre. Valuing milk at $3.25 per hundred pounds and crediting

Fertilized grass pasture afforded early grazing in second production year, Rosemount, May 8, 1959.

$1.50 to reduced seed cost for the grass mixture, the simple mixture had a $25.36 per acre advantage in 1958.

In 1959, however, nitrogen fertilizer returned an additional 1,300 pounds of milk worth $26.50 above fertilizer cost over the simple mixture. Thus, following unusually severe winterkilling of legumes, the grass mixture yielded the highest returns.

Combine for Best Results

To get best returns from a newly renovated or cropland reseeded pasture, combine the advantages of both systems of supplying nitrogen. A pasture program that will allow renovation every 4 or 5 years on a specific pasture will likely have certain areas renovated each year.

Seeding these areas to recommended legume-grass mixtures at optimum fertility (lime, phosphorus, potassium) will allow first-year production of high-quality forage with no additional nitrogen cost. First-year stands will likely be high in legume content and can thus be used for hay or silage.

Second-year, third-year, and areas renovated earlier may be used for pasture. With adequate phosphorus and potassium and normal winter conditions these pastures will normally retain enough legumes in the mixture to provide adequate nitrogen for the grasses in the second and possibly the third year. **If, however, the legumes have been killed or weakened by winterkilling the stands must be given enough nitrogen to boost the grass production.**

Thus, a productive pasture and forage program must include legumes and grasses alone and in combinations. This approach will lend permanence to dairy production in areas where grassland crops are particularly adapted.

Fattening Lambs with Pellets

R. M. JORDAN and H. E. HANKE

MECHANIZED LAMB FEEDING received a stimulus when P. E. Neale of the New Mexico Agricultural Experiment Station reported that feeder lambs fed a pelleted, low-quality, high-roughage ration made greater gains than comparable lambs fed a high concentrate ration in conventional form (long hay and whole grain). Since then, most experiment stations and many commercial feeders have tried feeding lambs a complete pelleted ration.

Will a feeding system that is successful in New Mexico, Colorado, or California be as effective in Minnesota? Minnesota lamb feeding operations differ from their operations in the following ways:

1. We grow most of the grain and roughage we feed.

2. Our lamb feeding operations are governed in part, by the amount, kind, and quality of feed we have.

3. Our feed lots are small, 500-5,000 lambs, while California or Colorado operations are large—feeding 5,000-50,000 lambs at a time.

Will feeding a pelleted ration increase the Minnesota feeders' chance for profit? Let's look at the record obtained at the Morris Station (table 1). You can expect increased gains of 10-20 percent or .05-.10 pounds additional gain per lamb daily. This additional gain will also be accompanied by increased feed intake and usually reduced pounds of feed nutrient per pound of gain.

What about the cost of putting on the gain? With existing charges for grinding and pelleting of $8-12.00 per ton, most research stations, including Minnesota, have found that the cost of producing the gain is not necessarily reduced by feeding a pelleted ration. Trials I and II bear out this point (table 1).

Data from trial III illustrate an exception. In this trial the lambs fed the pelleted ration of 50 percent alfalfa and 50 percent corn actually gained slower and ate less than comparable lambs fed the ration in meal form. Lambs fed a pelleted ration of 75 percent alfalfa gained as rapidly as the lambs fed the meal ration of 50 percent alfalfa. In other words, pelleting a ration consisting of about 75 percent roughage made the additional pelleted roughage as valuable as corn.

Results of trial IV favored the pelleted rations on all counts. Feed consumption increased about 10-15 percent, and because of a 20-58 percent increase in rate of gain, feed costs per pound of gain were greatly reduced.

Can you depend on such favorable results? The fact that the increased gain in the first three trials was between 0-20 percent suggests that a 10-20 percent increase in average daily gain is more reasonable.

You can be sure that as the **roughage content** in the ration is **increased,** the difference in rate of gain between the long hay or meal ration and the pelleted ration will increase. For example, pelleting a ration containing 85 percent roughage increased the rate of gain 58 percent over the same ration fed in meal form. Pelleting increased the rate of gain of a 50:50 ration 22 percent, and in trial V the pelleting of a high concentrate feed (ground ear corn) actually decreased rate of gain and feed consumption.

The reports of 100-200 percent increase in rate of gain from feeding pelleted rations have occurred when extremely high levels of low-quality

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Table 1. Fattening lambs with pellets

Type of ration*		Lambs	Average daily gain	Average daily feed	Feed per pound gain	Cost per pound gain
		number	pounds	pounds	pounds	cents
Trial I						
Not chopped	42:58	30	.31	2.70	8.63	15.55
Pelleted	40:60	60	.37	2.81	7.62	16.47
Pelleted	47:53	30	.38	3.03	8.06	16.81
Grinding and pelleting costs—$10 per ton						
Trial II						
Not chopped	50:50	12	.52	3.40	6.52	9.02
Pelleted	50:50	12	.57	3.72	6.58	11.19
Pelleted	75:25	12	.56	3.96	7.12	9.85
Grinding and mixing—$5.20 per ton; pelleting $2.70 per ton						
Trial III						
Chopped	50:50	14	.48	3.79	7.92	12.18
Pelleted	50:50	14	.43	3.39	7.87	13.72
Pelleted	75:25	14	.48	4.24	8.77	12.43
Grinding and mixing—$5.20 per ton; pelleting $2.70 per ton						
Trial IV						
Chopped	50:50	12	.46	3.39	7.44	12.87
Pelleted	50:50	12	.56	3.83	6.83	12.73
Chopped	75:25	24	.45	4.02	8.99	13.44
Pelleted	75:25	24	.56	4.28	7.68	12.51
Chopped	85:15	11	.36	3.76	10.47	14.66
Pelleted	85:15	10	.57	4.56	7.97	12.27
Grinding and mixing—$3.20 per ton; pelleting $2.70 per ton						
Trial V						
Shelled corn		20	.42	3.07	7.70	10.80
Ground ear corn		44	.37	3.15	8.98	11.44
Pelleted ear corn		44	.34	2.98	8.98	13.57
Grinding—$4.00 per ton; pelleting $6.00 per ton						

* Corn and good quality alfalfa hay was fed in all trials. In each case roughage proportion is listed first. For example, not chopped 50:50 means the ration was 50 percent long hay and 50 percent shelled corn.

Note: Hauling charges are not included in pelleting costs.

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roughage (usually unpalatable nonlegume roughages) have been used. This has done much to popularize pelleted feeding, but it can mislead the feeder. At Morris, for example, a 100 percent pelleted high-quality alfalfa ration increased the average daily gain 60 percent when compared with an identical ration in meal form (.48 pounds per lamb daily) *but* the lambs lacked sufficient finish, shrank more from the feed lot to market, and had lower carcass yields.

How much per ton can a lamb feeder pay for pelleting? In general, pelleting is of greatest value when feed and labor costs are high. In addition, feed lots with high volume that buy rather than raise the major part of their feed will benefit most from feeding pelleted rations.

If 800 pounds of lamb feed are required to produce 100 pounds of lamb gain, then for each $2.00 per ton increase in feed costs the cost to produce 100 pounds of lamb gain increases 80 cents. (One-tenth cent × 800 pounds = 80 cents.)

Table 2 shows the added cost of fattening a lamb for each additional $2.00 cost of feed preparation. You will note that when the feed is fed in pelleted form we have arbitrarily assigned 800 pounds of feed to produce 100 pounds of gain, or 240 pounds to put on 30 pounds of lamb gain. If the lamb is fed long hay and shelled corn and gains somewhat slower, it requires 900 pounds of feed to produce 100 pounds of gain, or 270 pounds of feed to produce 30 pounds of gain.

Knowing the amount of feed required to finish a lamb when fed either a pelleted ration or an unpelleted ration, we can now calculate the relative feed costs of both. For example, a $4.00 grinding and pelleting charge increased the cost of 240 pounds of feed (amount required to finish one lamb) 48 cents. The added cost of the 30 additional pounds of feed (270 pounds of long hay and shelled corn vs. 240 pounds of pelleted ration) when valued at $1.50 per 100 pounds is 45 cents.

An $8.00 grinding and pelleting charge increases the cost of finishing one lamb 96 cents or 51 cents more than the value of the 30 additional pounds of unpelleted ration. In most commercial lamb feeding operations the reduced labor, lower death loss, and shorter feeding period would offset this 51 cent added cost to finish one lamb. However, when the cost of pelleting gets much above $8.00 per ton the added cost of producing 100 pounds of gain exceeds the advantages.

There is one other very important factor that makes pelleting popular. Pelleted high roughage rations (70-80 percent) will produce as great a gain with as great or greater feed efficiency than a high concentrate (50-60 percent) ration that has not been pelleted. *If* roughage is inexpensive in relation to the concentrate then it is possible to pellet the ration and save enough on the feed ingredients cost to pay for the major part or all of the pelleting costs.

On the basis of experimental work at the University of Minnesota and cost studies kept by commercial lamb feeders, the cost of grinding and pelleting the feed plus the transportation of these feeds to and from a pelleting mill increased the cost of their rations $10-$16 a ton. With very few exceptions this added cost has exceeded the advantages derived from pelleting.

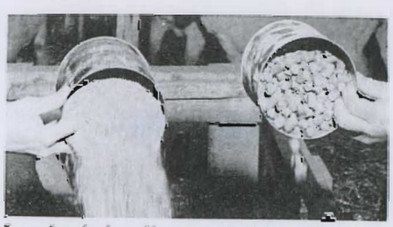
Since Minnesota lamb feeders produce their own feeds and feed lambs according to feed available, we would conclude that what is good for California feeders is not necessarily good for Minnesota feeders at this time.

The lambs prefer the pellets, but do the results justify the costs?

Table 2. How much feeders can pay for pelleting

	Feed required to finish one lamb	
	240 pounds of pelleted ration	270 pounds of long hay and shelled corn
If pelleting* adds this much more per ton . . .	Added feed costs per lamb will be	Added cost of 30 pounds of feed†
$ 4.00	$ .48	$ .45
$ 6.00	.72	.45
$ 8.00	.96	.45
$10.00	1.20	.45
$12.00	1.44	.45
$14.00	1.68	.45

* Grinding and transportation are part of the costs.
†Lamb feed valued at $1.50 per 100 pounds.



Lambs fed pellets containing 75 or 85 percent hay had choice to prime finish after 70 days feeding.

HIGH-LIME CHLOROSIS--
A Problem in Western Minnesota

R. G. BURAU and J. M. MACGREGOR

IF YOU DRAW A NORTH-SOUTH LINE through the center of Minnesota and down through east Texas to the Gulf of Mexico, you will roughly separate two vastly different soil regions.

The soils to the east of the line will require liming, since the greater rainfall has dissolved and leached all free lime out of the soil. This produces an acid (sour) reaction.

West of the line, rainfall is much less and most of the original lime is still present in the soil. Actually, there are more fertility nutrients in the drier western soils, but relatively large concentrations of lime make it difficult for some plants to extract all of the nutrient elements they need.

Soils that are high in lime (calcium and/or magnesium carbonates) are frequently low in available iron, manganese, copper, and zinc, though large amounts might be present as insoluble mineral forms. There are several tons of iron present in 6 inches of soil on an acre; however, with high lime soils, less than 5 pounds of this iron may be available to some crops. If they don't have enough iron, some plants will yellow as they emerge from the soil. Their growth will be limited, and they may die within a few weeks.

This is a common condition among some crop and ornamental species over large areas west of the Mississippi River where the soil has an alkaline reaction. Fortunately, not all plants are affected, and some varieties of affected species are quite resistant. Soybeans and flax are the field crops most affected in Minnesota, but garden peas, beans, strawberries, raspberries, grapes, plums, apples, hydrangea, roses, spirea, boxelders, birch, elm, and silver maple are also affected.

An iron shortage apparently reduces the amount of chlorophyll a plant produces. Plant leaves become chlorotic (yellow) because color pigments usually hidden by chlorophyll become visible. On annual plants, the chlorosis (yellowing) first appears on the upper young leaves; on perennials, it appears on leaves of new growth. Later other leaves of the plants may become chlorotic. Field and garden plants usually survive but yield is noticeably less. In ornamentals the appearance is impaired.

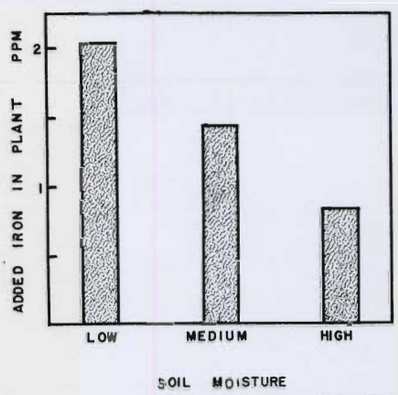


Fig. 1. Iron in soybeans from RA 159 Fe applied to calcareous soil at the rate of 2.0 pp$_2$ M. Fe.

The pattern of the chlorotic vegetation shows that the deficiency is either iron or manganese. Extensive greenhouse and field tests showed that iron corrected the condition. Iron was applied to the soil as an iron-organic compound (chelate). The uptake and movement of the added iron within the soybean plant was traced by radio tracer techniques. As the iron uptake increased, the manganese in the plant decreased. It was apparent that the chlorosis occurred because the soybean plants were unable to obtain enough iron from these problem soils.

Why are some plants unable to extract the very small amounts of iron needed for normal growth from high-lime soils? This question still has not been satisfactorily answered after many years of study, since many soil factors other than lime are involved. As shown by figure 1, increasing soil moisture decreases iron uptake from iron chelate by soybean plants. Some investigators now believe that high phosphorus availability in soils favors the condition, since chlorotic soybean plants are generally higher in phosphorus than are the normal green soybean plants.

Two methods may be used to remedy the yellowing condition:

1. Foliar sprays with soluble forms of iron, and,
2. Soil applications.

Foliar sprays are low in cost, but since several applications are often necesary, this method may be troublesome. Ferrous sulfate is the iron salt usually used at the rate of 6 ounces per 5 gallons of water (1 percent solution). Foliage should have complete but not heavy coverage, since leaves may "burn." Leaves should become green within 1 or 2 weeks. Iron sprayed on leaves does not move from one leaf to another within the plant and so new leaf growth must also be sprayed.

When added to high-lime soils, soluble forms of iron so effective in sprays are quickly immobilized and made unavailable. Some, but not all of the new chelated iron compounds become unavailable soon after application.

This was shown in a greenhouse experiment where three iron chelates were added to soils **before** planting at rates ranging from ½ to 4½ pounds of iron per 2 million pounds of soil. The leaves on soybeans growing on soils treated with Sequestrene 330 and Versenol F were chlorotic, but treatment with a third iron chelate (RA 159) resulted in normal plants. The two autoradiographs (figure 2) indicate the additional iron taken up by the green plants. However, when any one of these chelates is applied to soil after chlorosis appears, affected foliage becomes green.

If you live in a high-lime soil area and have yellow plants, you can either spray them periodically with

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Special Rust Tests in Puerto Rico

E. R. AUSEMUS

Improvement of cereal crops depends on the team work and cooperation of plant breeders, plant pathologists, biochemists, and often other researchers. At the University of Minnesota this involves several departments and cooperation with the United States Department of Agriculture.

This article tells about the team work between the USDA and the Land Grant colleges. Here we tell about a specific service to the Experiment Stations located where small grains are grown. This service is supplied by the USDA as a part of this cooperative effort.

NEW FACILITIES AND METHODS for the improvement of the cereal crops—wheat, oats, and barley—are being developed. A recent and very important improvement is a small grain testing program by the U. S. Department of Agriculture through cooperation of the Crops Research and Territorial Experiment Station Divisions. The work is being done at the Federal Experiment Station, Mayaguez, Puerto Rico. This program has been in various stages since 1951, but in 1958 Congress appropriated funds to support the testing work with small grains.

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Puerto Rico is a mountainous island located about 1,000 miles southeast of the southern tip of Florida. The principal crops are sugarcane, coffee, tobacco, pineapple, bananas, and citrus fruits, the first two being more important.

Small grains are not grown commercially, but wheat and oats thrive in the winter if protected from insects and weeds. The crop conditions in Puerto Rico provide an excellent opportunity for evaluating breeding material because we can create artificial epidemics of the rust races in North America. There is only a slight risk of rust spores blowing from one location to another on the island and there is almost no risk to the United States. This area provides a solution to the long-felt need among breeders and pathologists for tests of special cultures or races of rusts.

This shows the normal growth of wheat plants at Isabella, Puerto Rico (12-inch stake in foreground), 1956-57.

This winter, hybrids and varieties of wheat and oats are being tested to special cultures of rust at four locations, Isabela, Lajas, Ponce, and Mayaguez. About 25,000 plots are under observation. A specific culture or race generally is used at each location. In some years a specific culture is used at each of the three locations and a mixture of races at the fourth. Hence, it is possible to get notes on the mature-plant reactions of the hybrid material to these specific cultures.

The cereals are assembled in the fall and planted in Puerto Rico. The cultures of rust to be used are increased in a greenhouse in continental United States. The plantings are inoculated in mid-winter; readings are made in late February to early April. Infection generally is very heavy on susceptible strains.

To illustrate how the program works: Wheat selections showing promise for rust resistance in tests conducted by D. W. Sunderman and J. D. Miller at St. Paul may be susceptible to a new culture of 15B found in Texas. To find out, seed of each selection is sent to Puerto Rico, where the Texas strain of 15B is being used. By early spring the reaction of the

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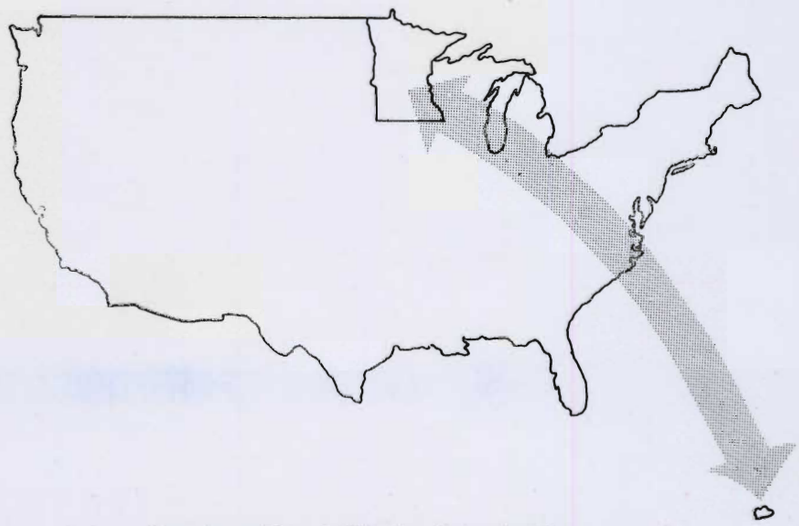

Location of Puerto Rico in relation to Minnesota.

What Brush Does to Minnesota Jack Pine Forests

B. A. BROWN

THE JACK PINE FORESTS OF MINNESOTA are a valuable, re-renewable resource. Once considered worthless, the jack pine is now widely used as pulpwood, sawtimber, posts, and poles. However, once the jack pine forests have been harvested, their regeneration is often far from adequate.

About two-fifths of Minnesota is considered best suited for producing forest crops. However, nearly one-quarter of these lands are out of production. In the 16 northeastern counties where forestry is the resource base of many communities, the grass-upland brush type dominates 1.4 million acres. Considerable expense as well as applying some basic forestry principles will be necesary to return these lands to production.

Establishing timber on areas now dominated by brush represents a great potential for an increase in Minnesota's forest productivity.

From 1936 to 1953, acreage of each of the coniferous types, except spruce-fir, went down at least 19 percent. It is commonly believed that aspen-birch occupies these acres. It is interteresting to note, however, that the aspen-birch acreage has decreased by 10 percent during this period.

In fact, contrary to common opinion, the hardwood types have increased only 1 percent. The net result is a 19-percent increase in nonstocked areas; areas devoid of trees or with too few trees to be considered sufficient to re-establish a forest on the area.

The conversion of brushy areas to productive forests is not the final solution. These forest tracts must also be perpetuated so they won't revert to brush after each harvest cutting. To do this better and possibly more economically, an understanding of "brush" populations is required. "Brush" is defined as all woody vegetation other than timber species 2 feet or more in height at maturity.

Dense hazel brush in a mixed pine stand.

The brush species seriously deter the establishment of red and jack pine seedlings. In some places there is intense competition for soil moisture and nutrients. Once brush becomes established in an area it will outgrow the pine seedlings, rapidly over-topping them and crowding them out. Thus, brush contributes to the decreasing acreage of pine forests. The problem becomes additionally acute because areas with potentially higher timber yields have the greater brush density. Under these conditions brush seems more vigorous and difficult to control.

Although brush species live for many years (in jack pine forests up to 60 years) the initial invasion of an area is slow. In a study of jack pine forests in north-central Minnesota, the oldest aerial stem of beaked hazelnut found was 60 years, willow was 43, and juneberry was 40 years. However, brush species have extensive underground systems, many of which produce new aerial shoots. These underground portions are frequently 10 to 15 years older than any above-ground part. Therefore, a nucleus of brush is available to occupy the area when the stand is harvested or when it begins to open up with old age.

The brush species most often present in jack pine forests are hazelnut, juneberry, willow, rose, cherry, and bush honeysuckle. At least 26 different species of brush have been found either singly or in combinations up to 10 species per area.

In pure undisturbed jack pine forests the amount of brush was found to be related to the soil texture, av-

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Comparison of 1936 and 1953 estimates of commercial forest land in Minnesota by forest type*

Forest type	1936	1953	Gain or loss	
	thousands of acres			percent
White and red pine	391	291	—100	—25.6
Jack pine	1,219	986	—233	—19.1
Spruce-fir	1,053	1,233	+180	+20.7
Black spruce	1,475	1,170	—305	—20.7
Tamarack	655	482	—173	—26.4
Cedar	378	284	— 94	—24.9
All softwoods	5,171	4,446	—725	—14.0
Maple-beech-birch	886	846	— 40	— 4.5
Ash-elm-cottonwood	607	1,144	+537	+88.5
Oak-hickory (including scrub oak)	988	1,182	+194	+19.6
Aspen-birch (including scrub)	6,680	5,997	—683	—10.2
All hardwoods	9,161	9,169	+ 8	+ 0.9
Nonstocked	3,768	4,483	+715	+19.0
All types	18,100	18,098	— 2	— 0.1

* Guillery, P. C., Granum, B., and Cunningham, R. N. 1954. *Forest Statistics for Minnesota.* Lake States For. Exp. Sta. Paper No. 31.

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Cloquet Forest Deer Herd

W. H. MARSHALL

AT LEAST 150,000 MINNESOTANS are interested in hunting white-tailed deer. Although their excitement is at a fever pitch in early November, the problems and possibilities of providing this army of hunters a trophy operate on a 12-month basis.

Most of our deer hunting is in the forested areas in northern Minnesota where the deer find food and cover on many of the same acres that are producing forest products for the wood-using industries of the state.

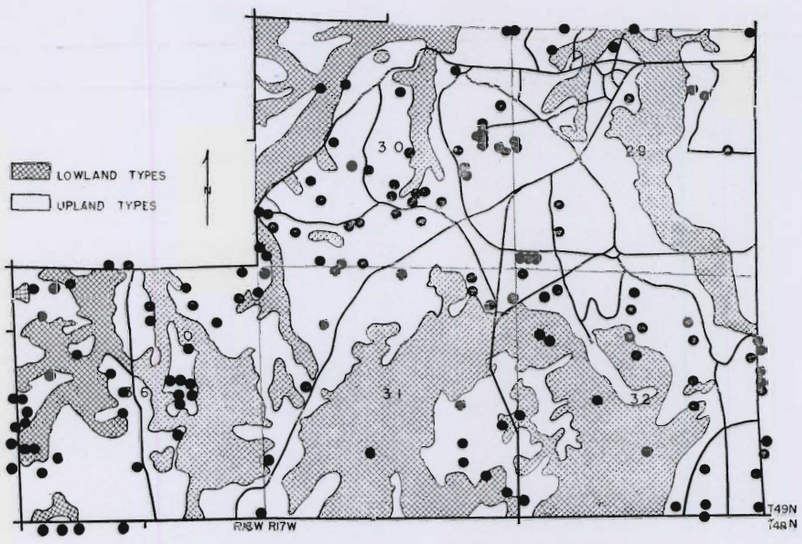
Can an area yield wood products and deer at the same time? If so, at what level can one expect the deer population to maintain itself? How much hunting will this level of deer populations supply? In other words, what is the productivity to the hunter of deer per square mile of managed forest lands?

There is no easy answer to these questions because just as soil fertility, weather conditions, intensity of land management, and other factors determine the yield of corn or soybeans so do many factors determine the yield of deer.

Since 1946 it has been possible to obtain good information on the numbers of deer per square mile, the numbers of hunters per square mile, and the kill of deer per square mile on the Cloquet Forest Research Center which lies about 4 miles west of Cloquet. This 3,300-acre tract, established by the University in 1912, has been intensively managed for research purposes and has yielded wood products at a high rate.

As a bit of background, the Center was made a refuge in 1924—to keep out hunters rather than to save deer. By 1945 the deer herd had built up so that it was severely browsing valuable forest reproduction. The density of deer was too high to be compatible with forestry—the major use of the area.

In 1946 annual spring estimates of the numbers of deer in the forest were started. These showed that there were about 15-20 deer per square mile at that time. The refuge was opened to hunting in 1947 and the herd was reduced to about 10 per square mile. The population level appears to have been steady since then.



Deer kill locations, 1947-1959, Cloquet Forest Research Center.

As shown in the table, the legal deer kill each year since 1952 has also been relatively stable at close to three deer per section. This kill has been slightly higher for bucks than does and for every doe killed there has been an average kill of 1.2 fawns per doe. If we apply this latter figure to the spring doe population, the late summer population would be about 16 deer per section. Hunters have shot three deer—leaving three unaccounted for. These unknown losses were probably due to weather, accidents,

(Continued on page 23)

Deer kill data, Cloquet Forest Research Center

Year	Adults		Fawns		Unidentified	Total	Kill/square mile
	Males	Females	Males	Females			
1947*	6	3	1	1	2	13	2.6
1948	0	2	1	1	...	4	0.8
1949*	4	1	2	1	...	8	1.6
1950†	...	...	...	...	...	...	...
1951	6	8	5	2	8	29	5.8
1952	6	1	0	5	...	12	2.4
1953	5	3	0	0	2	10	2.0
1954	2	4	5	1	3	15	3.0
1955	2	5	2	4	...	13	2.6
1956	3	2	2	5	2	14	2.8
1957	4	4	3	2	...	13	2.6
1958	3	3	2	1	2	17	3.4
1959	3	5	0	2	4	14	2.8
Total	50	41	23	25	23	162	...

* There were 5-day seasons in 1947 and 1949. The rest were 9-day seasons.
† There was no state season in 1950.

W. H. Marshall is a professor in the Department of Entomology and Economic Zoology.

Early Harvest--
A Key to Better Flax Seed Crops?

J. HARLAN FORD

Both the yield and quality of flaxseed are at their peak before the flax is ripe. Harvest flax as soon as moisture conditions will permit normal harvesting operations. We do not recommend chemicals for earlier harvesting, but this procedure has looked promising on some experimental plots.

CAN FLAX REALLY BE LEFT STANDING AFTER MATURITY without loss in yield or quality of the seed? Or can it be harvested before maturity and not seriously reduce the yield? How early can flax be harvested without injury to the seed? Experiments at the University of Minnesota indicate that flax may be harvested early and the yield or quality of the seed will not be affected.

We have been conducting experiments on this problem for several years. We have been harvesting flax at weekly intervals starting several weeks before it was considered ripe and continuing for several weeks after it was ripe. In addition to yield, we studied the moisture content of the bolls, seed size, germination, oil content, and the drying quality of the oil. We measured these factors over a range of approximately 1 month during harvest.

Yield

We found that yield was reduced only slightly when flax was harvested 2 weeks before it was ripe. If all the light seeds could be saved, it is doubtful if there would be any reduction at all. Flax produced slightly higher yields when harvested 1 week before maturity than when harvested 1 to 2 weeks later. This slight increase in yield is surprising since the moisture content of the bolls at this time was still 20 percent. At maturity the moisture content of the bolls is about 10 percent.

When we delayed harvest until after the flax was ripe, the yield fluctuated widely. No doubt this fluctuation is due to the weather conditions at harvest time. If the weather is satisfactory and there is little rain, there is no appreciable change in yield. If the weather conditions are injurious, the yield may be sharply reduced.

In addition, a flax disease called pasmo sometimes further reduces the yield if harvesting is delayed. This disease is prevalent at harvest time. It attacks the stems and pedicels of the plant and weakens them so that they break off easily. Varieties of flax differ in their tolerance to the disease, but no variety available to farmers is highly resistant.

Some years, a late summer rain will cause flax plants to produce new flowers when they appear to be through blossoming. The bolls formed from these flowers will be considerably later than the rest. In Minnesota, it usually does not pay to delay harvest until these bolls become ripe. The late bolls produce such a small amount of seed that usually the risk is too great to wait for them.

Seed Quality

We found that flaxseed quality was generally highest when the flax was harvested 1 or 2 weeks before it was ripe. Seed size did not vary much before or after maturity. However, the germination percentage of the seed was influenced to a great extent by the harvest date. In some cases, the germination is reduced when flax is harvested 2 weeks before it is ripe. Once the seeds are mature and the germination is at a maximum, any harvest delay reduced the germination percentage. The reason for this decrease with a delay in harvest is not readily apparent. We are now studying the relationship between germination and the date of harvest.

Both the oil content and the drying quality of the oil reached a maximum before the flaxseed was ripe. They reached maximum values at least 1 week before maturity; after that they gradually decreased. In general, nothing seems to be gained in seed quality by delaying harvest.

Use of Chemicals to Facilitate Early Harvest

Flax has been treated with chemicals in some experiments to aid in drying the crop. Since weeds are sometimes a serious problem at harvest, the chemical desiccants also help to dry up the green material. Desiccants are used to dry both the crop and the weeds enough to permit straight combining.

This procedure sounds promising, but the results have not been consistent. In some cases the flax has been dry enough for combining in 5 days to 1 week after spraying, sometimes it took longer. Even though the chemicals do not always permit straight combining, they will make harvesting easier. The cost of the chemicals is too high to use simply for an easier harvest. Although the cost may prevent the general use of desiccants, they might be useful where special weed problems exist.

J. Harlan Ford is research agronomist, Crops Research Division, ARS, USDA.

What Brush Does—

(Continued from page 16)

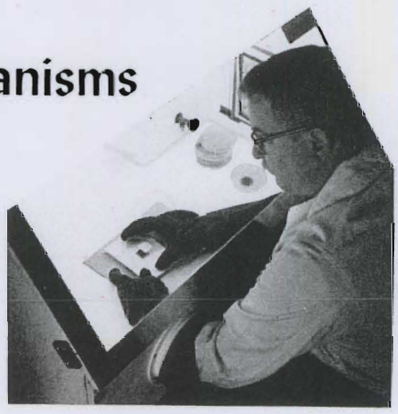
erage stand diameter, stand basal area per acre, stand age, and site index. These facts suggest a basic relationship to the productive capacity of the area.

Therefore, jack pine stands must be kept at full stocking, particularly on good sites. This is especially important after age 35. Intermediate cuttings should be made early in the life of the stand (before age 35) to get maximum crown response with a rapid return to full crown density and to utilization of the rooting area. The age at felling (50 and 55 years) for good and medium sites is most critical. Only in rare instances is brush competition the limiting factor in the establishment of reproduction on poor sites, even up to age 70. Additional studies are required to establish the necessary modifications in the silvicultural treatments for the jack pine forests.

Ten Years of Research Show--

Effects of Radioactivity on Microorganisms

J. B. ROWELL and T. W. SUDIA



CAN WE LIVE WITH RADIOACTIVITY? Have we in the past? What about the hazards of radioactive fallout? To answer the last question, we have to consider fallout from bomb testing as an addition to the radioactivity already existing in nature. While continued bomb testing will increase environmental radioactivity, present levels of fallout contribute relatively little to our total natural background radiation.

At the University we have studied for the last 10 years the effects of radioactive materials occurring in nature on plant pathogens and other microorganisms. This research has been supported by the United States Atomic Energy Commission.

Radioactive elements such as radium 226, uranium 238, thorium 232, radon 222, polonium 210, potassium 40, and carbon 14 are found everywhere through soil, water, and atmosphere. They are a part of the environment of all living things. Together with cosmic rays they produce a small constant amount of radiation known as the "background radiation" of the earth. Therefore we wanted to know what, if any, effects this natural background of radiation produces on living systems.

One of our major objectives was to study genetic variation in microorganisms and plant pathogens caused by exposure to radiation from naturally occurring substances. A better understanding of the variation brought about by radioactivity under controlled conditions would give us insight into the origin of new races of plant pathogens and other economically important microorganisms.

Microorganisms are so small that 100 or more times the human population of the earth can be kept in one small culture dish. What's more, a single individual can produce this number of highly uniform microorganisms. Simply transferring a portion of an old culture into fresh culture medium will produce a new generation of billions of individuals every few days. With so many microorganisms, we can study not only relatively infrequent genetic changes but also changes that occur only once in a billion or more individuals.

Uranium 238, thorium 232, and polonium 210 and their various compounds were the principal materials used as sources of radioactivity. These elements give off alpha particles. Alpha particles release 20 times as much destructive energy in their path through a cell as other types of radiation. Thus they are the most intensely damaging type of radiation from radioactive elements. We incorporated these radioactive materials in the nutrient medium in which organisms were grown, irradiating them internally and at close range. We also used them in their pure metallic forms as an external radioactive source.

Some of the changes we studied in detail were: growth rate, cell form, sex characteristics, and reproductive cycles; colony color, texture, and form; nutrition; and pathogenicity of those organisms that cause disease.

Genetic changes—Rate of growth changes were common among the fungi exposed to alpha radiation. The majority of these grew more slowly than the parent types. Unusual alterations in cell size and shape were also frequent. These not only involved bizarre types with distorted and enlarged cells, but in corn smut, a change from a thread-like to a yeast-like cell growth resulted.

Color changes were frequent with *Chlorella pyrenoidosa*, a single-celled green alga. Cells were lighter in color than the parents. These cells in turn produced lighter colored cells after additional irradiation. This process resulted in cells that were colorless and indistinguishable from a known species of fungus. The fungi and algae differ primarily in the possession of the green pigment, chlorophyll.

Pathogenicity of various plant pathogens was studied for effect of genetic changes. Among the important pathogens studied were corn smut, head smut of corn and sorghum, pod or stem blight of soybeans, wheat stem rust, flax anthracnose, potato late blight, crown gall, root rot, and seedling blight organisms.

Alpha Radiation Helpful in Research

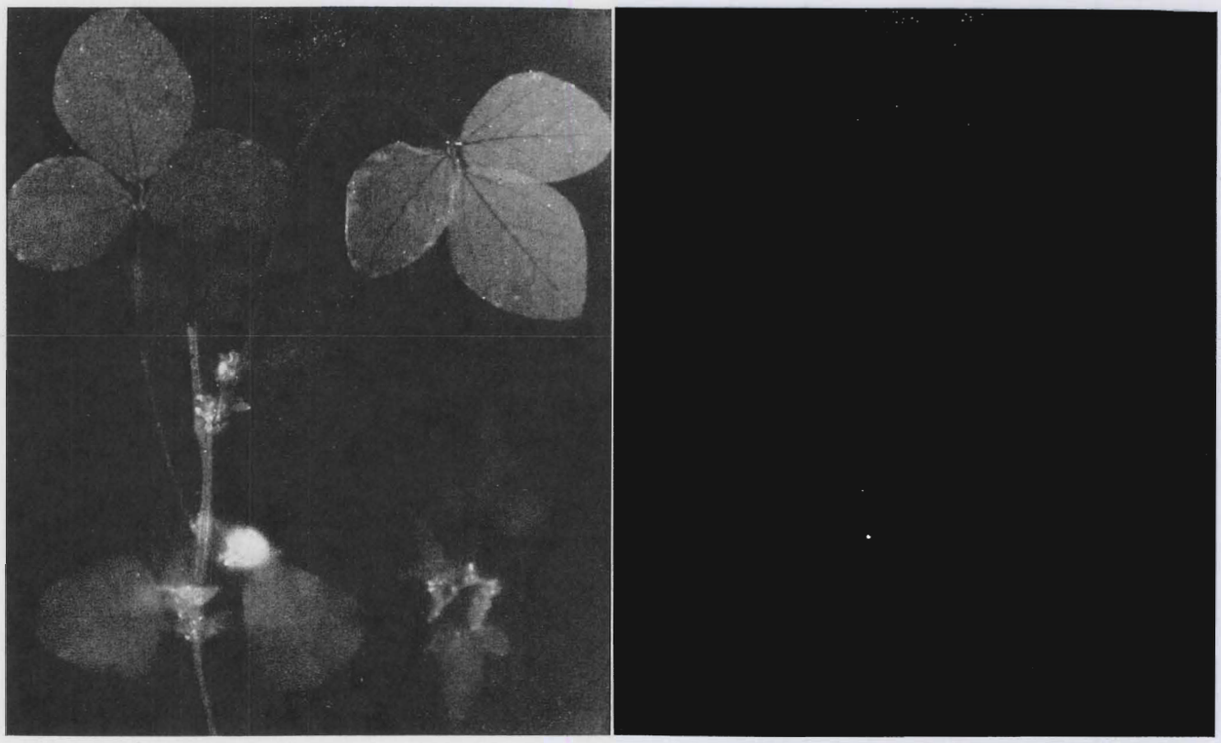
These researchers have indicated the usefulness of alpha radiation in many research areas.

First, there is the study of microbiological genetics. With a source of such radiation, a scientist can quickly explore much of the species' range in variation in characters. The discovery of similar variants in the species in its natural environment might take years of study.

Second, the radiation-induced variation has many practical applications. The fungi's metabolic activities have long yielded useful products such as alcohol, cheese, antibiotics, and growth-promoting substances. Alpha irradiation has induced variation in such characters in fungi making possible the selection of better varieties. We studied the influence of alpha radiation on the production of vitamins by *Eremothecium ashbyii*, the growth hormone gibberellic acid by *Gibberella fujikuroi*, and the starch-sugar conversion enzyme amylase, by *Aspergillus oryzae*. In the last case a variety was found which produced significantly more enzyme than the parent.

(Continued on page 22)

J. B. Rowell is associate professor, Department of Plant Pathology and Botany, and Plant Physiologist, USDA, and T. W. Sudia is research associate, Department of Plant Pathology and Botany.



High-Lime Chlorosis—

(Continued from page 14)

a 1 percent solution of iron sulfate, or you can add a suitable iron chelate to the soil.

Sequestrene 138 Fe iron chelate has been very satisfactory in correcting chlorosis in soybeans in relatively small amounts. Apply the chelated iron in a band near the roots as soon as possible after the leaves begin to yellow. In trees, place the chelated iron treatment about 6 inches deep in 4 or more holes around the drip perimeter.

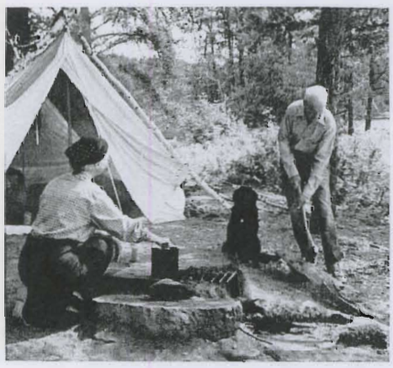
Fig. 2. (Left) Autoradiograph of green soybean plant grown in soil treated with 1.5 p.p.2m. Fe as RA159Fe 59. (Light areas indicate location of radioactive iron 59.)
(Right) Autoradiograph of chlorotic soybean plant grown in soil treated with 1.5 p.p.2m. Fe as Sequestrene 330 Fe 59.

Canoe Country Camping—

(Continued from page 3)

stayed longer or covered a longer route. Others regretted not having done more exploring and hiking or taken more photographs. Only 4 percent, after completing their vacation, wished that they had vacationed elsewhere. When asked how satisfied they were with their vacation, over 90 percent said they were either completely or at least largely satisfied. Only 4 percent of the campers and 3 percent of the canoeists replied they were more dissatisfied than satisfied with the trip.

Most (88 percent) of the canoeists and 28 percent of the campers reported that a canoe trip appealed to them most among the alternative vacations for next year; the latter had not canoed this year. Nineteen percent of the campers and 17 percent of the canoeists thought they would



rather have a less vigorous type of vacation next year. Of the total, more indicated interest in a more vigorous rather than a less vigorous vacation.

Attitudes Toward Management

Almost everyone wanted forest areas left in the "natural state." Many, at the same time, wanted improvements. The campground campers called for wells, firewood, toilets, more space for parking and camping, more and better picnic tables and fireplaces, or facilities for first aid and garbage disposal.

Canoeists suggested more marking of canoe routes (done on the American but not on the Canadian side), better maps, and reconnaissance to watch for people in trouble.

Many people said they wanted more information about the area. Canoeists felt they had been provided for but campers, being less self-dependent, were more likely to say that their needs were not met. Canoeists and campers both felt some crowding. Both suggested that other users of the area be educated to leave the campsites in better condition.

These answers, and others to be acquired later, will help in developing plans for continued enjoyment of forest recreation.

Cubic Bales—

(Continued from page 8)

able weather, by using a hay conditioner, it is possible to cut alfalfa in the forenoon and bale it at 25-percent moisture or less during the afternoon of the following day. Unconditioned hay usually requires another day of field drying to reach a moisture content of 25 percent.

Artificial drying can further shorten the time between cutting and storage. Freshly cut hay loses moisture rapidly, but the rate of moisture loss decreases as the hay becomes drier. In the haying system using 12-inch cubic bales, the hay would be baled at a moisture content of 30 to 35 percent. The bales would be artificially dried to a safe storage level. Research with hay conditioners shows that it would frequently be possible to cut and bale the same day if the hay were conditioned and baled at 30- to 35-percent moisture content.

The modified baler used to make small bales.

Alfalfa cut and conditioned in the forenoon in good drying weather would dry to 35 percent moisture content by about 3:00 p.m. of the same day. Even under moderately unfavorable drying conditions the hay would likely reach a moisture content of 35 percent by noon of the following day.

Saving the leaves is important because they have a much higher protein content than stems. Raking at about 50-percent moisture results in little leaf loss and more uniform drying. Few leaves are lost or pulverized during baling if it's done when the moisture content of the hay is 30 to 35 percent.

Mechanical Handling

An important advantage of the 12-inch cubic bale over the standard-size bale is that it's easier to handle mechanically. The small size and cubic shape work well for wagons equipped with mechanical unloading devices. This means that the bales can be mechanically moved from the baler to a trailing wagon; unloaded mechanically into the hopper of a bale elevator; and conveyed into a storage space equipped for artificial drying.

For satisfactory artificial drying, conventional bales must be rather precisely arranged on the drier, requiring extra labor. The 12-inch cubic bales are small enough to fall into place in the drier or storage space equipped for artificial drying. With such random arrangement drying air can be used efficiently because of the small size of the bale.

Another reason why the small bale is better adapted to artificial drying is that in the small bale a higher percentage of hay is located near a drying surface.

Three batches of hay were dried with unheated air in a 1,000-bushel steel bin equipped for drying research. Moisture content of the hay when baled varied from 28 to 32 percent, but quality after drying was excellent in each case. Practically all the leaves were still attached to the plant and there was almost no leaf pulverization.

The cost of twine would be approximately $.70 per ton more than the twine cost for tying conventional-sized bales. It is likely, however, that one tie per bale would be sufficient. The greater number of twine pieces to be taken care of when the bales are fed may be objectionable.

Agribusiness—

(Continued from page 6)

group doubled during the 1940's but increased only 10 percent during the past decade. The output group, on the other hand, increased at a steady and high rate throughout the entire 20-year period. A small, but steady increase came about in the facilitating group.

Implications

Minnesota farm employment has decreased 28 percent during the past 20 years while employment in the off-farm agribusiness groups increased 52 percent. This clearly indicates the shift in job opportunities within agribusiness in Minnesota. This is substantiated by changes in placement of College of Agriculture graduates in recent years. Presently, about 10 percent of the graduates go back to the farm and this number is smaller each year. About half of those remaining enter agricultural business and industry jobs and the rest find jobs with the government.

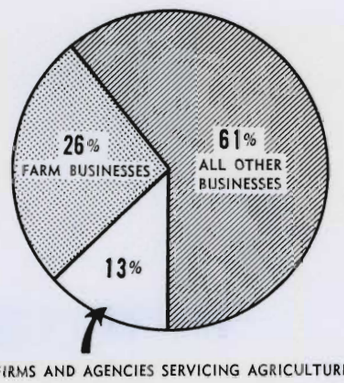


Fig. 2. Minnesota Employment, 1954. The vast agricultural sector of the Minnesota economy.

The long-run trend is toward continued expansion of employment in commercial and industrial areas. To meet this need, curriculum offerings in the College of Agriculture have been adjusting to provide the training necessary for jobs in agriculturally related businesses. This trend also suggests changes of vocational agriculture programs in secondary schools toward more off-farm agribusiness training.

Continued increases in employment in the output and facilitating groups of the state's agribusiness complex have occurred despite severe declines in farm employment and lower farm income. This suggests that these off-farm groups depend more on a high level of agricultural production and a high level of national income and employment than on the well-being within farming itself.

Declines in farm employment and incomes appear, on the other hand, to have an influence on the input group. The sharp decline in the **rate** of increase in employment in this group over the past 10 years indicates its dependency on the trends in agriculture in the state.

Special Rust Tests—

(Continued from page 15)

wheats will be known and only the resistant ones need be sown again at St. Paul, or if sown, work will be concentrated on the selections with the best all-round records. This rust test is done without introducing the new culture into the spring wheat belt or perpetuating it artificially in Texas.

This shows the severity of rust infection, Isabella, Puerto Rico, 1953-54.

Radioactivity—

(Continued from page 19)

Finally, the radiation-induced variation has use in solving the problems of biosynthesis. Radiation often produces organisms which have lost the ability to make substances they need to grow and survive normally. These biochemical "cripples" can be sustained by supplying the deficient substance. Thus, they can be tested for the specific interrupted step in the chain of their metabolism. This technique has been widely used to follow the pathways by which cells transform a few relatively simple food materials into essential cellular constituents.

Importance in Nature

Are naturally radioactive materials important in nature? This question cannot be answered easily. Spontaneous variation appears regularly in the fungi in their natural environment but we do not always know the cause of the variation. However, isolations from the uranium-bearing soil of Port Radium, Canada, yielded many varieties of the mold *Mucor ramanianus*. This species is stable in culture, and variants are rare in non-uranium soils. Irradiation with alpha particles of the typical form of this mold produced all the major variants found in the Port Radium sample. In the laboratory, then, we produced mutants resembling those found where the organism is naturally exposed to uranium ore.

As few as 30 alpha particles traversing a single living cell can cause any of the profound changes discussed in this report. Since about 3,300 alpha particles per hour are given off from the surface of one square millimeter of metallic uranium 238, the potentiality for inducing variation exists. Fortunately, most natural uranium is greatly diluted in the soil, otherwise the variation among the microorganisms might be greater and more difficult to study.

Although radiation may be a specific threat to individuals, all species have lived and evolved in its presence. It may well be that evolution in the microorganisms was speeded up by the presence of alpha emitters in their environment.

Energy Needs—

(Continued from page 9)

calories that would have been needed to maintain a constant body weight. In his book *Reduce and Stay Reduced*, Dr. Norman Jolliffe has suggested that a deficit or a surplus of 3,500 calories is required for the loss or gain of 1 pound of body weight. The average daily loss (¾ ounce) of these girls therefore represents an average daily deficit of 165 calories. Adding this amount to the actual intake of 2,210 calories gives a total of 2,375—the average number of calories necessary for weight maintenance by these college women.

This value is in good agreement with the National Research Council's recommended daily allowance of 2,300 calories for a woman 19-25 years old, 63 inches in height, and weighing 128 pounds. This recommended allowance is, of course, a general overall one—which must be adjusted on the basis of age, body size, activity, and other factors to meet individual needs. In these studies the caloric needs of the girls varied considerably depending on their size and activity. The average caloric intake necessary for weight maintenance ranged from 2,150 to 2,575 calories.

Just what does "2,300 calories" represent in terms of actual foods? One answer to this question is in the accompanying table which shows a sample menu providing approximately 2,300 calories. A dietary plan, such as is suggested by this menu, can be modified to provide either more or fewer calories—but care must be taken that the basic core of foods which is needed to provide all the essential nutrients is maintained.

One important fact for weight-watchers demonstrated in these studies is that only a slight variation in calories will produce a significant weight change over a period of time. On the basis that 3,500 calories is is equivalent to 1 pound of body weight, an excess or deficit of 100 calories per day will result in a 10-pound gain or loss in body weight in a year's time.

Cereal Viruses—

(Continued from page 5)

The oat blue dwarf virus attacks all of the commonly grown oat varieties, but fortunately, the disease is not, as yet, as devastating as red leaf.

Aster Yellows

The aster yellows virus is familiar to Minnesota farmers because it caused severe flax damage in 1957. Now it has been found that aster yellows virus attacks barley and causes extreme stunting and deforming (figure 3). The leaves of such stunted barley plants roll tightly backward, the internodes fail to elongate, and the plants usually fail to head. Occasionally, when plants head, the spikes are deformed and produce no seed.

Fig. 3. Aster yellows infected Vantage barley, 2 months old. Healthy, left; infected, right.

The extent of the damage to barley in Minnesota due to aster yellows has not been determined. It would seem likely that in seasons such as 1957 when the population of leafhoppers multiplied early and rapidly, the damage could be considerable. All varieties of barley which were tested in the greenhouse were extremely susceptible. Oats is apparently completely resistant to the aster yellows virus.

Control of aster yellows is very difficult because it attacks more than 270 kinds of plants, many of which are weeds which harbor the virus. The leafhoppers that feed on these plants also migrate and can spread the virus over long distances.

Barley Stripe Mosaic

Barley stripe mosaic, often referred to as "false stripe," is widely distributed. It has been at least partially responsible for completely eliminating the barley variety, Mars, from commercial production in Minnesota. Barley stripe mosaic virus attacks wheat and oats also, but is not as important in these crops.

Symptoms of infection of barley begin with white streaking in the leaves which eventually turn brown (figure 4). Yield from such plants is markedly reduced, and a high percentage of the seeds from diseased plants are infected with the virus. This seed harbors the virus until the following season when it again infects the seedling, thus perpetuating the disease.

Fig. 4. Barley leaves infected with barley stripe mosaic virus.

Barley stripe mosaic can also be spread in the field by simple mechanical contact. Infected plants brush against healthy plants and spread the virus in this way. Although seed treatment aids to control certain fungus diseases of grain seedlings, it is of no value in controlling seed-borne barley stripe mosaic virus. Control of barley stripe mosaic has been by development and selection of resistant varieties.

Cloquet Forest—

(Continued from page 17)

predation, poaching, or a combination of these factors.

How about the hunters? The area is used primarily by local residents who usually hunt on a half-day basis during the week. Through the years there has been a hunter-day use per section for the whole season of 40 to 90 trips annually. In other words, with a 9-day season between 360 and 810 days of recreation have been obtained in the forest.

With this number of hunters, you may wonder why the deer are not eliminated. The map, showing the locations of the 144 kills that were mapped, gives us the answer. Only 6 of the 144 kills were made in the lowland type or swamps which cover one-third of the area. This, in spite of the fact that at no place would a hunter be more than ¼ mile from a road. Track counts during the seasons show that the deer are in the swamps as well as the uplands and that some hunters go into the swamps. This demonstrates that the swamps in this area are effective refuges for deer.

A 5-square-mile area under intensive forest management has consistently yielded three deer per square mile to hunters with no damage to forest reproduction. This deer herd has provided recreation for between 40 and 90 man-days per section over a 10-year period and has maintained itself because of the "refuge" action of the lowland types.

Their smiles tell the story.

Research Shorts

Editor's note: Here we brief some of the research not covered in *Minnesota Farm and Home Science*. Some of it may be reported in detail in later issues. Other areas have been or will be reported in press, radio, and farm papers or in scientific journals. We hope this feature will enable *Farm and Home Science* to report even more research to you.

Narrow soybean rows have increased yields in field trials at the University's Southern Experiment Station at Waseca. Here soybeans in rows 24 inches apart yielded up to 6 or 7 bushels more per acre than beans in 42-inch rows. The greater yields are due to higher number of plants per acre. The studies also show that the best seeding rate in narrow rows is 100-110 pounds per acre. The early maturing soybeans, in these tests, had most of the advantage. In late varieties the advantage was less. The lack of equipment for handling narrower rows is holding back the idea in soybean production.

The hungrier fish are the better they bite. Research now bears out this fact that many an angler had found out for himself. This explains why fishing is better in June than later in the season.

* * * *

Bigger herds mean less labor per per cow. That's obvious, but here are some research figures to back up this claim. For example, in dairy farms with loose housing systems, it took 1.3 hours of labor time per week to feed baled hay once a day to 30 cows. For 90 cows the requirement was 2.8 hours.

* * * *

Fertilizer costs per pound of nutrients are going down. Since 1951, the cost per pound of nutrient has gone down 8 percent. This difference is due to higher plant analysis in recent years. A high-analysis fertilizer is cheaper to ship. High-analysis fertilizer has less filler material, of course.

* * * *

Chemical weed killers may someday replace oats and other companion crops for establishing alfalfa stands. This might mean more forage the year of seeding and less competition from weeds. And it could mean eliminating low-return companion crops like oats. So far, though, the idea is only experimental. The most promising chemicals for this purpose have not yet been cleared for use.

* * * *

There's no cure for blackhead disease in turkeys, but several drugs can reduce losses by 50 percent or more. That's the finding at the University Branch Experiment Station at Crookston. However, since there is no immunity to blackhead, the best answer so far is a preventative program based on drugs and careful, sanitary flock management.

* * * *

Watch it. Farm work may be becoming less hazardous, but it's still dangerous. And the situation isn't improving in farm homes, either. Of 156 total farm and home accidents in 1959, 41 resulted from farm work mishaps and 115 were classed as farm home accidents. Machinery and equipment accounted for 37 of both farm work and farm home fatal accidents. Falls, often involving older people, accounted for 34 fatalities.

* * * *

Too much detergent? Yes, it's possible and it in part may cause yellow or tattle-tale gray. Many homemakers use far more detergent than necessary to get clothes clean. As a result, the detergent not rinsed out builds up in the clothes, giving them a harsh feeling which may irritate the skin. Overuse of detergent may give a clean looking wash the first few weeks but clothes will appear dingy as the detergent builds up. When clothes are dried in an automatic dryer, the detergent not rinsed out tends to turn yellow.

FIELD DAYS

Here are the dates for the 1960 Minnesota Field Days.

July 6—Rosemount
July 7—Waseca
July 8—Lamberton
July 14—Morris
July 19—Crookston
July 21—Grand Rapids
July 22—Duluth

New Research Publications . . .

Following is a list of the new research publications since the last issue of "Minnesota Farm and Home Science." This is a new feature to keep you up-to-date on Experiment Station publications.

Tech. Bul. 233 SOIL-SITE RELATIONS IN FORESTRY: SOIL FACTORS AFFECTING THE GROWTH OF QUAKING ASPEN FORESTS IN THE LAKE STATES.
Tech. Bul. 234 EARLY GENERATION SELECTION FOR HIGH OIL CONTENT AND HIGH OIL QUALITY IN FLAX.
Sta. Bul. 451 LABOR USED IN CATTLE FEEDING.
Misc. Rpt. 20 MATURITY RATINGS FOR CORN HYBRIDS IN MINNESOTA.
Misc. Rpt. 28 1959 MINNESOTA HYBRID CORN PERFORMANCE TRIALS.

The following publications will be available within the next month.

Tech. Bul. 235 AGRICULTURAL DROUGHT AND MOISTURE EXCESSES IN MINNESOTA.
Tech. Bul. 236 PROCESSING COSTS OF WHOLE MILK CREAMERIES.
Misc. Rpt. 38 MINNESOTA LANDSCAPE ARBORETUM.
Misc. Rpt. 39 CANOE COUNTRY VACATIONERS—A Report of Recreation in the Quetico-Superior.
Misc. Rpt. 40 GRAIN SORGHUM VARIETY AND HERBICIDE TRIALS IN MINNESOTA.

You can get these publications from your county agent or from the Bulletin Room, 3 Coffey Hall, Institute of Agriculture, University of Minnesota, St. Paul 1, Minnesota.