MINNESOTA
FARM AND HOME Science

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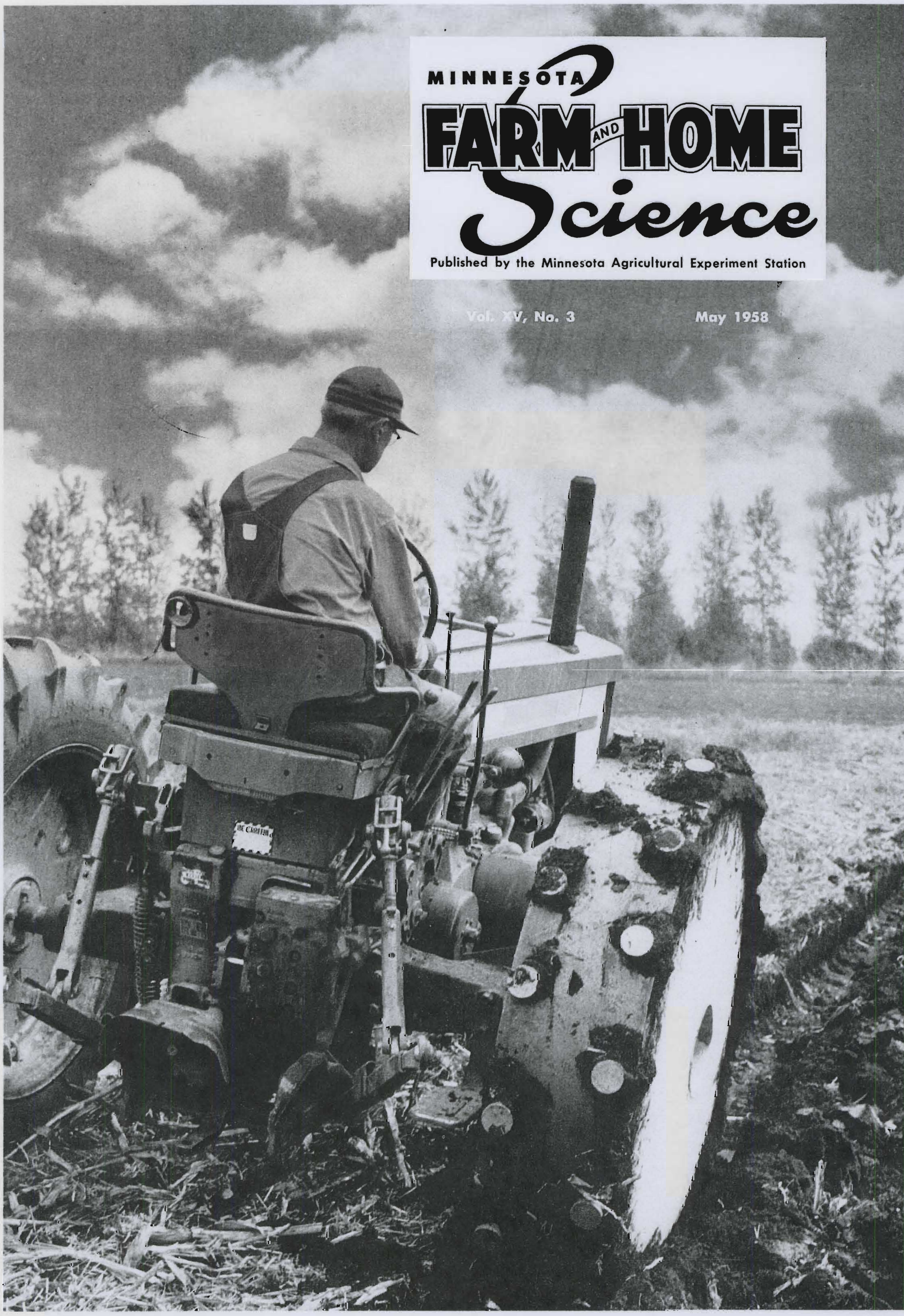

MINNESOTA FARM AND HOME Science

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May 1958

THE COVER—Not for ordinary farm use, this tractor with its special 2½-ton wheel aids the Soils Department's soil-compaction studies. In one test, the plow bottom was packed as shown here, surface soil packed by a truck loaded to bear 3½ tons on each rear dual wheel, and corn sown at 24,000 plants to the acre (thinned to 20,000). Corn yields per acre: on uncompacted soil, 84.1 bushels; surface soil only packed, 77 bushels; soil packed in the bottom of each plow furrow and on the surface, 72 bushels.

Minnesota's Men of Science

Editor's Note—This is the twenty-sixth in a series of articles introducing scientists of the University of Minnesota's Institute of Agriculture. Here we present Lowry Nelson, head of rural sociology.

Perhaps no name is better known in the field of rural sociology than that of Minnesota's Lowry Nelson. We would not be amiss by calling him "Mr. Rural Sociology" because his accomplishments are many and his fame widespread. Much of this recognition comes as a result of his work in rural community organization and in population trends and problems. On June 30, 1958, Nelson will retire from the University after 21 years of service to the University and to Minnesota.

Nelson's career has been a varied one, with experience in many fields. A native of Ferron, Utah, he received his B.S. degree from Utah State Agricultural College. Later he earned his M.S. and Ph.D. degrees from the University of Wisconsin.

Lowry Nelson

Much of his early career was centered in his home state of Utah. First he served as secretary to the president of the Utah State Agricultural College, as county agricultural agent, Sanpete county, and as assistant state leader of county agent work.

In 1921 he shifted fields to become editor of the *Utah Farmer*, state farm magazine. Two years later he joined the staff of Brigham Young University, Provo, Utah, as director of the University Extension Division, serving from 1923 to 1934. In 1929 he was also made Dean of the College of Applied Science, holding both positions from then until 1934.

He organized the social welfare division in the Utah Emergency Relief administration, 1934; was regional adviser for the rural rehabilitation division of the Federal Emergency Relief Administration, covering Utah, Nevada, California, and Arizona, from December 1934 to June 1935; Assistant Director, Rural Rehabilitation Division, Resettlement Administration, Washington, D. C., 1935-36; and Director, Utah Agricultural Experiment Station, 1936-37.

He has had several overseas assignments. In 1938 he attended, as the U. S. member, the first meeting of the Permanent Agricultural Committee of the International Labor Organization at Geneva, and has attended subsequent conferences in 1947 and 1949. In 1945 and 1946, he was a rural sociologist for the U. S. Department of State and made a study of Caribbean rural life. In 1954 and 1955, he studied Italian rural life under a Fulbright Research award.

He was a member of the President's Farm Tenancy Committee in 1936 which drafted the recommendation that Congress create the Farm Security Administration. In 1952, he was a consultant for the Ford Foundation to study the problem of evaluating technical assistance in Latin America, and in 1957 was a consultant for the International Cooperation Administration on special assignment in Brazil.

He is a member of several honorary and professional groups, including the Rural Sociological Society (past president); American Association for the Advancement of Science (fellow and former vice-president); American Sociological Society; Utah Academy of Science (past president); Minnesota Academy of Science; Population Association of America; Midwest Sociological Society; and others.

He is the author of several books including *Rural Sociology*, published in 1948, with a second edition in 1955; *Rural Cuba*, 1950; *The Mormon Village*, in 1952; and *American Farm Life*, in 1954. In addition he has written many bulletins and journal papers.

Plastic Greenhouses

R. E. WIDMER

GLASS GREENHOUSES require a relatively high initial investment. Greenhouses covered with plastic film provide a relatively low cost structure. Are they practical? This is a question asked by many hobbyists, vegetable growers, florists, and others.

A test structure was constructed on the St. Paul campus, University of Minnesota, in the fall of 1955 to help determine how practical such a structure would be in Minnesota. Construction details of plastic film greenhouses vary greatly but most of them have an all wood framework. In the case of the University structure, all side posts were imbedded in concrete and parts of the structure near the ground line were treated with copper naphthanate wood preservative. Wooden rafters, 2 by 2 inches, were spaced 2 feet apart on centers. The sill at the ground line and all other sills and side posts were of 2 x 4 stock. Corners were of 4 x 4-inch material. Vents were in each end just under the ridge and in the side walls. Plastic film was applied to the structure early in October of each year.

Which Plastic Film?

A major question is which plastic film should be used. Cellulose and plastic films which contain cotton or wire mesh generally cut out too much light, especially in winter or early spring. For that reason, only films which contained no reinforcing mesh were considered. We have tried several thicknesses and types with the following results:

Two-mil (0.002 inch) polyethylene. Held up fine through the winter and spring. Holes appeared in early July.

Four-mil (0.004 inch) polyethylene. Holes developed from late July until September.

Six-mil (0.006 inch) polyethylene. Holes developed in some sections in September. Other sections lasted until as late as December in the second winter.

Five-mil (0.005 inch) Polyflex (Sisal-Glaze.) Some sections broke out within four months, others are still intact after 17 months.

Polyethylene, in general, lasted well for one season, if applied in the fall, but it deteriorated rapidly when exposed to the summer sun and heat.

Three additional plastic films are currently under test. All plastic has been fastened down with wood lath and nails, but we are now testing a double faced adhesive film as well. Solvent adhesives advocated for use with some of the plastics have not been very satisfactory.

Other Factors

Since these plastic films are pervious to gases but not to moisture, the plastic structures are usually tighter than the glass houses with their tiny openings wherever the glass overlaps. As a result, considerable condensation takes place on the inside and proper as well as adequate ventilation is essential. The use of exhaust fans or a ridge vent is advisable.

Snow seems to slide off the plastic quicker than off glass and as a result, even the thinnest film tried in our tests has been fully satisfactory. It should be pointed out, however, that the angle of the roof in the plastic covered structure is 40 degrees and that the past few winters have not brought any real heavy snowfalls.

Heating is relatively easy because of the tightness of the structure. The test structure was heated with an LP gas burning perimeter heater. Heat is distributed around the perimeter of the greenhouse in 4-inch galvanized stove pipe which is vented to the outside on the end opposite the heater. A second layer of plastic applied to the inside of the rafters reduces the heat requirement further by providing an insulation area of dead air space.

TEST STRUCTURE built in the fall of 1955. Several different thicknesses and types of plastic film have since been tested.

Light intensity will vary with the type of plastic film used. A double layer of polyethylene reduced the light intensity by about 10 percent compared to that in the glass house. Sisal-Glaze did not reduce the intensity to any extent. A wide variety of good quality bedding plants as well as chrysanthemums have been grown in the University structure.

Discussion and Conclusions

Based on the observations of the past 2½ years, it is evident that good quality plants may be grown in plastic film greenhouses. In view of the fact that condensation on the plants and on the inside surface of the plastic itself is a serious problem, exhaust fans or a ventilator along the ridge are highly desirable.

Observation on our campus, at commercial establishments in Minnesota and by other universities indicate that we still do not have a relatively low priced plastic film which has been thoroughly tested over a period of years for use as a greenhouse covering. Frequent replacement of the plastic film is expensive, especially in terms of labor required. Until a reasonable plastic film with long lasting qualities and other desirable qualities for use as a greenhouse covering is available, we must conclude that the glass greenhouse is still the better investment over a period of years. A plastic greenhouse would seem preferable where a temporary

(Continued on page 5)

How practical are "plastic greenhouses" for Minnesota? Here's a report on what a University horticulturist has learned from two-and-a-half years experience with a test structure on the St. Paul Campus.

R. E. Widmer is assistant professor, Department of Horticulture.

KEEPING A FINGER ON THE PULSE OF AGRICULTURE: 57 YEARS OF FARM ACCOUNTING RECORDS

G. A. POND and T. R. NODLAND

AT THE TURN of the twentieth century two far-sighted pioneers in agricultural research, Andrew Boss and Willet M. Hays, saw the need for more precise information about farm costs, farm incomes, and farm production. They felt this information would serve as a guide in planning more profitable farm organizations. They wanted a check on changing farm practices and the effect of these changes on farm production and farm profits. Consequently in 1902, they organized groups of farmers, in three type-of-farming areas, who were willing to permit the University to keep accounting records on their farms.

This pioneer farm accounting was the first organized farm management research work in the United States. With the exception of similar work started a few years earlier in Switzerland, it was the first in the world. This was the first official recognition of farming as a business and of the need for more information about the economics of farming.

Before this the major, if not the sole emphasis, in agricultural research was on the technical rather than on the managerial aspects of agriculture. Except for 1918 and 1919, when this work was suspended because of World War I, the University has carried on these farm accounting studies continuously.

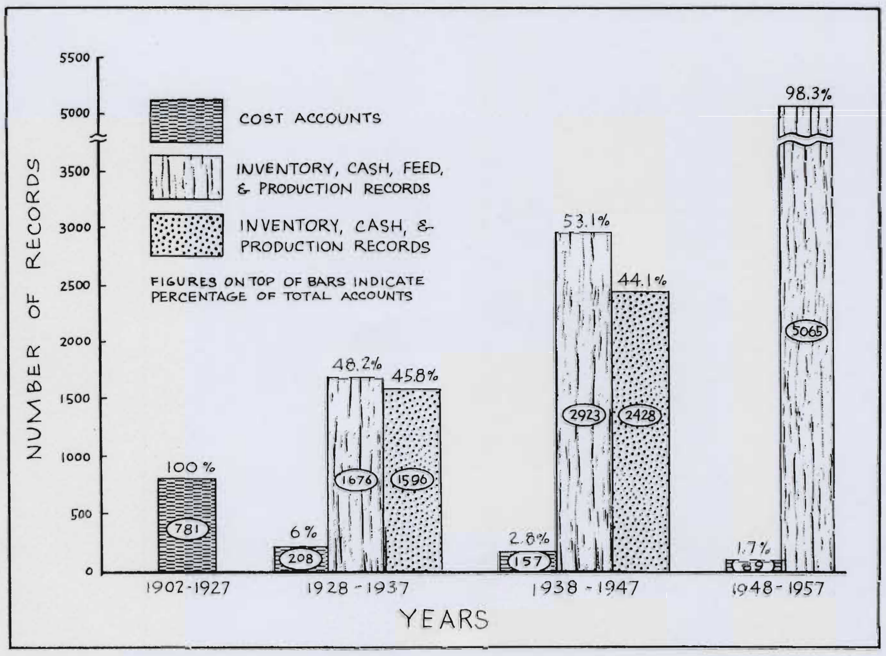

Fig. 1. Numbers and different kinds of farm accounting research records kept by cooperating farmers under the Minnesota program, from 1902 through 1957.

Types of Records Kept

For the first 27 years the records kept were all cost accounting records. During the first two years they included only crop costs, but since then have covered the entire farm business. Cost accounting records provide a wealth of useful information about the farm business, but they are expensive and time consuming.

Starting in 1928 a simpler type of record was tried. This included a complete record of farm inventories, farm receipts and expenses, feed distribution to each class of livestock, crop and livestock production, and farm practice records. There has been an increasing emphasis on this type of record.

In 1936 a still simpler type of record was adopted. This included only inventories, cash receipts and expenses, and some production records. These were the least expensive to supervise and analyze. They made it possible to increase greatly the number of farms that could be covered but they provided relatively little research information, and their use for research has been dropped gradually.

The development of farm records as a research tool shows a steady trend toward the "inventory, cash, feed, and production-record" type. It has gradually supplanted the other types of accounting studies, largely because of its low cost as a research tool. Farmers supplying the information are willing to contribute a substantial part of the costs because of the value of the results to them as a guide in their own farm businesses. It thus has become a combination of extension, research, and individual accounting service.

The Need for Good Records

The extensive array of new farming techniques makes it increasingly necessary to have accurate records to indicate whether or not their adoption

The University of Minnesota has the distinction of carrying on the first organized farm management research in the United States. Here two men connected with this work for many years tell about the progress in the field.

G. A. Pond is professor, and T. R. Nodland, assistant professor, Department of Agricultural Economics.

is proving profitable. Farms are increasing in size and complexity, and records are needed to check results and locate leaks in the farm business.

Since records are also required as a basis for income tax returns, the farmer has an additional incentive to keep farm accounts. The "granary door" is no longer adequate to record the facts the farmer needs to know about his business.

The farmers' current willingness to share the cost of these farm record studies contrasts sharply with the attitude of farmers back in the first decade of the century. At that time they demanded pay for recording their receipts and expenses and supplying the information to the farm management researchers.

Farmers cooperating with Department of Agricultural Economics and the Agricultural Extension Service in supporting their farm accounting studies have set up their own organizations—the Southeast Minnesota Farm Management Association and the Southwest Minnesota Farm Management Association—to handle their records on a cooperative basis. The Southeast Association has completed 30 years of work and the Southwest Association 18 years. Other groups made up of adult members of vocational agriculture classes have been included in similar cooperative farm accounting studies with the Department of Agricultural Economics.

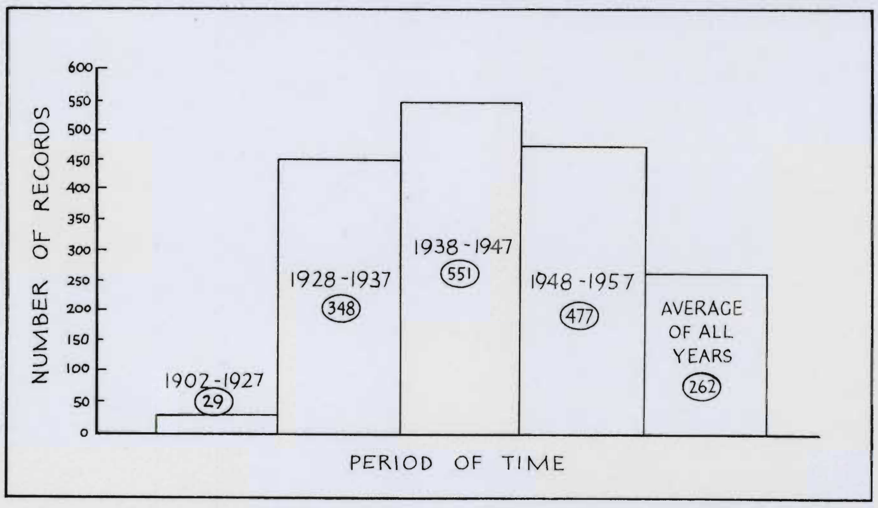

Fig. 3. Average number of farm accounting research records per year, 1902 through 1957. The periods are explained in the text and illustrated in Fig. 1.

Records Prove Their Value

Farm records provide a wealth of information about farm costs, farmers' earnings, and a wide variety of data needed in farm planning. Association members are representative of the types of farming in the areas covered. In general, their farms are somewhat larger in acres and volume of business than the average farm of the area. Since farm size is increasing rapidly, more information is needed about larger farms.

These records serve as a "barometer" to record current changes in farm costs, incomes, production, practices, and organization.

They provide data needed in various types of research in agriculture as well as factual information and illustrations for resident and extension teaching.

Because of the flood of new techniques now crowding their way into the current farm picture these records are of unusual value. In fact, more detailed information is needed than ever before and more records of the cost account type especially are needed to provide the guidance farmers are seeking from the University of Minnesota Institute of Agriculture.

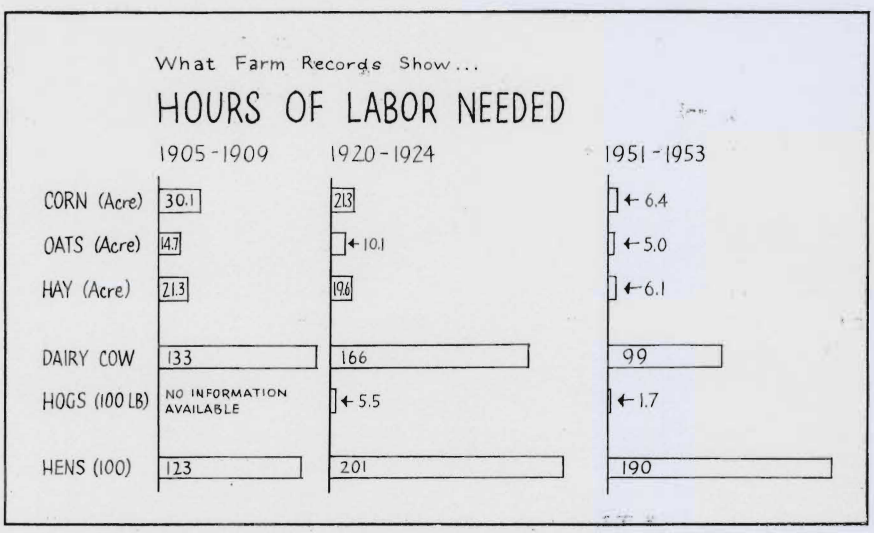

Fig. 2. One example of the type of information provided by farm records, valuable both to agricultural research of many kinds and farm planning programs.

PLASTIC GREENHOUSES

(Continued from page 3)

structure is desired, where the greenhouse is used during part of the year only, in areas of especially high tax rates or in similar situations.

Persons interested in a small greenhouse as a hobby may wish to consider an idea developed at Cornell University. The plastic film is applied directly to removable sections or frames. The frames, which are covered with polyethylene, are stored away from the direct rays of the sun and extreme heat in the summer. In this way the plastic lasts for more than one season in satisfactory condition. This procedure which opens up the greenhouse during the warm season of the year may or may not be satisfactory to the hobbyist, depending on how the greenhouse is used. It also involves the need for additional work and storage space.

Unfortunately, some persons unacquainted with the culture of plants in greenhouses look upon the plastic greenhouse as a means of making a good income with a limited investment. Just as much, if not more, knowledge and experience are required to grow good crops in a plastic greenhouse as are needed to grow them in a conventional greenhouse.

THE CONTROL OF BOVINE MASTITIS

K. I. LOKEN and H. H. HOYT

THE ADVENT of the "antibiotic era" was regarded by many as the end of all of our problems with mastitis in dairy cattle. This assumption was incorrect, and mastitis continues to be a major source of economic loss to the dairyman.

To understand why it continues to be a major problem, we must define what we mean by mastitis. Mastitis is a nonspecific term meaning inflammation of the mammary gland.

It must be emphasized that not all cases of mastitis have the same cause, therefore all mastitis problems cannot be handled alike. Much of what is written and said about mastitis is concerned with the possibility of finding "a cure" for mastitis, but when we remember that mastitis has a variety of causes it becomes evident that there will never be a single treatment which will be effective in all cases.

Causes

Mastitis is influenced by factors which lower the cow's resistance to infection (predisposing causes) and caused by microorganisms which infect the mammary gland.

The factors which tend to lower the resistance of the udder to infection include injuries, high production, improper milking procedures, chilling, poor sanitation, certain undesirable udder conformations, and several others. The udder seems to be more susceptible to infection shortly after the cow freshens.

A large number of microorganisms can cause mastitis. However, some of these are much more common than others. Over 90 percent of chronic mastitis is caused by several varieties and strains of streptococci and staphylococci. Other organisms which may be incriminated include *Pseudomonas sp.*, *Klebsiella sp.*, *E. Coli,* and various yeasts. Some of these microorganisms may infect the udder only when its resistance is lowered by one of the predisposing factors. Others can infect an udder which has not been weakened by any of these factors.

Appearance

The appearance of a cow with mastitis varies considerably depending on the severity of the inflammation. We speak of the more severe cases as **acute mastitis** in which one or more quarters of the udder are hot and swollen, the milk is visibly abnormal, and the cow may exhibit a systemic reaction. Acute mastitis usually develops quickly and may occasionally result in the death of the animal. Acute mastitis is easily recognized.

Milder forms of mastitis or **chronic mastitis** are more difficult to recognize. In many cases the only evidence that mastitis is present is the occasional appearance of small flakes or clots in the milk. Various chemical and bacteriological tests are often necessary to detect chronic infection.

Chronic mastitis often persists through several lactation periods, during which the secretory tissue of the udder is gradually replaced by scar tissue, thus lowering the milk producing capacity of the cow. Because chronic mastitis is not very dramatic, it may often be overlooked although the economic loss from lowered production may be very great.

Control Measures

The control of mastitis in different herds cannot always be accomplished by the same means. We cannot state that mastitis can be controlled by careful attention to management alone nor can we hope to control all herd problems by treatment.

In many cases an important reason for the lack of success of treatment has been the fact that cows have been treated on an individual basis without regard to the over-all herd picture. It is necessary to examine the entire herd when a mastitis problem exists since there may be certain animals which carry a very low-grade infection. Although these cows may show no signs of mastitis themselves, they may serve as a source of infection for other animals. Various chemical and bacteriological tests are often necessary to detect these "carrier" animals.

One can reduce the spread of mastitis within a herd by adjusting the milking order so that the young cows are milked first, the older cows next, and the infected cows last. Younger cows should be milked first because a higher percentage of old cows carry chronic infections.

Management Factors

In addition to selective treatment within a herd, good management is necessary in a control program. Proper care and sanitation of the milking machine is very important. The milker should be kept repaired and adjusted to the manufacturers specifications. The cow should be stimulated to insure milk let-down prior to milking and milked out as rapidly as possible. Such management factors as general barn sanitation, proper bedding and stall size, and daily use of the strip cup to aid in earlier detection of mastitis are also important. Careless administration of udder infusions may introduce yeasts and other organisms into the udder which may produce additional mastitis problems.

Conclusions

Many have adopted the philosophical viewpoint that mastitis is here to stay and there is very little that can be done about it. Because mastitis is a complex of various factors which affect the mammary gland, it may be it cannot be eradicated completely.

We can, however, considerably reduce the economic loss due to this disease by applying the knowledge which we now have. For example, streptococcal mastitis can be readily controlled by the application of bacteriological tests and treatment of infected cows, and many mastitis problems can be reduced by adjusting the milking order, sanitation, and other management improvements.

Future research will no doubt improve our ability to control mastitis problems. At the same time we are not making full use of our present knowledge. Consequently, we can reduce our economic loss considerably by applying this knowledge.

K. I. Loken is research fellow, and H. H. Hoyt, professor and head, Division of Veterinary Medicine and Clinics, College of Veterinary Medicine.

Cockroaches Serve Science

MARION A. BROOKS

MOST PEOPLE think of insects as pests to be eradicated as efficiently as possible. As if by reflex, we slap, swat, step on, spray, or screen out all insects we see. We know of the millions of dollars' worth of damage that insects do to farm crops and livestock. So it is small wonder that taxpayers believe that entomologists should devote their time and energy exclusively to controlling insect pests.

It comes as a surprise, then, to some people to learn that there are entomologists who are not directly concerned with control, but who actually raise insects with tender care. Some of the insects are most obnoxious; for example, cockroaches. It is with cockroaches that this article is concerned.

A cockroach performs all of the bodily functions of other animals, such as eating, walking, and egg-laying. To do these things, the body is made up of nerves, eyes, and other sense organs; a mouth and a digestive tract; muscles, skin, and reproductive organs. The blood, enzymes, and cell fluids are similar to those of more familiar animals.

Marion A. Brooks is an instructor, Department of Entomology and Economic Zoology.

Since the cockroach is similar to other living things, it is useful in research. In fact, it has several advantages:

First, a cockroach is small and therefore does not require much space or food. This makes it inexpensive to maintain.

Second, its life span is short—one generation can be completed in anywhere from 3 to 18 months, depending on the species. Thus we are able to compile data on genetics, breeding, or long-term nutritional effects in a relatively short time.

Finally, cockroaches are harmless and easy to handle.

In short, a cockroach is a convenient experimental animal. We may now turn to some of the specific problems for which we researchers use these insects.

Of direct interest is the study of the effects of insecticides. All of the processes the insecticide goes through in penetrating the body can be followed in a step-wise manner in one of the large species of cockroach. The information gained from this can be applied to smaller insects, such as aphids or leafhoppers, which are of more economic importance.

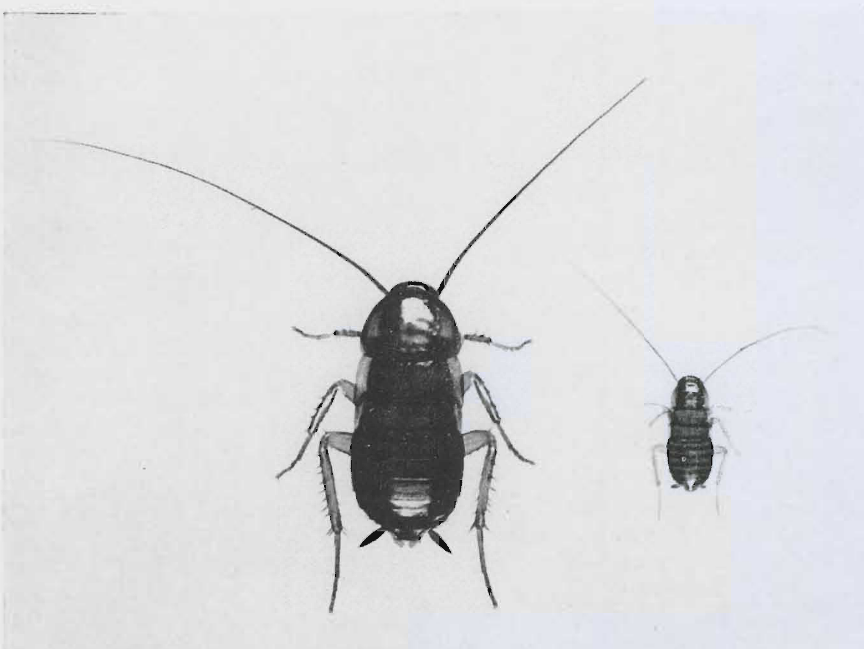

Fig. 1. Cockroaches on controlled diets can aid nutritional research. An "optimum" diet produced the insect on the left; an inadequate diet, the one on the right.

Muscle Action

Of less obvious interest is the study of muscle action. Any farm boy knows that a cat can run as fast on a cold day as on a hot day but that a frog or a turtle moves more and more slowly as the autumn days grow colder. Insects are in the same category with the cold-blooded frogs and turtles. The speed of their muscular movements is affected by the air or water temperature. Even so, the structure of the muscles of cockroaches is similar to that of warm-blooded animals, being composed of long fibers joined together in bundles. The enzymes, which cause the muscles to contract and relax thus producing motion, are in general the same as in warm-blooded animals.

Altogether, the likenesses as well as the peculiarities of cockroach muscle are useful in giving us a better understanding of muscle action in general. For this reason, we have studied the effects of temperature, of metallic ions, of poisons, and of age on cockroaches. One of our findings was that the pink muscles in the adult male's legs use much more oxygen during respiration than do the white muscles next to them. Furthermore, the pink muscles have not always been pink. In immature roaches and in young adults—that is, for the first 2 or 3 days after molting to the winged stage—all of the muscles are white and use relatively little oxygen. With the development of the pink color during the next few days, the oxygen consumption rises abruptly.

We are continuing to attempt to extract the substance responsible for the color. If we can extract the substance in pure form, we can study its effect on the ability of muscle to do work and to withstand fatigue. This may give researchers valuable clues to muscular fatigue in animals and man.

Nutrition

Another aspect of insect physiology which is poorly understood is that of nutrition. Most insects will eat only one, or at most a few, host plants, and will starve to death rather than eat something different. But cockroaches in cages in the laboratory are accessible for study all around the year. Moreover, they will eat almost anything. This latter point is very important.

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New Varieties of Farm Crops for 1958

CARL BORGESON

FOUR NEW CROP varieties, developed by agricultural experiment stations in the United States and Canada, are making their official appearance in Minnesota this year.

One of them, Arny flax, is on the recommended list approved by the Minnesota Agricultural Experiment Station. Two others, Burnett oats and Comet soybeans, are promising but must be tested further before the Station can take action on them. The fourth is an addition to the Station's open-pedigree corn hybrids, Minnhybrid 416.

How do these varieties get their names? How are they distributed? These are the questions we are frequently asked.

Some varieties are named after well-known agronomists, such as the late Professor A. C. Arny of Minnesota or the late Professor L. C. Burnett of Iowa. Others are given numerical designations or an appropriate name by the Station developing them.

Seed Distribution

County seed distribution committees allot seed of new varieties distributed through agricultural experiment stations. In Minnesota, the new varieties other than Minhybrid 416 corn will be distributed in this way:

Variety	Number of counties	Total seed allotted: Foundation	Total seed allotted: Registered
		(bushels)	
Arny flax	33	240	250
Burnett oats	69	312	3,188
Comet soybeans	56	200	1,560

Our policies on these allotments are as follows:

1. The allotments per county were based on the number of registered seed growers, approved growers, and average production of the crop within the county during the past 3 years for which information was available. Distribution of Comet seed was limited to the counties south of the Northern Maturity Zone.

2. The minimum and maximum number of bushels allotted per grower was as follows: **Arny flax**—minimum, 20; maximum, foundation, 20; maximum, registered, 30. **Burnett oats**—minimum, 24; maximum, foundation, 45; maximum, registered, 90. **Comet soybeans**—minimum, 10; maximum, foundation, 20; maximum, registered, 30.

3. Individual growers were selected this way. Only registered growers could be allotted foundation seed. Growers were assigned registered seed in this order of priority:

a. Registered growers with good production records for the crop involved.

b. Other registered growers.

c. Other approved growers with good seed production records.

d. Farmers who were not approved growers but who would do a good job of seed production. In this instance, seed is allotted only after requests from growers in other counties qualifying under a, b, and c, have been met.

4. All growers allotted seed must sign a Memorandum of Agreement with the experiment station.

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

Description of Varieties

MINHYBRID 416

In addition to the three varieties distributed through county committees, hybrid seed corn producers will have available crossing stocks for a new Minhybrid for southern Minnesota, Minhybrid 416.

This new yellow-dent hybrid has a maturity rating of 108-112 days and is well-adapted to the southern zone. It is high yielding and has good resistance to both root and stalk lodging. It has a high percentage of good ears per plant, is resistant to smut, carries its ears well, and husks readily.

Its pedigree is (Oh51A x A264) (A257 x A375). Double cross seed will be available from growers at the end of this season.

ARNY (C.I.1658) FLAX

This variety was developed through the cooperation of the Crops Research Division, Agricultural Research Service, of the United States Department of Agriculture, and the Minnesota Agricultural Experiment Station.

Arny is a selection for improved oil content and oil quality out of C.I. 1559. C.I.1559 was a selection from a cross of Crystal x Redson made at the University of Minnesota. Fifty selections of C.I.1559 were grown in 1955. Eleven of the 50 selections were removed in the field. The remainder were tested for oil content and iodine number. Seed of selections that were fairly uniformly high in oil and iodine number was bulked.

The variety was named after the late Professor A. C. Arny, long-time agronomist and flax specialist at the University of Minnesota.

Arny is a blue-flowered variety with medium-sized brown seeds. It is about 4 days later than Marine and 1 day later than B5128. It does not have any yield advantage over the other recommended varieties in Minnesota of about similar maturity (B5128 and Redwood). The variety is slightly taller than the recommended varieties and is similar in test weight. It has good resistance to lodging.

In oil quality, it is slightly higher in iodine value than B5128 and Redwood but somewhat lower than Marine. It is very similar to the recommended varieties in oil content.

In disease reaction, Arny is immune to prevalent races of flax rust and has a type of resistance not contained in the varieties Redwood and B5128. It is quite superior to the recommended varieties in resistance to wilt. It is as resistant to pasmo as Marine.

Other flax-growing states have had Arny in test, and North and South Dakota and Wisconsin have increased seed for distribution.

BURNETT OATS

Burnett, at present, is in the "Not adequately tested" group of varieties. It was developed at the Iowa Agricultural Experiment Station in cooperation with the United States Department of Agriculture. It is a selection from the cross [(Victoria x (Hajira x Banner)] x Colo. The name was selected in honor of the late L. C. Burnett, cereal crop breeder at the Iowa Station.

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Revolution in Fertilizer Nitrogen

JOHN M. MacGREGOR

DURING THE PAST TEN YEARS, Minnesota farmers have tripled their total fertilizer consumption. At the same time, the average concentration of plant food in these fertilizers has increased from 26 to 43 percent. Thus, in this period, the *actual plant food content* of the fertilizers applied to Minnesota soils increased from 26,825 tons to 178,080 tons—or a 665 percent increase in one decade.

Although impressive, this rate of increase was partly brought about by the increased supply and crop productive effect of fertilizer nitrogen, which increased from 4,500 tons in 1947 to 37,000 tons in 1957, or a 822 percent increase for the period. The greater usage of a more effective balance of plant nutrients, made possible by synthetically produced nitrogen, has increased crop yield and lowered the unit cost of production.

Where It Comes From

The rapid increase in the supply and consumption of fertilizer nitrogen was not an accident. The foundations were laid 60 years ago by two research chemists working in Germany, where nitrogen compounds were in great demand for both agricultural and military purposes. They developed the first process whereby nitrogen could be extracted from the air (almost four-fifths of our atmosphere is nitrogen). Then, by use of high temperatures and pressures in the presence of a catalyst, they were able to combine the relatively inert nitrogen with other elements into relatively stable and useful compounds.

Ten years later an improved method of synthetic nitrogen production was developed. However, it was not until 1922 that the first nitrogen plant was built in the United States. It was followed by others, so that by 1946 most of our fertilizer nitrogen was being obtained directly from the air. At present more than 60 mammoth industrial plants scattered over the United States take nearly 4,000,000 tons of nitrogen annually from the air, to be largely used as fertilizer.

Nitrogen has been a part of many mixed fertilizers in Minnesota for many years. Originally it was supplied in organic forms such as tankage, dried blood, or cottonseed and other meals. Sodium nitrate (Chile saltpeter) never became a popular source of nitrogen in Minnesota (unlike the southeastern United States), largely because of transportation cost. Ammonium sulfate, a by-product of coke production, gradually replaced organic nitrogen in mixed fertilizer goods, largely because of lower unit cost and higher concentration. Essentially all of the nitrogen in mixed or chemical fertilizers now popular in Minnesota is obtained directly from atmospheric nitrogen.

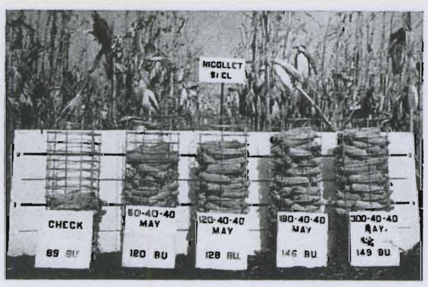


Fig. 1. Effect of nitrogen, phosphate, and potash on the 1956 yield of third-year corn in a McLeod County test plot.

Why It's Needed

Originally most of agricultural soils of Minnesota were well supplied with organic matter and available nitrogen. Nearly a century of cultivation gradually depleted the active organic matter and the available nitrogen content. It was shown over 50 years ago that many soils needed phosphorous for good legume production. The relatively slow deterioration of the organic matter and persistance of the dark color in most soils was misleading to most agriculturalists.

The slow appreciation of the need for fertilizer nitrogen is evident, since as late as 1948 the most popular mixed fertilizer in Minnesota was 2-12-6. Application rates were usually less than 100 pounds per acre (1 or 2 pounds of fertilizer nitrogen per acre) and nitrogen sidedressing was then a novelty. The growing of legumes and applying farm manure was the backbone of fertility management.

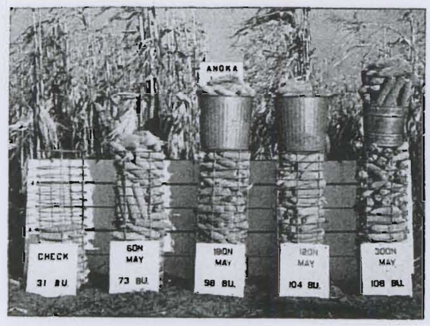


Fig. 2. Effect of nitrogen on the 1956 corn yield in an Isanti County test plot.

Then, about 10 years ago, high-quality ammonium nitrate fertilizer became available. Field experiments on non-legume crops also proved beyond all doubt that a deficiency of available nitrogen was limiting crop production on some of the best agricultural soils in Minnesota. The resulting demand for fertilizer nitrogen exceeded the supply for another five years. The supply was rapidly increased, however, so that during the past four years the Minnesota farmer has been able to select the type of nitrogen fertilizer which best fills his need.

Sixteen nutrient elements are now known to be essential for normal plant growth. Nearly three-quarters of the cultivated farm land in Minnesota is presently used for growing non-legume crops, and nitrogen is removed from the soil in varying amount by all of them. Nitrogen is also known to be the most transitory of all the essential nutrient elements. It can be leached from the soil, or it can escape as a gas, or it may be converted into forms only slightly available to plants.

Much Yet to Learn About It

Experiments with fertilizer nitrogen conducted by the Department of Soils have been largely concerned with efficient field use—such as rate

(Continued on next page)

John M. MacGregor is professor, Department of Soils.

(Continued from preceding page)

of application, time of application, source or type of nitrogen, placement, and residual effect on the yield and composition of crops. In general, there have been substantial increases in crop yield and protein content where a deficiency of available nitrogen was evidently limiting plant growth. (See figures 1 and 2.)

Also there have been some field experiments where the application of nitrogen has not been effective for increasing plant growth when it should normally be expected (figure 3).

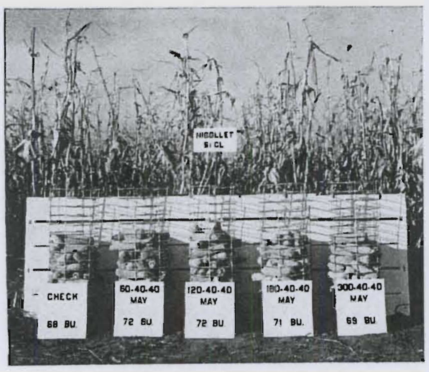


Fig. 3. Applying nitrogen, phosphate, and potash had little effect on this mediocre corn yield on a productive agricultural soil in Redwood County, 1955.

Such occasional failures of fertilizer nitrogen to effectively increase non-legume crop yields on some soils points up a gap in our present information. We need to make fundamental studies of nitrogen behavior under the varied conditions and soils where it is used. Such research could be of great value to the farmers of Minnesota.

How Much More Could We Use?

During the past two years, the increase in consumption of fertilizer nitrogen has slowed from the tremendous rise of a few years ago. This raises the question of how much fertilizer nitrogen could be effectively used in Minnesota in future years. Let us look at the rate of withdrawal of nitrogen from our soils on two of our most important crops—field corn, and grass hay or pastures.

The nearly 6,000,000 acres of corn, with average yields of about 50 bushels per acre, is removing at least 150,000 tons of nitrogen annually from Minnesota soils. This is partly replaced by growing legumes and applying the available farm manure. In addition to this, a few pounds of nitrogen is brought down by rain and some is fixed by soil microorganisms. However, on the average, our corn crop is probably removing twice as much nitrogen from the soil as that being returned.

Approximately 6,000,000 acres of non-legume pasture and hay remove another 150,000 tons of nitrogen annually from our soil. Even with the return of manure, much less than half of this nitrogen is returned to the soil.

Since none of the fertilizer nutrients reach maximum efficiency (100 percent taken up by plants) it can be reasonably assumed that the soils of the state are being depleted of at least 250,000 tons of nitrogen annually. This is a minimum of seven times the annual consumption of nitrogen now being used.

NEW CROP VARIETIES

(Continued from page 8)

The seed of Burnett is yellowish-white, is large and plump, and has good test weight. The variety is medium in height and maturity and has good straw strength.

Burnett was in field plot tests in Minnesota in 1957 and compared favorably in yield with the recommended varieties.

In disease reaction, it is resistant to all races of stem rust except 7A. It is resistant to the smuts but moderately susceptible to crown rust.

The Iowa Station made seed available to the other interested states and distributed seed under contract to Iowa growers in 1957.

COMET SOYBEANS

Comet, at present, is in the "Not adequately tested" group of varieties. This is an early variety, developed at the Central Experimental Farm, Ottawa, Canada, from a cross of Pagoda x Mandarin.

In cooperative regional trials including tests at Saint Paul, Morris, and Crookston, Comet has averaged 1 or 2 days earlier than Ottawa Mandarin, is several inches taller, is similar in yield and standing ability, and is slightly higher in oil content. The variety has been tested in Minnesota field plots 2 years.

From the results of tests thus far, Comet has most promise as a variety for late planting in the southern and south central zones. It should also prove useful as a relatively high-yielding variety for early harvest in these zones.

Comet has medium-sized, yellow seed with a colorless hilum.

Some seed has been brought in and produced with Certified No. 2 classification.

COCKROACHES

(Continued from page 7)

We can formulate diets for which we know exactly all of the chemical ingredients. Then by omitting certain chemicals, we can observe the effect on growth, general health, and reproduction. It has been found in our physiology laboratory that minute or trace amounts of certain metals, specifically manganese and zinc, are important for egg-production.

At this point the picture becomes more complicated, because a cockroach is not just one simple animal, but a complex of insect-plus-bacteria. The bacteria, which live in the ovaries, the eggs, and the fat-body cells, provide vitamins necessary for proper growth and egg-production. When we omit manganese and zinc from the cockroach's diet, the bacteria are no longer found in the eggs. Eggs without bacteria usually cannot hatch. This raises the age-old question with a new twist—which came first, the bacteria or the egg?

Cockroaches are not unusual in containing bacteria or fungi since many species of insects have such associations. We would like to know more about the benefits that each organism renders the other. Cockroaches are like animated test tubes for this purpose because the bacteria involved in egg-production, in contrast to those found in the intestinal tract, have not been cultured on agar or broth in the laboratory. So far we can only study the requirements and synthetic abilities of the bacteria by growing them in the cockroaches. This situation is likewise similar to that of many disease-producing organisms and viruses which can be cultured only in other living tissues, such as the polio virus which is grown in monkey kidney cells.

Thus cockroaches serve science by being convenient experimental animals for the study of fundamental biological problems.

SPICES—Their Effect on Keeping Qualities of Food

J. R. CHIPAULT

THE WORD "SPICE" brings to the mind visions of paradise-like South Sea islands and of strange, exotic cities such as Zanzibar, Djidouti, and Tamatave. It suggests romantic tales of intrepid navigators who set sail on the Seven Seas in small ships to seek fortunes in the form of cloves, cinnamon, pepper, and nutmeg.

Indeed, spices were so important and so highly valued during the Middle Ages that domination of the spice trade by a nation opened for it the gate to riches and power. As far back as earliest civilization, spices influenced world history. In the search for spices, battles were fought, men won and lost empires, piracy flourished, new sea lanes were opened, and America was discovered.

Many Spices in Use Today

Although about 39 individual spices are known to the food industry today, not all of them find their way to the home spice collection.

The plant materials making up these spices contain fats, proteins, and carbohydrates. However, they are used in such small amounts that they may be considered as having no nutritional value and contributing no calories to the human diet.

Since prehistoric times, however, spices have been used by man to flavor and preserve his food. In addition, certain spices increase the secretion of saliva and other digestive juices and stimulate appetite and digestion.

Many spices prevent or retard the growth of food spoilage micro-organisms. Before the advent of modern methods of food preservation, spices were used as food preservatives, also. In many cases, however, the distinctive aromas of the spices undoubtedly simply masked unpleasant odors and flavors resulting from minor food decomposition.

Since natural spices are widely used in a variety of food products, we should know what effects they have on the keeping qualities of such products. We know that fats are present in variable amounts in most foods and are responsible for a type of deterioration known as rancidity. Recognizing this, researchers at the University's Hormel Institute studied the effect of 32 spices on the development of rancidity in fats and fatty foods.

Spices Delay Rancidity

All 32 delayed rancidity in lard samples. Some had only a slight effect, but others increased the stability of the lard by as much as 16 times.

We also used the lard to which spices had been added for piecrusts. By measuring the time necessary for the baked piecrust to become rancid, we found that the antioxidant power of many of the spices had been destroyed during preparation of the pastry, and that they had no effect on the stability of the piecrust.

With some spices antioxidant activity was only partly destroyed. These spices were still able to delay rancidity of the piecrust. Spices, however, are less effective in piecrust than in lard. With others, pro-oxidant effects developed, and rancidity actually speeded up. Among the spices which speeded up rancidity in piecrust were cardamon, cassia, cinnamon, coriander, cumin, dill, and fennel. Some of these sometimes are used to flavor breads, rolls, cakes, cookies, and pie fillings.

Meats and Salad Dressing

Spices are much more widely used in meats and salad dressing than in baked goods. We studied fresh sausage, mayonnaise, and a separating type of French dressing made essentially with oil and vinegar to represent these types of foods. We mixed the spice with food and measured the time necessary for the food to become rancid. The results are summarized in our table.

Allspice, cloves, rosemary, sage, and a spice mixture were outstanding in preventing development of rancidity in ground pork. The samples containing the spices were not rancid when the experiments were stopped after freezer storage of nearly 2 years. However, we only considered the effect of the spices on rancidity. Other changes, such as discoloration, drying, and the development of a stale, or old, odor and flavor made the samples stored for such a long period undesirable.

The most effective spice in mayonnaise was oregano. Mayonnaise containing it kept for nearly 6 months before it became rancid, while the sample of mayonnaise containing no spice was rancid at the end of 3 weeks. Cloves, rosemary, sage, and thyme approximately doubled the stability of mayonnaise.

None of the spices was very effective in French dressing, although

(Continued on page 13)

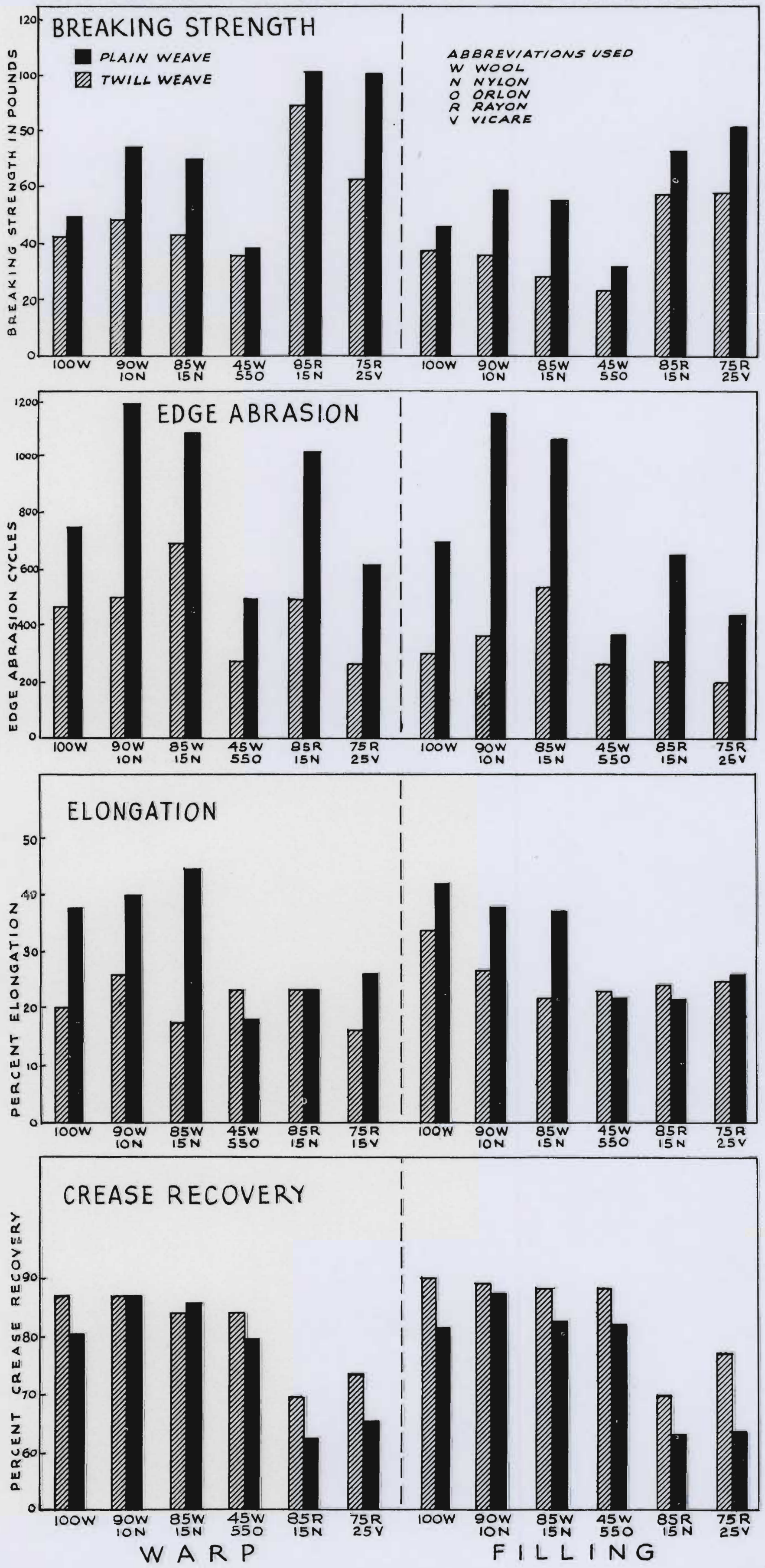
Time for rancidity to develop

Spice	Lard Hours at 209° F.	Pie Crust Hours at 145° F.	Sausage Weeks at 5° F.	Mayonnaise Days at 72° F.	French Dressing Days at 98° F.
None	6.5	78	9.7	21	23
Allspice	11.7	87	96.0+*	29	26
Cardamom	8.5	70	7.8	22	......
Cassia	9.1	74	6.8	22	......
Cinnamon	8.5	72	7.8	22	......
Cloves	11.7	103	96.0+*	42	46
Ginger	11.7	85	14.5	21	......
Mace	16.9	85	30.0	20	......
Mustard	13.0	109	10.7	20	......
Nutmeg	20.2	112	25.2	19	......
Oregano	24.7	252	36.0	181	62
Black pepper	9.1	85	9.7	21	......
White pepper	7.8	83	9.7	19	......
Rosemary	114.0	350	96.0+*	46	......
Sage	107.0	230	96.0+	51	52
Savory	10.4	92	9.7	31	......
Thyme	19.5	152	31.0	39	......
Turmeric	14.8	100	33.0	19	......
Mixture†	......	......	96.0+*	......	......

* The tests were stopped after 96 weeks and these samples were not rancid.
† Sage, black pepper, and red pepper.

J. R. Chipault is associate professor, Department of Agricultural Biochemistry, assigned to the Hormel Institute at Austin.

COMPARISONS OF DIFFERENT PLAIN AND TWILL WEAVE SUITINGS



SUITING QUALI

All-Wo

A BLENDED SUITING or an all-wool suiting—this is a choice which often faces consumers today. With many new fibers available and a multitude of fiber combinations possible, it becomes harder and harder to choose the fabric which is most satisfactory in appearance, comfort, durability, and economy. To answer these questions we need information about all-wool and blended suitings in ready-to-wear and yard goods.

The University of Minnesota and South Dakota Agricultural Experiment Stations have cooperated in a study of certain plain and twill weave suitings, both all-wool and blends of different fibers.

Chemical analyses of fiber content showed that 29 of the 33 suitings studied were within 0 to 8 percent of the amounts given by the manufacturer or retailer. One fabric labeled 80 percent wool-12 percent silk proved to be all wool. In three fabrics the wool content was 8 to 16 percent higher than indicated when purchased.

The May 1955 issue of MINNESOTA FARM AND HOME SCIENCE discussed some properties of plain weave blended suitings. This article compares durability, ease of care, and aesthetic qualities of different twill and plain weave suitings. Comparisons are limited to fabrics labeled with the same percentage fiber content.

As would be expected, the number of yarns per inch, the weight, and the thickness of the twill fabrics were higher than plain weave fabrics. Since the number and twist of the yarns vary with the individual fabric, no distinction in these properties can be made between the two types of weaves.

Durability

Durability is measured by a fabric's breaking strength (force required to break the fabric) and its ability to withstand abrasive wear, i.e. rubbing along folded edges or against flat surfaces. The latter is measured in the laboratory by the number of cycles required to wear away the fabric.

Blends Containing Newer Fibers

ΊSON, LILLIAN O. LUND, MARY ANN MORRIS, and ETHEL L. PHELPS

In all instances twills were higher than the plain weaves in breaking strength and resistance to abrasion (see chart).

The 45 wool-55 orlon fabric ranked the lowest in breaking strength. This fabric is among the lowest in count and weight and is made of yarns which are less tightly twisted. It is important then to know the structure as well as the fiber content. This material also was less resistant to edge abrasion and will show signs of wear at sleeve edges, skirt hem, or trousers cuffs sooner than a firmer fabric.

In comparing all-wool fabric and the wool-nylon blends the addition of 10 and 15 percent nylon to wool resulted in:

1. About equal increases in strength and resistance to abrasion for the twill fabrics.
2. Little change in the strength of the plain weave suitings.
3. Some increased resistance to edge abrasion in plain weave suitings.

The relationship between the amount of nylon and durability is not uniform, however. Some of the variation in the blended fabrics might be accounted for by differences in fabric structure.

Fabrics containing 75 and 85 percent rayon ranked highest in breaking strength. In resistance to abrasive type wear, however, the wool-nylon blends were superior to these two, followed in order by the rayon-nylon and the rayon-vicara fabrics.

Ease of Care

Resistance to wrinkling and the ease with which wrinkles fall out between wearings, the ability to retain the original appearance, the handle and feel of the fabric, and other aesthetic qualities are important to consumers.

In the laboratory these are studied through (1) **crease recovery,** a measure of the recovery of cloth from creasing during normal wear; **flex stiffness,** which influences the handle of the fabric and indicates softness; and **elongation,** a measure of the ability to stretch or the elasticity of the cloth.

In elongation and flex stiffness, many of the twill suitings were superior to those of plain weave (see chart).

In crease recovery, part or all-wool fabrics were superior (see chart) and the plain weave was as good or better than the twill weave.

Fabrics containing large amounts of rayon were lower in elongation and crease recovery and were higher in stiffness properties in some cases than the blends containing wool.

Appearance

The appearance or aesthetic character of a fabric is difficult to measure in the laboratory. Nevertheless, it is extremely important. Although a suiting fabric may be durable and easy to care for, it may not look good to the consumer and may, therefore, be unacceptable. Laboratory measurements, such as stiffness and crease recovery, will give indications of fabric characteristics that contribute to appearance.

These methods must be supplemented by personal judgment. The appearance of the suitings included in this report would rank the fabrics containing the larger amounts of wool highest in aesthetic properties. In addition, the twill weave wool and wool-nylon blended suitings were reasonably strong, resistant to edge abrasion, extensible, had good body or stiffness, and had high recovery from creasing.

Summary

1. Twills are more durable than plain weaves.
2. Adding as much as 10 to 15 percent nylon to wool strengthens suitings. This also increases resistance to edge wearing.
3. Wool-nylon blends, 75 rayon-25 wool, 85 rayon-15 wool, rayon-nylon, and rayon-vicara fabrics rank in that order in edge wearing.
4. Part-wool or all-wool fabrics are superior to the other combinations studied in crease recovery, and the plain weave is as good or better than the twill weave.
5. In general appearance, fibers with larger amounts of wool rank high.

Suzanne Davison is professor, School of Home Economics, University of Minnesota; Lillian O. Lund is associate home economist, South Dakota Agricultural Experiment Station; Mary Ann Morris is assistant professor, University of California, Berkeley; and Ethel L. Phelps is professor emeritus, University of Minnesota. Acknowledgment is made to Mildred L. Bell for the chemical analyses and other laboratory work.

SPICES AND FOODS

(Continued from page 11)

cloves, oregano, and sage doubled its storage life.

The results of our studies at the Hormel Institute indicate that in general spices tend to delay the development of rancidity in fats and fatty food. However, there are some exceptions, and some spices actually can speed up fat deterioration in certain food products.

The effectiveness of any spice depends largely on the nature of the product in which it is used. One of the more important lessons learned in our work was that it is impossible to predict the antioxidant property of spices in any given food from the results obtained in other products.

Oregano, rosemary, and sage were quite effective in all the foods in which they were tested. Cloves and allspice, however, which were very good in sausage, were relatively weak in the other food products. The reasons for these differences are not known.

We do know, however, that certain factors influence antioxidant activity. They include:

1. Type of fat—such as corn oil in mayonnaise and French dressing and animal fat in lard, piecrust, and sausage.
2. Presence of varying amounts of water.
3. Presence of other compounds such as proteins, salt, vinegar, and flour.
4. Temperature to which the product is subjected during either preparation or testing.

Bunker Silos

RODNEY A. BRIGGS, R. B. AAKRE, and C. K. OTIS

THE PRINCIPLE of crop preservation by making silage in air-tight earthern pits was practiced in ancient Greece. But to the modern livestock farmer, however, silage is comparatively new as a feed.

It is different from other common farm feeds in that it is moist, and that it has been preserved by a bacterial fermentation or by the addition of fermentation-inhibiting chemicals. It can be made from any green crop, corn, sorghum, small grains, grass and legumes, even weeds if necessary. To make silage there must be (1) the elimination of air, and (2) a proper fermentation or preservation.

Silos Serve a Dual Function

Unlike most farm buildings a silo has two functions to perform, processing and storage. The processing function is to eliminate air and to prevent oxidation and surface drying. The air must be kept out to insure an anerobic ("without oxygen") fermentation. The storage function is to store and maintain the silage in a stable form after the preservation process is completed.

There has been a growing demand for a convenient and economical method of storing silage on Minnesota farms. One result has been an increased interest in bunker silos.

In the spring of 1955, therefore, we arranged to have two experimental bunker silos constructed at the North Central Experiment Station, Grand Rapids, Minnesota. Our purpose was to study the construction, location, drainage, and problems related to quality loss and freezing in such silos. Each silo was 16 feet wide, 62 feet long, and 6 feet deep with a capacity of 120 tons of silage.

Construction Details

One silo was constructed with cantilever posts set in a concrete floor, 4 feet on center. The second silo had braced-post construction with the posts set outside the concrete floor, 6 feet apart. One wall of each silo was constructed of 2″ x 6″ D&M planks, while the other wall was a double thickness of 1-inch boards with a 55-pound felt, overlapped roofing paper between.

The concrete floors of both silos were crowned 2 inches at the center to provide lateral drainage. A 1 percent grade was put in the floor sloping to either end for lengthwise drainage. A 1-inch gap between the concrete floor and the bottom of the wall was provided for lateral drainage. Posts were set 4 feet deep in both silos and had a 5-inch top.

Silage has been made in these silos for the past three silage seasons with varying results.

Deflection of Posts

Inside measurements were taken at the top of each pair of opposite posts before silo filling began in 1955 and each year since to determine deflection of the posts. Results are given here:

	Average Deflection	
	Cantilever post	Braced posts
1956 (after 1 filling)	1.46″	.51″
1957 (after 2 fillings)	.03″	....*

* At the second filling the braced posts in the experimental silo failed, and the posts and the enire wall were lifted out of the ground 4 to 6 inches. No deflection readings were taken on this silo as posts and walls had to be reset.

After the first year of use, the braced post construction showed the smallest deflection. But it appears that in the cantilever-type of construction the maximum deflection occurs in the first year, with little subsequent deflection. Hence the cantilever type appears to be the better type of construction.

Complete failure of the braced-post type in the second year was due to pressures developed on the sidewalls, accompanied by low soil moisture. After resetting, the silo was again filled successfully; however, the danger still exists.

Sidewalls

After the first filling in 1955, visible bulging occurred with the 6-foot post spacing, when using the double thickness of inch boards with roofing paper in between. This bulging has increased in the 2 years following. Measurements taken in January 1958 indicate a 2¾-inch bulging. In two areas of this wall outer boards cracked, opening a space for entrance of air. Only a slight deflection was observed when using 2″ x 6″ D&M planks with 6-foot spacing between posts.

Little bulging was found when using either the plank or double board walls with 4-foot post spacing. This appears to be the best spacing.

Drainage

In all three fillings, juice and excess water effectively flowed out of the silage structure by the paths provided for lateral and lengthwise drainage. Juice flow was visible one

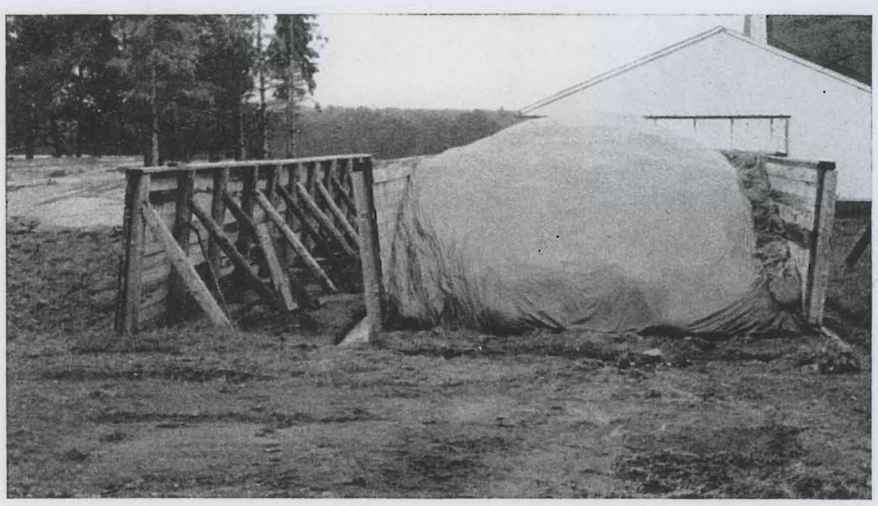


Fig. 1. "Braced post" bunket silo at left, with wet sawdust used as a covering. "Cantilever type" at right has a full plastic cover for the silage.

day after filling along the lateral drainage area.

This provision of a 1-inch gap between wall and floor was particularly effective in assuring adequate drainage. It also prevented the development of high-moisture silage along the floor of either silo.

The exposed juice and water along the walls attracted flies and other insects and shortly after filling an extremely foul odor of putrefaction originated at this same area. However, sand used as a cover along the base of the entire wall effectively decreased insect and odor problems.

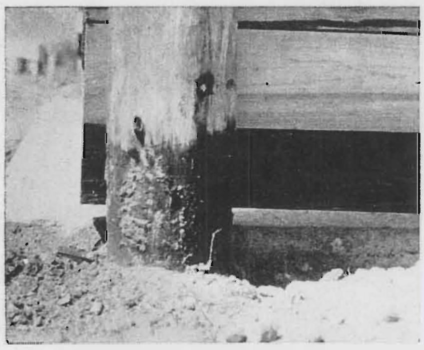


Fig. 2. A 1-inch gap between cement floor and walls provided the test silos with excellent lateral drainage.

When filling a silo, it is necessary to crown the silage both laterally and lengthwise to provide surface drainage at the top of the silage. The depth of settled silage in the two bunker silos sloped toward each end, with approximately 7 feet of silage in the center and 4 feet of silage at the ends.

Spoilage

All types of horizontal silos have large surface areas exposed to air. Some type of cover is necessary, therefore, to insure that the first prerequisite of silage making is met—that is, to eliminate air. Various types of covers have been used successfully on these silos. In 1955 and 1956 we used sawdust as a cover on the bunker silos and in 1957, plastic film. Where 8 inches of wet sawdust was used as a cover, visible spoilage amounted to only ½ inch. Total discarded top silage, when covered with sawdust, has ranged from 3 to 11 percent.

Sidewall spoilage has varied considerably. When careful attention is paid to distribution and packing, sidewall spoilage is nearly eliminated. With uneven distribution and poor packing, cracks can appear in the silage and air and water gain entrance. The resultant losses from spoilage are very high.

Temperature records that have been kept indicated that temperatures of the silage mass reduces as it approaches the floor of the silo. Temperatures under a sawdust cover ranged slightly over 100°F. at maximum near the surface to approximately 85°F. 6 inches off the bottom. Continued heat production would indicate nutrient loss in the silage. Temperatures under plastic film never reach as high as when there is exposed surface. Rain falling on the surface of a bunkers silo can leach out the acids produced by fermentation and cause a new, and many times with grass or legume silage, an improper fermentation to take place resulting in high losses and stinky silage. This is particularly true where the depths of settled silage is less than 6 feet. Covering with plastic film can eliminate this danger of losses due to rain.

Fig. 3. Walls bulged when posts for this silo were spaced 6 feet apart. A 4-foot spacing of posts on the other test silo resulted in very little bulging.

Packing is extremely important in a bunker silo as the low vertical height of the silage doesn't add much weight for packing. In conventional upright silos the weight of the vertical column of silage insure good packing at the bottom. Forages put into a bunker silo should have a higher moisture content than in an upright silo and extra care should be used in packing.

Costs and Adaptability

Bunker silo costs will range from one-half to three-quarters of the cost of an upright silo for the same storage capacity. However, costs alone should not determine if you will build a bunker silo. Good silage is easier to make in conventional upright or air-tight silos. Where capital is limited, lower cost structures should be considered. But to make them work properly, more attention and management must be given to construction details to provide airtight walls and a good floor, drainage, handling, and covering to reduce storage and preservation losses. Bunker silos must be evaluated along with all other types of silage structures to see if they fit on your farm.

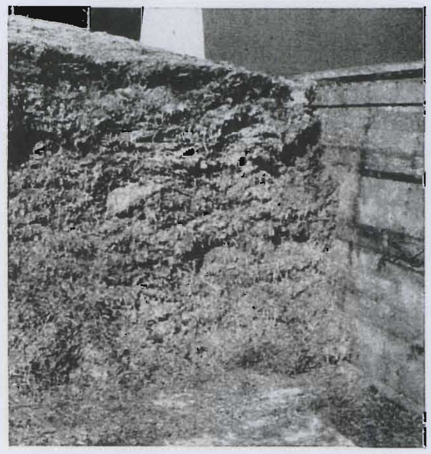


Fig. 4. Bunker silos can produce very good silage. No visible wall or floor spoilage resulted here. (The covering is sawdust.)

Plans Available

Construction plans for the Cantilever Post type bunker silo are available from your county agricultural agent or at the Bulletin Room, University of Minnesota, Institute of Agriculture, St. Paul 1. Construction details are given in Minnesota Plan Sheet M-126 and include wall, and floor construction and a self feeding gate.

Silage fits into all livestock feeding operations. Good silage can be made in all types of silos if proper attention is given to the elimination of air and a proper fermentation.

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What's New in Calf Starters and Rations?

J. B. WILLIAMS and W. A. OLSON

THE DAIRYMAN who always buys the replacements needed to maintain his dairy herd does not improve the production of milk and butterfat. There are few times when it will not pay him to raise his own replacements.

There have been several developments in recent years, however, that affect his choice of calf starters and rations. For one, Minnesota farmers now market most of their milk production as fluid milk. As a result, less skim milk is available on the farm. For another, several dried milk products are now available to replace the skim milk formerly used.

We've been working with some of those products—the "milk replacers" —here at the University of Minnesota for the past two-and-a-half years. Our work is now at the place where we can report the more important results.

Milk Replacers

Milk replacers for raising calves have now been marketed commercially for almost ten years. Some dairymen have reported excellent results with such products; others haven't had much success with them. One factor may be that milk replacers should always be fed according to directions on the shipping container, since the manufacturer compounds them to meet specific conditions on the farm.

Beginning in July 1955, we conducted a series of experimental trials to see how certain milk replacers affected the growth rate of dairy calves. The results are summarized below.

Dried skim milk powder is a nutritious, high-protein feed for all young animals. However, it does not contain vitamin A, since in whole milk that vitamin is found in the butterfat portion. One of our trials was set up to study the growth rate of calves when fed dried skim milk powder with added vitamin A.

Calves fed the powder without the vitamin gained 0.94 pounds per day for 84 days. Those that received the vitamin, in the form of codliver oil, gained 1.25 pounds per day during the trial. Codliver oil can be purchased at some feed stores, and at any drug store. But dairymen should be sure to feed it according to the directions on the container.

Fresh skim milk and dried skim powder were compared in another trial. Both groups of animals also received vitamin A. The calves on fresh skim milk gained 1.09 pounds per day for 84 days. The calves on dried skim milk powder gained 1.06 pounds per day in the same length of time.

Vitamin A-supplemented skim milk powder is acceptable as a feed as a substitute for fresh skim milk. Dairymen who can purchase the powder from their local milk plants at 10 cents per pound or less could well afford to use such a system in raising their calves.

There is little need to feed milk replacer, whole milk, or fresh skim milk after the calf is 8 weeks old.

A chemical substance, sold under the trade name of Dynafac, was added to the milk diet in another series of trials. Chemically, the product is "tetra-alkyl-ammonium-stearate," a quarternary nitrogen compound. In the first of these particular trials, the calves gained 1.12 pounds per day, as against 1.02 pounds per day for the calves that did not get the chemical. (A previous similar trial did not show any advantage to the use of Dynafac.)

In the second of this group of trials, calves fed fresh skim milk plus Dynafac gained 1.30 pounds per day, while those without Dynafac gained 1.08 pounds per day. When this same experiment was repeated, the gain per day for the chemical-fed calves was 0.99 pounds, while that for the control group was 0.85 pounds. This was on the basis of a 42-day trial.

The reason for Dynafac to show an increase in daily gain when combined with fresh skim milk is not clear. Nevertheless, in the third of this group of trials, fresh skim milk plus the chemical gave a daily gain of 1.19 pounds, while dried skim milk powder plus the chemical gave a daily gain of 1.04 pounds. This advantage may not hold for more than a few weeks, however.

Fats in Milk Replacers

Milk fat not only carries vitamin A but fat is high in calories. Consequently, milk is deprived of considerable energy when the fat is removed for other purposes. Therefore, we also set up a study to evaluate three feeding levels of a fat mixture combined with unfortified, low heat, extra-grade, dried skim milk powder. The fat mixture contained 60 percent choice white pork grease, 20 percent soybean lecithin, and 20 percent crude, non-degummed soybean oil.

In a 28-day trial, calves that received a milk replacer with 80 percent dried skim powder and 20 percent of the fat mixture gained 0.69 pounds per day. Calves that received 85 percent dried skim powder and 15 percent of the fat mixture gained 0.60 pounds per day. But calves that received the dried skim milk with 10 percent of the fat mixture made daily gains of 0.90 pounds per day.

The difference in growth rate in favor of the 10 percent fat group may have been due to the lesser amount of non-hydrogenated soybean oil in the ration. The increased energy in the other rations did not improve the growth rate.

Calf Starters

Forage and grain were also combined into a calf starter ration as follows: alfalfa hay, 20 pounds; beet pulp, 12.5 pounds; shelled corn, 25 pounds; molasses, 5 pounds; wheat bran, 15 pounds; soybean oil meal, 20 pounds; plus trace mineral salt, steamed bone meal, and vitamins A and D. This ration was ground in a hammer mill. Half of it was then made into quarter-inch pellets, and the other half fed in a meal or mash form.

In the first of this group of trials, calves getting the mash gained 1.18 pounds per day while the pellet-fed calves gained 0.97 pounds. Calves ate more of the meal than they did of the pellets.

(Continued on page 18)

J. B. Williams is associate professor, and W. A. Olson, research assistant, Department of Dairy Husbandry.

Mechanical Treatment Speeds Field Drying of Hay

JOHN STRAIT, R. P. MARVIN, and B. H. FIEDLER

MORE AND MORE FARMERS are using crushers and crimpers to speed up drying of freshly cut hay in the field. This mechanical treatment causes plant stems to dry faster, almost as fast as the leaves. By cutting down drying time in the field, there is less danger of damage during periods of rain and generally poor weather. Over a long period this will mean production of higher quality hay.

We conducted field trials with three different machines at the Agricultural Experiment Station, Rosemount, during the summer of 1957. The trials were designed to study the influence of:

1. Mechanical treatment with different types of machines on the field drying rate of alfalfa hay; and
2. Different weather conditions on the effectiveness of mechanical treatment.

Three Machines Used

We used a smooth roller crusher, a bar-type crimper, and a combination machine. The combination machine has two rollers. One is smooth and the other has iron bars placed spirally on the roller and welded to it. After 2 or 3 hours of drying the hay was raked with a side-delivery rake.

Obtaining a representative sample for moisture content determination is difficult in this kind of an experiment. We measured moisture content by oven-drying material from a sample obtained by boring a one-inch core from the outside to the center of cylindrical bales, gathered from the windrows.

The trial plots were cut and treated in the morning as soon as the dew was off the standing crop. The swaths were then raked into windrows 2 to 3 hours after cutting or when the moisture content of the hay was about 50 percent. Two windrows were made for each type of machine. Moisture content of one windrow was determined late in the afternoon and the other in the early afternoon or the following day. In a few trials moisture samples were taken more frequently.

John Strait is associate professor, R. P. Marvin, instructor, and B. H. Fiedler, research assistant, Department of Agricultural Engineering.

cut was about 47 percent, while the moisture content of the untreated material was 57 percent. The following morning, July 10, at 11:00 a.m., the moisture content of the check was 50 percent, as compared to a moisture content of 38 percent for the the hay that had been crushed or crimped. By 4:00 p.m. of the second day the moisture content of the check was 40 percent, and the mechanically treated material had dried to 21 percent.

Weather conditions were favorable for field drying on July 9 and 10.

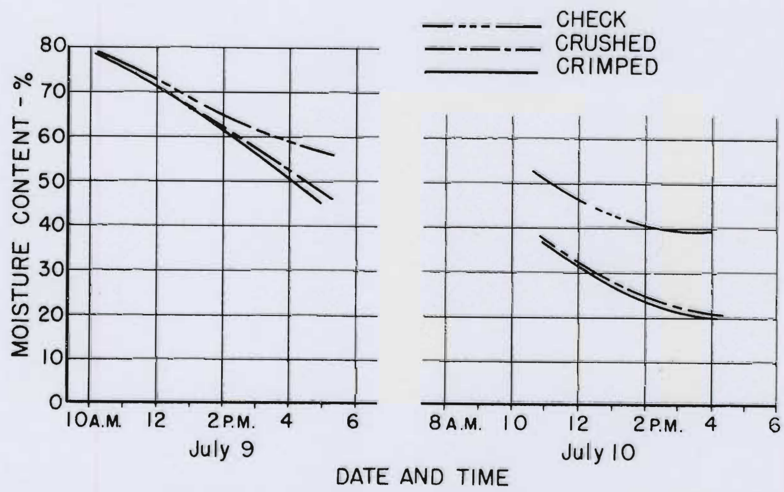

Fig. 1. Typical comparative drying rates of crushed, crimped, and untreated hay under good drying conditions. The hay was cut in the morning of July 9.

We also wished to determine whether or not mechanical treatment had any effect upon the field-drying rate of bales. The bales formed for taking moisture content samples were weighed frequently to study their drying characteristics. After about 3 weeks of drying in the field, we took a 2-inch core from each bale and judged for quality, considering color, odor, and mold.

Faster Drying

Mechanically treated hay always dried faster than the check material, the difference in drying rates depending upon weather conditions. Figure 1 compares the drying characteristics of crushed, crimped, and untreated alfalfa cut July 9. The moisture content of the hay when cut was 79 percent. We measured moisture frequently in establishing the drying curves shown, and the curves are typical for good drying weather.

The moisture content of the treated hay at 5:00 p.m. on the day it was

Afternoon temperatures reached 82 and 88 degrees with relative humidities as low as 45 percent. Wind velocities varied from 5 to 15 miles per hour. Under weather conditions similar to July 9 and 10, mechanical treatment was very effective.

Data from selected trials in which the moisture contents were observed after approximately 5 and 26 hours of drying are shown in table 1. The drying time is the time interval between cutting and sampling for moisture content.

The data show that while there were some variations in the drying rates for different treatments, the differences did not consistently favor any one machine. In every instance, mechanically treated hay dried faster than the untreated check.

General weather conditions relating to cloud cover are given in the table. It rained during some of the trials. Rainfall during the test period was as follows: August 12, 0.25 inches

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WHAT'S NEW IN CALF STARTERS . . .

(Continued from page 16)

The same forage-grain formula was compared in a second trial with a simple herd grain mix and long hay. All groups of calves received fresh skim milk plus vitamin A. The forage-grain ration in pellet form gave daily gains of 0.97 pounds; in a meal form, it gave daily gains of 1.18 pounds. The long hay-grain meal calves, however, gained 1.43 pounds per day.

Previous work at other agricultural experiment stations has shown that pelleting does not improve calf starters, but it does add to the cost of preparing the feed. Apparently, long hay will help to start the rumen function in the calf and will do a better job than the forage-grain formula used in these trials.

Long hay, grain, and fresh water should be made available to the calf within a week after birth. This will help the calf to get an early start toward the development and use of the four stomach compartments. Leafy, green hay along with a simple grain mix of 40 pounds coarse ground ear corn, 30 pounds ground oats, 20 pounds wheat bran, 10 pounds soybean oil meal, 1 pound of trace-mineralized salt, and 1 pound of steamed bone meal will do an excellent job of supplementing any of the liquid feeding systems used on the farm.

Summing Up

Our experiments point out the need for the addition of vitamin A in the diets of small calves being fed fresh skim milk or dried skim milk powder. It is not an economical practice for a dairyman to discard either of these in favor of a commercial milk replacer.

Table 1. Calf starter form and vitamin A supplementation

Group number	Experimental treatment	Number of calves	Chemo-biotic	Calf starter form	Milk system	Average daily gain in pounds: First 6 weeks	Second 6 weeks	Trial average
1	vitamin A	6	Dynafac*	Meal	Dried skim	0.69	1.76	1.25
2	No vitamin A	6	Dynafac*	Meal	Dried skim	0.48	1.37	0.94
3	Forage-grain mixture	5	None	Meal	Fresh skim	0.66	1.62	1.18
4	Forage-grain mixture	5	None	Pellets	Fresh skim	0.54	1.36	0.97
5	Long hay and grain	5	None	Meal	Fresh skim	1.05	1.77	1.43

* Tetra-alkyl-ammonium-stearate.

DRYING OF HAY

(Continued from page 17)

late in the afternoon; August 13, 3.56 inches during the morning; August 23, 2.56 inches early in the morning; and August 29, 0.02 inches during the afternoon.

Summary

All methods of mechanical treatment resulted in faster drying rates than for untreated check examples. Under crop and weather conditions during the experiment, it usually would have been possible to bale hay for storage starting in the early afternoon of the day after the hay was cut.

There were no consistent differences in the effectiveness of the different machines as measured by rate of drying of the treated hay.

When weather conditions were less favorable for drying, mechanical treatment was comparatively less effective than under good drying conditions.

The field drying rates of bales did not appear to be influenced by mechanical treatment. The quality of the hay also did not appear to be directly influenced by mechanical treatment, as judged by samples taken from the bales. Instead, quality seemed to be determined by the moisture content of the hay when baled.

Table 1. Field drying characteristics of alfalfa hay with and without mechanical treatment

Date cut	Time cut	Estimated percentage of full bloom	Moisture content of standing crop	Moisture sample taken: Date	Time	Approximate drying Time	Observed moisture content: Check	Crushed	Crimped	Combination	Weather conditions
July 8	10:30 a.m.	70	81.2%	7/8	5:30 p.m.	7.0 hrs.	55.5%	46.5%	47.0%	....	Partly Cloudy
				7/9	1:45 p.m.	27.3	42.0	24.2	25.6	....	Clear
				7/9	4:10 p.m.	29.8	37.4	21.2	24.6	....	Clear
July 9	10:00 a.m.	75	79.1	7/9	4:50 p.m.	6.8	57.5	49.0	46.0	....	Clear
				7/10	11:15 a.m.	25.3	49.0	35.5	35.0	....	Clear
				7/10	3:50 p.m.	29.4	41.0	21.0	21.0	....	Clear
July 10	10:10 a.m.	75		7/10	4:50 p.m.	6.7	52.0	40.7	37.4	....	Clear
				7/11	1:40 p.m.	27.5	35.2	19.1	19.0	....	Clear
Aug. 1	10:10 a.m.	70	78.6	8/1	4:15 p.m.	6.0	45.8	42.6	40.5	....	Scattered Clouds
				8/2	4:10 p.m.	30.0	39.4	37.7	39.1	....	Cloudy
Aug. 7	10:30 a.m.	75		8/7	4:00 p.m.	5.5	38.2	30.5	32.4	....	Scattered Clouds and clear
				8/8	11:30 a.m.	25.0	29.2	21.7	21.0	....	Cloudy
Aug. 12	10:30 a.m.	5		8/12	5:50 p.m.	7.3	45.2	32.2	36.1	35.0%	Scattered clouds
				8/14	12:30 p.m.	50.0	37.3	32.9	33.2	31.7	Clear
Aug. 14	11:10 a.m.	100	70.9	8/14	4:15 p.m.	5.0	37.5	25.5	28.5	27.7	Clear
				8/15	4:30 p.m.	29.2	27.4	20.7	18.7	19.1	Light overcast
Aug. 19	11:25 a.m.	100	72.8	8/19	4:00 p.m.	4.5	43.6	34.4	36.5	36.6	Clear
				8/20	1:00 p.m.	25.5	30.2	20.6	20.5	23.4	Partly Cloudy
Aug. 20	10:05 a.m.	5	77.5	8/20	4:40 p.m.	6.5	50.3	43.4	42.0	43.1	Partly Cloudy
				8/21	1:20 p.m.	27.3	33.1	23.4	21.3	21.1	Clear
Aug. 22	10:40 a.m.	5	76.2	8/22	3:45 p.m.	5.0	41.5	31.7	28.3	30.7	Cloudy
				8/24	12:40 p.m.	50.0	40.3	29.7	30.6	33.7	Clear to partly cloudy
Aug. 29	10:45 a.m.	5	78.1	8/30	1:15 p.m.	26.5	66.5	63.1	63.7	62.8	Cloudy, light rain

Swine Breeding: Past, Present, Future

R. E. COMSTOCK and W. E. REMPEL

THE PIG is a machine. It manufactures pork from animal feeds. The well-being of the swine industry depends on the efficiency of this machine. Improvement of the machine is the business and responsibility of swine breeding.

Present day economic pressures have placed a premium on rapid swine improvement. At the same time genetic research has shown that traditional procedures cannot yield rapid improvement. At the very least, we must intensify direct selection for characters of primary economic importance. In the end more far-reaching changes are likely.

We at the University have outlined future swine breeding research. This called for (1) review and evaluation of past developments and (2) identification of the most critical problems relative to future developments.

The first significant development of modern swine breeding was formation of the standard breeds. This was followed by growth of the concept that no practical purpose would be served by attempts to develop still other breeds.

Other significant events had to wait until genetics emerged as a science and have come in the last 25 years. Experiments with crossbreeding and development of practical crossbreeding systems brought almost universal adoption (in the U.S.) of crossbreeding for market hog production.

Development of scientific bases for predicting effectiveness of selection enabled evaluation of current practices. Specifically, it has led to realization that selection must be focused directly on the primary economic traits and based on sound performance testing programs.

Finally, formation of new breeds that are finding a place in commercial swine production has forced reexamination of an old concept.

Four issues stand out in survey of present problems. Three are pertinent to choice of research objectives, and we will consider these first along with the Minnesota research program.

R. E. Comstock is professor, and W. E. Rempel, associate professor, Department of Animal Husbandry.

Finally we will discuss the fourth issue, maximum efficiency.

The Meat-Type Hog

Consumer demand has changed. The value of lard to both the packer and the housewife has decreased sharply. Consequently, production of swine with a higher proportion of lean meat and a lower proportion of fat is now necessary. This was apparent 20 years ago to all who were disposed to face the facts. Actually it did not become a red hot issue until the past few years.

Fortunately, we can assess this problem and see how it can be solved. There is no urgent need for new basic information. Percent lean cuts and percent lean tissue are highly correlated with backfat thickness. In the past selection for carcass traits (including backfat thickness) was hampered because accurate measurement required slaughter. Now the mechanical probe (developed by the Iowa Experiment Station) allows measurement of backfat in the live animal. Backfat thickness is a highly heritable character, and the genetic variation in it and in percent lean cuts is sufficient to make effective selection possible. In addition the carcass characters of purebred stocks are fully reflected in the crossbred market animal.

Taken together these facts indicate that the meat-type hog is an attainable objective. Marked change in this direction is possible within 10 years if a sound program of measurement and selection is continued.

New Breeds

The basic genetic issue is, "Does each existing breed lack desirable genes that are present in one or more other breeds?" If so, the most beneficial genes can only be gotten into one population by crossing breeds.

Present evidence does not enable a final firm conclusion. However, many geneticists firmly believe that the ultimate in swine improvement can be approached only by developing new breeds. Moreover, new breeds of the last 20 years (Minnesota No. 1 and No. 2, Beltsville No. 1, etc.) have been good enough to justify and insure further exploration in breed formation.

Performance in Crossbreds

Professional swine breeding operates on the premise that market hog improvement will be taken care of by improvement of performance in the breeds themselves. This concept pre-dates the widespread practice of crossbreeding and therefore must be re-examined.

Market hogs are crossbreds. The vital issue *now* is performance in crossbreds. Is the performance of a purebred an accurate guide to its value for crossbreeding? There are other ways to phrase the question. Do genes have one value relative to performance in a particular breed and another value relative to crossbreds involving that breed? Should selection within a breed be based on performance of the purebred animals or on combining ability as measured in crossbred offspring?

We know that carcass characters of purebreds are faithfully reflected in breed crosses. However, there are good reasons to suspect that the situation is significantly different for traits like litter size and growth rate that exhibit marked hybrid vigor in crosses.

The performance of corn hybrids is predictable from parent line performance in some traits but not in others. Selection for combining ability has become important in corn yield improvement. We cannot determine what is best in swine breeding without knowing more about the correlation between purebred and crossbred performance.

Minnesota Research

Minnesota has made important contributions to swine breeding. Research programs, directed by the late L. M. Winters, led the way in the areas of crossbreeding and formation of new breeds.

We will devote future work to the two basic questions outlined on new

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THE CONTROL OF BREEDING PROBLEMS IN CATTLE

RAIMUNDS ZEMJANIS and LESTER L. LARSON

BREEDING TROUBLES in cattle cost the average farmer in Minnesota about $200 per year! Actually this amounts to more in dollars and cents than any cattle disease today. Unfortunately these losses are hard to see, so we tend to overlook them.

Stated in other terms, these losses total three-quarters to one billion dollars a year in our nation, or 25 to 50 million dollars a year in Minnesota alone!

Dairy and beef products and breeding stock provide one of the largest, and often the largest, source of income on Minnesota farms. Livestock men generally recognize the role that good breeding and feeding plays in cattle raising. They often, however, overlook reproduction or breeding, an equally important factor. If breeding is impaired, no animal will produce to its capacity no matter how good its breeding or feeding.

To maintain the highest productivity in a dairy or beef hard, cows should calve every 12 months, and heifers should begin milking when they are 25 to 27 months old. Thus the time when an animal is not producing is kept as low as possible. Breeding difficulties prolong the time when animals do not produce and drastically cut net income.

Effects Often Overlooked

There are several reasons why we overlook and do not fully appreciate the effects of breeding problems.

1. Breeding difficulties have a delayed and relatively inconspicuous effect. They ordinarily arise in dairy cows at the same time as the cows are giving milk. Infertility, with exception of abortions, is seldom accompanied by alarming signs of disease. Thus an animal actually having breeding difficulties may appear completely healthy.

The effect of breeding problems does not ordinarily become apparent for several months. The dry period is prolonged and a situation where a cow, thought to be pregnant, fails to have a calf, is rather common.

In beef herds, disturbances of breeding, experienced during a breeding season, may remain undetected until the end of the following calving season.

2. Owners commonly fail to consider all the costs involved when breeding problems arise. These include cost of raising feed crops, the time and effort spent in care of animals, and the investment in replacements, particularly those raised on the farm.

3. Owners too commonly accept breeding problems as "bad luck."

Losses Not 'Inevitable'

Should breeding problems and the resulting loss be taken as inevitable "bad luck" and accepted with resignation? Certainly not, at least not to a degree greater than soil depletion, erosion, insect damage, and plant diseases. Breeding problems reflect diseases involving sex function and should be considered accordingly.

All cases of disease cannot be cured. Likewise, recovery of all animals experiencing breeding difficulties cannot be expected. You can, however, reduce considerably the losses caused by breeding problems by preventive measures in the form of fertility or sexual health control, a service rendered by veterinarians in the field.

The overall objective of such a service is to prevent or reduce the loss of production due to different types of fertility. Failure to show heat and repeat breeding are the most common reproductive problems. There are many reasons for them including disease conditions as well as nutritional and management factors. Consequently sexual health control, in order to be successful, requires close cooperation between the farmer and the veterinarian.

Raimunds Zemjanis is associate professor and head, Division of Veterinary Obstetrics, College of Veterinary Medicine. Lester L. Larson is assistant professor in the same division.

Fertility Control

Fertility control in dairy herds should include all female animals of breeding age and should consist of periodic examinations of selected animals or if indicated, the entire herd. In selecting animals to be examined pay special attention to these groups:

1. **Virgin heifers**—Have these heifers examined 4 to 6 weeks before the desired time of breeding to detect potential causes of infertility. Heifers failing to show heat should receive special attention.

2. **Cows that have calved 30 to 60 days previously**—The genital tract of a cow should have returned to the normal nonpregnant state by this time. Examination during thes period also leaves approximately 4 to 6 weeks for treatment and recovery from the diseases detected before the time of planned rebreeding. Cystic ovaries, inflammation of the uterus, "silent heat," and failure to show heat are the most common problems. Most of these require time for recovery. Consequently the need of early detection is obvious.

3. **Cows and heifers that have been bred and have not returned to heat.** About 15 percent of the animals not observed in heat following service are actually nonpregnant. In certain circumstances this figure may be considerably higher.

Some of these nonpregnant animals may show heat several weeks later. Heat may be absent in others until the expected due date. Thus several months of production may be lost.

You can reduce this time loss by examining all bred animals a week before the second expected heat. Pregnancy diagnosis may not be possible this early in some cows. Reexamine these within 55 days following service. This would allow time for treatment if required and rebreeding without further loss of time.

4. **Problem cows**—These cows need special attention to determine the feasibility of treatment and rebreeding. Culling of hopeless animals is thus decided upon in time.

5. **Animals in midpregnancy**—Reexamination of these animals is desirable in herds where abortions and fetal deaths have been observed.

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CANADA THISTLE — Spotlight on a Troublesome Weed

A. J. LINCK and THOR KOMMEDAHL

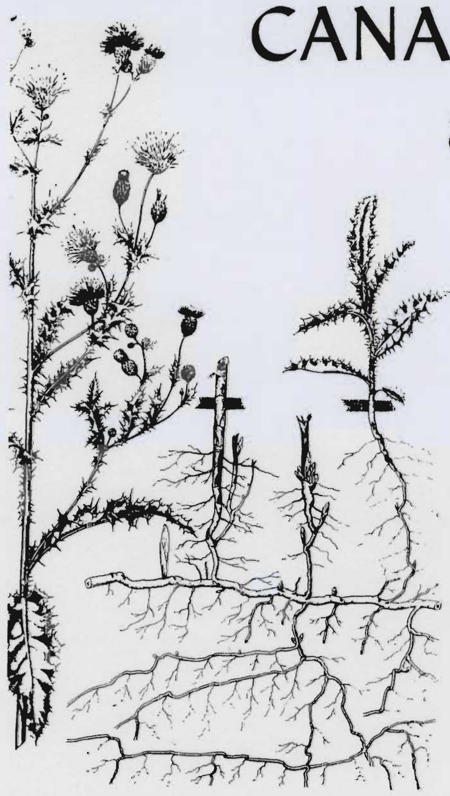

Fig. 1. General growth characteristics of the Canana thistle. The root-rhizome system, clearly indicated at the right, may spread over many square feet. Each segment of the rhizome can produce a new thistle plant.

MENTION THE THISTLE to a Scotsman and he will proudly tell you that it's the floral emblem of Scotland. But mention Canada thistle to a Minnesota farmer and he'll tell you it's one of our state's most troublesome weeds!

Scots honor the thistle emblem for an historical reason. In about 1000 A. D., an invading army of Danes stumbled into a thistle patch as they were about to surprise a Scottish castle. Their pained outcries warned the defenders and saved the fortress. The Scots, however, have little trouble in making a distinction between their proud floral emblem and the weed itself.

Bearing the botanical name of *Cirsium arvense*, the thistle is a perennial weed introduced to America from its native Europe. It is found in cultivated areas and waste places throughout this country and southern Canada and has, in fact, been declared "noxious" in the seed laws of at least 43 states. The term *Cirsium* comes from the Greek word for veins, and according to legend some thistle species were used for treatment of varicose veins. The *arvense* means "of the fields," and when found in great numbers in our cultivated fields the thistle becomes a noxious weed that must be eradicated.

Life History

The Scots describe the thistle as a plant having pugnacity and the ability to live frugally. Such a description is justified botanically, because Canada thistle has characteristics which make eradication difficult. The underground parts of this weed include the roots and the underground stem, or rhizome. These parts are very extensive and can reach a depth of 6 to 8 feet in some soils. When these fleshy underground roots and rhizomes are broken by cultivation, each broken segment may produce a new plant from a dormant bud. The general growth characteristics are shown in figure 1.

The root-rhizome system of a single Canada thistle plant may spread over many square feet. For example, it was demonstrated that a single 2-inch root segment produced a patch of Canada thistle 60 feet in diameter in 3 year's time.

The spiny prickles that line the toothed edges of the leaves remind the unwary person walking through an infested field that this is the most prominent characteristic of the plant. Crowning the usually dark green foliage are small, compact, pink, pale purple or white flower heads.

A. J. Linck is assistant professor, and Thor Kommedahl, associate professor, Department of Plant Pathology and Botany.

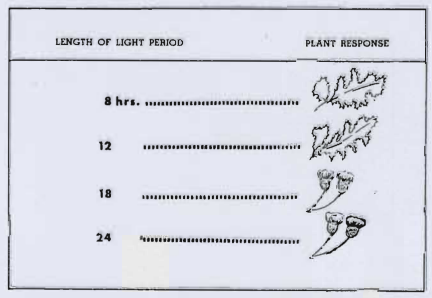

Fig. 2. How "long-day" conditions cause Canada thistle to flower. When under light 8 to 12 hours, the plant produces only leaves.

A single plant of Canada thistle may bear male or female flowers. Occasionally both reproductive structures may be present in the same flower head. The female flowers produce many seeds, each equipped with feathery bristles that aid in their dissemination by the wind.

In this area, Canada thistle usually produces flowers in July and August. Research at the University of Minnesota Agricultural Experiment Station indicates that this plant can be classed as a long-day plant, because of its flowering habit. Plants grown under continuous illumination or under light periods of 18 hours produced flowers, but plants grown under light periods of 8 or 12 hours failed to flower. This change of the plant from a form producing leaves to one producing flowers under long day conditions is shown in figure 2.

A Triple Threat

Canada thistle presents a triple threat to agriculture:

1. It harbors insects and plant disease organisms

(Continued on next page)

Minnesota agriculture has a prickly problem on its hands in the Canada thistle. Because of the prevalence of the weed, the current search for better methods of control and eradication involves at least three departments of the University: Agronomy and Plant Genetics (controlling the weed in field crops); Horticulture (controlling it in vegetable crops); and Plant Pathology and Botany (studying its growth habits, life history, and some problems in using herbicides in its control). This is a report on work in the latter department.

(Continued from preceding page)

2. It injures livestock while grazing or feeding

3. It competes with crop plants for soil moisture and minerals

This weed can harbor insects such as the bean aphid or the stalk borer that attacks corn, tomatoes, asters and dahlias. It may serve also as an alternate host for several pathogenic organisms. For example, crown rot of clover, Verticillium wilt, and possibly aster yellows are diseases whose pathogens have been reported on Canada thistle.

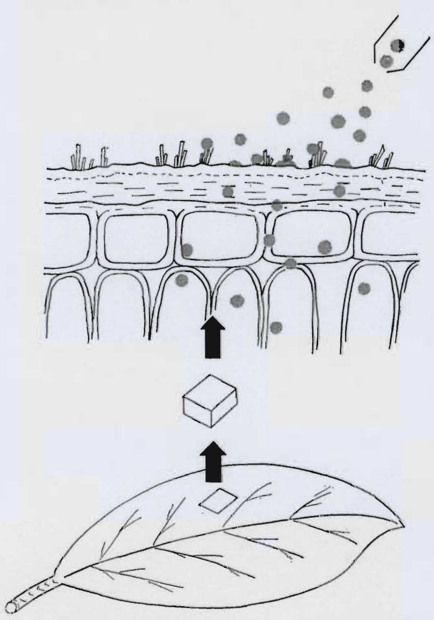

Fig. 3. How herbicide molecules must first penetrate the waxy outer layer of a plant leaf before reaching the inner cells.

Livestock grazing in pastures infested with thistles can be scratched around the eyes and mouth, thus providing avenues of entry for pathogenic bacteria. If thistles are cut with hay, livestock later may suffer wounds resulting in infections of the alimentary tract when the spiny foliage is eaten.

Besides being a troublesome weed to eradicate in crop land and a nuisance in home gardens, the small thistle buds may be harvested in canning crops such as peas. Since the buds are similar to the shelled peas in size and weight, canning companies must use special precautions in their processing operations to insure a product free from these flower buds.

At the Minnesota Agricultural Experiment Station, research on the control and eradication of Canada thistle is being conducted in several departments. In the Department of Plant Pathology and Botany, we are investigating the growth habits and life history of this weed and some problems in the use of herbicides in its control.

Following the Herbicide

When an herbicide is applied to the foliage of a weed, the herbicide molecules usually must penetrate the waxy layer covering the leaves, and then move into the inner cells. This is shown diagramatically in figure 3.

As the herbicide molecules move through the leaf they come into contact with the veins and then move into them. At this point the herbicide begins its journey through the plant. For perennials such as Canada thistle the herbicide must move in sufficient quantities into the extensive underground parts to kill the entire plant. If only the top is killed the underground buds will produce new plants, thus requiring additional spray applications.

The pathway which herbicide molecules take in their movement through a weed, such as the thistle, is shown schematically in figure 4. We are investigating, in particular, the effects of humidity and light on the leaf absorption of the herbicide, amino triazole.

Introduction of a "foreign" molecule like amino triazole into the normal metabolism of a plant greatly alters the chemical processes occurring in the cells. The most apparent effect following spraying with amino triazole is the formation of small, deformed white leaves at the tip of the plant. Many other chemical changes occur within the cells. This herbicide affects the rate at which the leaf cells breakdown sugar—a process of central importance in plant metabolism.

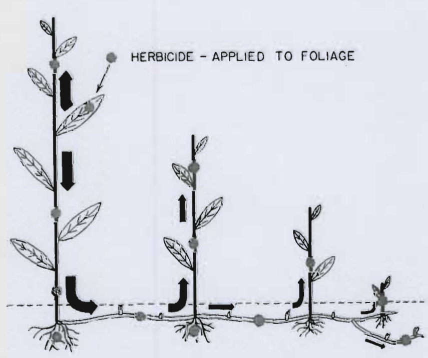

Fig. 4. The path followed by herbicide molecules in moving through a weed.

These studies should aid in the understanding of the effects of environmental factors on the uptake and movement of such herbicides as amino triazole. The result should be improved practices in the control or eradication of Canada thistle.

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(Control of Canada thistle is described in Extension Folder 191, "Weed Control in Minnesota, 1958." The methods include repeated applications of 2,4-D plus certain cultural practices, or the use of amino triazole. All chemicals used in weed control must comply with the provisions of the Miller Amendment to the Federal Food and Drug Act.)

BREEDING PROBLEMS IN CATTLE

(Continued from page 20)

6. **Herd bull**—Examine him whenever he is suspected of being the cause of breeding difficulties in the entire herd.

The number of these periodic examinations require per year depends upon the size of the herd, the breeding practices, and the extent of breeding problems in the herd. In herds where animals are bred to calve within a certain time period, fewer examinations are required than in herds where calvings are spread throughout the year. Ordinarily an examination of selected animals every 3 to 4 months is sufficient.

Beef herds, where breeding is restricted to seasons, do not require the more or less continuous sexual health control desirable in dairy herds. One or two yearly examinations of all animals of breeding age or generally adequate. If only one examination is performed, it would be 5 to 8 weeks following the end of breeding season. The females found to be nonpregnant can be separated from pregnant cows either for rebreeding or feeding for market. An additional examination, if done before the breeding season, allows detection of abnormalities that cause breeding difficulties.

Fertility control, if properly maintained, can greatly increase production efficiency. The success or failure of fertility control depends upon full cooperation between the herd manager and his veterinarian.

SWINE BREEDING

(Continued from page 19)

breeds and on performance in crossbreeds. We are starting a comparison of selection on the basis of purebred performance with selection based on crossbred performance. Both kinds of selection will be used in the same three breeds. In each breed two separate populations will be developed, one by each method of selection. Evaluation of the methods will be based on performance in the three-breed crosses of population derived by the same selection method.

The second phase of the program is designed to obtain further information on new breeds as an approach in swine improvement. The three breeds used in comparison of selection systems will be intercrossed to provide the foundation for a potential new breed. Selection in this new population will be based on performance of the animals themselves (not on combining ability). The question, of course, is whether the new population will become superior to all of the similarly selected populations of the three parent breeds. If so, the case for new breeds will be strengthened.

Maximum Efficiency

A fact to be reckoned with by professional swine breeders is that we know more about swine breeding than we are putting into practice. This poses a challenge and an opportunity. Selection of the key animals of our seed stock populations can be greatly intensified. The maximum rate of genetic improvement will not be approached until this happens.

The importance of this issues does not depend on the nature of future seed stock populations or what is eventually found to be the optimum basis of selection. It would be as important in new breeds or inbred lines as in standard breeds. It would be as important in direct selection for crossbred performance as in selection for purebred performance.

Key animals are those whose descendants will be the seed stock of the future. It is the selection of *these* that has a bearing on permanent genetic improvement.

The need for direct attention to the primary economic traits in terms of sound performance testing is being recognized. This is evident in the growth of swine testing stations and increase in on-the-farm testing programs.

The next question is whether the use of such facilities will be effectively mobilized around selection of key animals. The problem is aggravated by the fact that the destiny of every breed is presently in the hands of a number of farmer-breeders. Some are more aware of present necessities than others. Some are more strongly motivated to contribute to genetic improvement of their breed. The effectiveness of the ablest breeder would be greater if his program were entirely his own rather than a portion of a program dependent also on the efforts of others.

This problem was met in the evolution of corn and poultry breeding by the emergence of large companies that are now dominant in those areas. These companies own and have complete control of their seed stock populations. They can insure maximum uniform and co-ordinated effort throughout each of their programs.

Maximum swine improvement in the future will depend on achievement of similar co-ordination and singleness of purpose. Will this be achieved by cooperation within groups of today's farmer-breeders or must the ends of swine breeding be gained by development of large, self-contained enterprises?

RESEARCH, 1858-1908

(Continued from back cover)

The tract known as the Edgar Bass farm in St. Anthony Park, comprising 154 acres, was purchased in June 1882, and an adjoining tract of 94 acres owned by Nathaniel Langford was also acquired. Actually, the Regents did not come into full possession until 1883-1884. Three years later, federal funds became available for research by state agricultural stations when Congress passed the Hatch Act of 1887.

Under the directorship of Edward D. Porter, agricultural research got under way on the Bass and Langford farms in the mid-eighties, with the first "University of Minnesota Experiment Station of the College of Agriculture" bulletin being published in January 1888. It included reports on Russian apples, wheat experiments, and potato culture. It was the first of four such bulletins published in the same year, and about 50 such publications were issued during the first decade.

The same period was marked by the recruiting of a singularly competent and active research staff, including Willet M. Hays, Samuel B. Green, Otto Lugger, and David Harper, with Peter M. Gideon serving as superintendent of Minnetonka Fruit Farm, a branch station. In the early nineties T. L. Haecker joined the staff.

It naturally followed that with these facilities, and such a competent staff, substantial contributions were made to the progress of Minnesota agriculture. Particularly to be mentioned were the selection and breeding of crops and horticultural species, soil treatments and cultural practices, insects and their control, forestry, dairy cattle management, cooperative creameries, livestock feeding, and other special subjects.

Later Activity and Expansion

The staff was increased during the late 1890's and the first decade of the 20th century by the appointment of numerous competent assistants. Undoubtedly additional federal funds provided by the Adams act of 1906 facilitated such additions of personnel and equipment, essential to expanded research projects.

Several sub-stations were also added, in consequence of the donation of 480 acres of farm land just north of Crookston, by James Hill in 1894, and acquisition of a considerable tract east of Grand Rapids in 1896. Likewise the Coteau Farm, near Lynd, was operated as a branch experiment station for several years, beginning in 1894.

The publication of bulletins by the agricultural experiment station continued, until by June 1908 a total of 109 regular bulletins had been issued. These were in addition to several so-called "Press Bulletins," prepared in a brief and popular style for general distribution. The Station's "press bulletins" were in fact the forerunners of the materials later to be issued through the Agricultural Extension Service. The publications program alone, rather extensive for the time, provides a good idea of the volume of work carried out during the first 50 years of agricultural research in Minnesota.

CENTENNIAL OF AGRICULTURAL RESEARCH

The First 50 Years, 1858-1908

C. H. BAILEY

THE YEAR OF 1958, when Minnesota Territory became the 32nd state of the Union, was a time of economic depression, westward migration, the famous Lincoln-Douglas debates, and a general political turbulence over "free soil," states' rights, and slavery that finally erupted in civil war.

But on the quieter side of history, the same year had a special importance for Minnesota agriculture. In its first sessions, the legislature of the newest state sought to provide public support for agricultural research. Agricultural research can therefore be considered to have had its "official" beginning in Minnesota in 1858.

Some Early Background

The action of the legislature was, of course, a reflection of a widespread public interest. That was shown by such events as the first agricultural fair, staged in Dakota County in October 1858. It was followed by a fair in McLeod County in 1859, and by the State Agricultural Society fairs in subsequent years. These fairs, and meetings of various county and state societies, were effective in stimulating the interest in agricultural research.

C. H. Bailey is Dean Emeritus of the Institute of Agriculture. As both Dean of the Institute and Director of the Agricultural Experiment Station (1941-52), vice-director of the Station (1938-41), and in numerous other positions associated with his own field of cereal chemistry, he has been in a particularly good position to gauge the impact of research conducted by the University of Minnesota upon the agriculture of our state. The second half-century of agricultural research, 1908-58, will be reviewed in a later issue of *Minnesota Farm and Home Science*.

The Minnesota State Horticultural Society was instrumental in establishing the Minnetonka Fruit Farm, for which funds were appropriated by the legislature in 1878, and which was directed by Peter Gideon. Offering similar support was the Grange (or "Patrons of Husbandry") which had been organized some years earlier by Oliver H. Kelley. Its committee, comprised of W. S. Chowen, J. D. Schofield, and J. A. Bull, from the start was active in promoting agricultural education and investigations.

Actually, the 1851 charter of the University of Minnesota stipulated that it was to have an agricultural department. However, W. S. Chowen introduced a bill into the 1858 legislature providing for a "Minnesota State Agricultural College," and an amendment was attached stipulating that an experimental farm of not less than 320 acres was to be provided.

The town of Glencoe then offered to donate land, and in 1859 actually deeded 320 acres to the state for an experiment station. In spite of the general depression that began in 1857 the citizens of Glencoe raised $10,000, and the cornerstone of the projected college building was laid on July 11, 1859. No substantial construction took place, however, and presently the Civil War diverted attention from such a project.

The University Takes Over

In 1862 the Morrill or Land-Grant College Act was passed by the U. S. Congress, which provided that federal lands could be transferred to approved state colleges for the support of instruction "in agriculture and the mechanic arts." Considerable efforts were made to effect the application of these provisions to various state normal schools, as well as to towns, including Gencoe, Hastings, and Red Wing.

However, a bill introduced by Senator John S. Pillsbury in the 1868 legislature and passed almost unanimously transferred the Agricultural College to the University of Minnesota. Thus the University qualified for the federal land grant, and later in 1868 purchased 96 acres of land lying east of the Minneapolis campus, extending from the junction of Washington and University avenues east to Prospect Hill and south to Franklin Avenue. In 1869 an additional 30 acres were acquired, making 126 acres in all. This tract became the first "state agricultural experiment station" in Minnesota.

Getting Into Full Swing

A succession of professors of agriculture were then appointed to the University faculty: Col. Daniel A. Robertson in 1869; Dalston P. Strange in 1872, with Walter R. Field as farm manager; Charles Y. Lacy in 1874, who expanded variety testing of cereals and vegetables; and Edward D. Porter in 1881. Professor Lacy had emphasized that the farm land in southeast Minneapolis was very inadequate for agricultural experimentation, however, and the 1881 legislature empowered the Regents to dispose of it and purchase more suitable farm land.

(Continued on preceding page)

Our centennial year of statehood also marks another significant but less known anniversary for Minnesota. It was also 100 years ago that the first formal action was taken to establish a state-supported "Agricultural College" and experimental farm where agricultural research could be carried on under public auspices. Depression and war prevented the early efforts from bearing fruit, but by 1868 the "Experiment Station" was an integral part of the University of Minnesota. Here is the story of the first 50 years of agricultural research.