MINNESOTA FARM AND HOME Science

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THE COVER—His tractor on "automatic pilot," the operator can just ride while cultivating corn till time to turn around at the end of the row. USDA engineer L. A. Liljedahl, stationed at the University, developed this device for use with hydraulic power steering. If the tractor moves out of line, the "feelers" move the opposite way. The movement closes an electric switch, in turn opening hydraulic valves in the power steering unit to guide the tractor back on course. The device doesn't affect the normal steering mechanism; the operator still has full control. Purpose: more accurate cultivating with less injury to corn, less fatigue for the operator. Research will continue to see if the pilot will work on extremely small plants, like corn or soybeans 3 to 5 inches high.

Minnesota's Men of Science

Editor's Note—This is the twenty-ninth in a series of articles introducing scientists of the University of Minnesota's Institute of Agriculture. Here we present Will M. Myers, head of the Department of Agronomy and Plant Genetics.

One of the nation's most zealous advocates of grassland farming and the value of forage crops—and certainly one of the top experts in the field—is Minnesota's Will M. Myers. Myers has headed the University's Department of Agronomy and Plant Genetics since 1952.

Myers' devotion to forage crops, however, doesn't diminish his efforts to improve all farm crops that will benefit Minnesota farmers. Oat breeding has also been one of his particular interests, but since he has come to Minnesota his department has introduced many new crop varieties and methods in all areas of agronomy.

W. M. Myers

His recognition as a leader was attested to last year when he served as president of the American Society of Agronomy, after terms as vice-president and president-elect. He also served as secretary-general of the Sixth International Grassland Congress at Pennsylvania State University in August 1952, and as chairman of both the executive and program committees for the Congress.

Before succeeding H. K. Hayes at Minnesota, he was director of field crops research with the Bureau of Plant Industry, Soils and Agricultural Engineering of the U. S. Department of Agriculture.

A native of Bancroft, Kansas, he received his B.S. degree from Kansas State College in 1932 and his M.S. and Ph.D. degrees from the University of Minnesota in 1934 and 1936, respectively. While working for his advanced degree, he served as an instructor of agronomy at Minnesota.

Myers has also been senior geneticist at the U. S. Regional Pasture Research Laboratory at Pennsylvania State University. In 1946-47 he was head of the agricultural research branch of the Agricultural Division, Natural Resources Section, General Headquarters, SCAP, at Tokyo, Japan.

In 1948 he was the first to receive the Stevenson Award for farm crops research from the American Society of Agronomy. He also received the University of Minnesota's Outstanding Achievement Award in May 1951.

In 1956 he was head of the U. S. delegation to the Seventh International Grassland Congress in New Zealand.

Since 1954 Myers has been a member of the Board of Agricultural Consultants for the Rockefeller Foundation. He is also a member of the Board of Directors to the Minnesota Crop Improvement Association.

He is co-author, with H. K. Wilson, of the book *Field Crop Production.* And he is author of chapters on "alfalfa" and "wheatgrass" in the German publication, *Handbuch der Pflanzenzuchtung,* Verlag Paul Parey, Berlin.

Fitting Young Adults into the Community

ROBERT R. PINCHES and MARVIN J. TAVES

MINNESOTA communities are on the threshold of new problems arising from the expanding number of young adults. Today about 42,000 Minnesotans reach 18 annually; by 1970 that number will be 70,000. Thus there will be seven young adults where today we have four asking for jobs, higher education, and services. This flood of young adults can bring serious problems as they hit the labor market, as happened in the 1930's. Or they can provide the energies and enthusiasms for a greater Minnesota, providing they develop their abilities and sense of citizenship.

Participation is the key to citizenship—especially in a country depending heavily upon voluntary organizations and agencies. One purpose of a recent University study of young adults in southern Minnesota was to determine how they were "fitting into the community's adult roles." Items considered were their independence from parents, both financially and in establishing homes of their own; how much they participated in adult organizations; how they looked at their community and their jobs; their preparation for their positions; and what they thought might be blocking their progress.

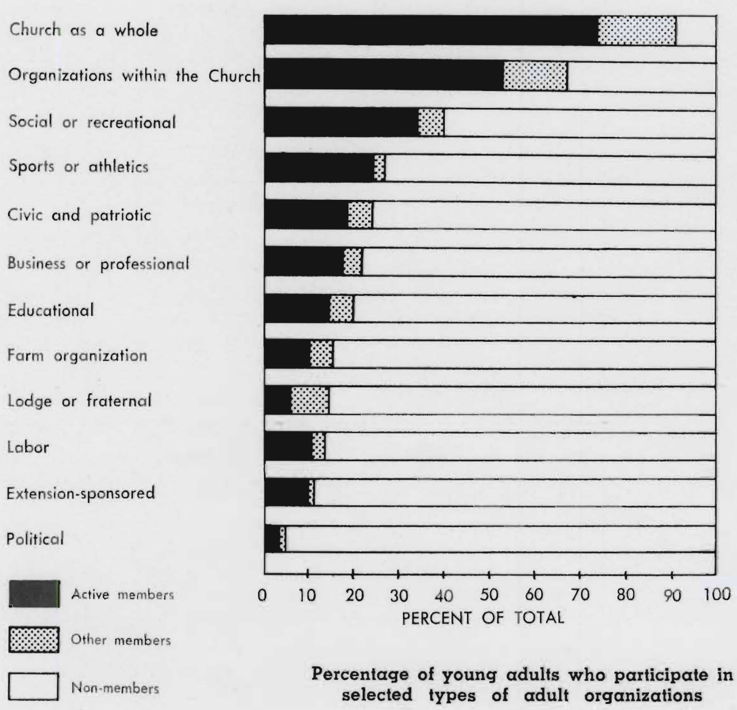
The Situation

The 271 young Minnesota men and women, 18 to 30, studied were a cross-section of those living in four representative southern Minnesota communities including the farms in the trade area.

Nine out of ten of the married couples lived apart from their parents or in-laws. However, only 20 percent of the single men and 33 percent of the single women lived away from home. Four out of five were completely self supporting, and the same proportion expected little or no help from parents.

When asked, "What are the things you feel you need most to help you get the kind of job you want or to get ahead financially?" they listed four main ideas: (1) more training and experience; (2) more education; (3) improved personal qualities; and (4) credit-money.

Robert R. Pinches is Assistant State 4-H Club Leader. Marvin J. Taves is professor, Department of Sociology, and rural sociologist, Agricultural Experiment Station.



Percentage of young adults who participate in selected types of adult organizations

Approximately one-half were not satisfied with their present jobs, and 48 percent of the men and 67 percent of the women had no training for their present jobs.

More than half of the young women and three-fourths of the young men were greatly interested in further education. Seventy percent had no education or special training beyond high school. In spite of this and their high interest in additional training, 65 percent of the men and 74 percent of the women were not participating in any form of organized educational effort.

The young adults expressed strong attachments to their present communities. Nearly nine out of ten liked their present community. They have many friends nearby, they consider the stores and other services as good or better than those in other similar communities, and they spend the majority of their social life locally.

Organizational Participation

Young adults did not participate in organizations as much as other groups. However, this survey showed higher participation than have previous national studies. Four out of five young adults attended at least one-fourth of the regular church services, and half participated in additional church centered organizations. Our chart shows the percentage of young adults participating in 12 types of adult organizations. Although three out of five attended at least one-fourth of the group meetings in some organization outside their local church, most civic, professional, and educational groups were reaching only one in ten.

Unless older adults draw younger ones into their organizations, the younger adults tend to stand by "willing but idle." Sixty-five percent of the men and 54 percent of the women said they felt at home in local adult organizations. This indicates a willingness to spend part of their time with older adults. In addition, four out of five said that "organizations specifically for young men and women my age are necessary," and over one-half said they have time to participate in another organization.

Organizations Preferred

One-half would prefer to belong to organizations in their immediate community and the other half to organizations in the larger trade area com-

(Continued on page 6)

Quackgrass Control in Potatoes

No effects of the dalapon treatments on sprouting or on storage decay were noticed.

WALLACE W. NELSON and R. E. NYLUND

MOST WEEDS in potato fields are easily controlled by timely use of the weeder or spike-tooth harrow just before potato emergence, followed by row cultivation after emergence. One weed not easily killed by these methods, however, is quackgrass. Quackgrass is a perennial grass which multiplies by sending up new plants from underground rhizomes as well as by producing seed.

Row cultivation holds down quackgrass between the rows but does not control the weed among the potato plants in the row. By harvest time, these quackgrass plants have formed a dense sod which makes digging difficult. In addition, the quality of many tubers is reduced by rhizomes of quackgrass growing through them.

Three-Year Study

Because quackgrass is a particularly serious problem in the potato-growing areas of northeastern Minnesota, a 3-year study was begun in 1956 at the Northeast Experiment Station at Duluth to determine if this weed could be controlled by the use of chemical herbicides. All trials were carried out on land that had been in sod for at least 2 years before planting potatoes. Herbicides used were applied in 14 gallons of water per acre to plots 20′ x 132′ using a field sprayer. Each treatment was applied to four plots each year.

The procedure used in all 3 years was to apply the various herbicides in the spring to quackgrass 6 to 8 inches tall, plow 7 to 10 days later, then immediately plant several rows of potatoes through each of the plots.

Herbicides which have been tested are maleic hydrazide, amitrol (amino triazole), telvar (chlorophenyl dimethylurea), polychlorobenzoic acid, and dalapon (sodium 2,2 dichloropropionate). Of these, only the latter has given any measure of quackgrass control.

Dalapon Treatments

In each year dalapon was applied at 5, 10, and 15 pounds per acre. The quackgrass control obtained with each of these rates is indicated in table 1, together with the temperature and rainfall conditions preceding and following the dalapon application. Dalapon at 5 pounds per acre gave fair to good control of quackgrass; good to excellent control was obtained with the 10- and 15-pound rates. Quackgrass control was also fairly consistent from year to year in spite of quite wide variations in temperatures and rainfall preceding and following application of the dalapon.

That potato yields were not affected by the dalapon treatments is shown in table 2. Yields were obtained from two varieties planted in the quackgrass plots in 1956 and from one variety in 1957 and 1958. However, one effect of the dalapon treatments on potatoes was very apparent. In 1956, tubers of the redskinned variety, La Soda, from dalapon-sprayed plots were much lighter red in color than tubers from unsprayed plots. (Since then, this effect of dalapon on red-skinned potatoes has been confirmed with other red varieties, notably Red Pontiac).

Samples of potatoes from each of the plots in 1957 were placed in storage and examined in the spring for possible differences in storageability.

Table 1. Quackgrass control with dalapon, 1956-58

	Quackgrass control rating*			
Herbicide applied	1956	1957	1958	3-yr. Ave.
Unsprayed	1.0	1.0	1.5	1.2
5 lbs. dalapon per acre	2.0	3.5	3.0	2.8
10 lbs. dalapon per acre	3.5	4.0	3.8	3.8
15 lbs. dalapon per acre	2.8	4.0	4.0	3.6
Ave. temp. during 6 days preceding treatment	48° F	46° F	51° F	
Ave. tempt. during 6 days following treatment	54° F	45° F	56° F	
Total rainfall during 6 days preceding treatment	1.30″	0.32″	0.04″	
Total rainfall between treatment and plowing	0.05″	0.89″	0.30″	

* Control ratings: 1 = none, 2 = fair, 3 = good, 4 = excellent.

Table 2. Yields of potatoes from quackgrass control plots

	Bushels potatoes per acre of indicated varieties			
	1956		1957	1958
Herbicide applied:	La Soda	Minn. No. 20	M-355	M-355
Unsprayed	402	294	277	306
5 lbs. dalapon per acre	437	335	274	250
10 lbs. dalapon per acre	439	306	237	264
15 lbs. dalapon per acre	437	290	261	317

Summing Up

In summary, the application of dalapon at 10 pounds per acre has given almost complete eradication of quackgrass. The method of treatment is as follows:

(1) Allow the quackgrass to grow 6 to 8 inches tall.

(2) Spray the quackgrass with dalapon, using 10 pounds per acre in a sufficient volume of water to give uniform coverage.

(3) Wait 7 to 10 days.

(4) Plow the field and plant potatoes.*

Do not use this treatment on land to be planted to red-skinned varieties of potatoes.

At present prices, the cost of the above method of controlling quackgrass is $20 to $25 per acre. This cost must be weighed against the improvement in potato quality obtained, the improvement in digging operations, and the elimination of quackgrass not only from the potato crop but from subsequent crops grown on the same land.

Wallace W. Nelson is assistant superintendent of the Northeast Experiment Station at Duluth. R. E. Nylund is associate professor, Department of Horticulture.

* A good job of plowing appears to be essential for success with this treatment. In field-scale applications using 8 pounds of dalapon per acre, good control was obtained in one field where a good plowing job was done, while in another field sprayed with the same rate of dalapon on the same day but plowed poorly, practically no quackgrass control was obtained.

How Much Nitrogen from Legumes?

A. R. SCHMID, A. C. CALDWELL, and R. A. BRIGGS

IT HAS LONG BEEN KNOWN that legumes and legume-grass mixtures increase yields of succeeding crops. This increase has been attributed to the nitrogen supplied by the legume, improved soil structure, more organic matter, improved drainage, disease and insect control, and other factors. Little information is available showing the relative importance of these factors. With this in mind, the University started at the Agricultural Experiment Stations at Waseca, Crookston, and Rosemount to measure the effect of the nitrogen contribution.

Corn Yields

In 1954 Superintendent R. E. Hodgson and Agronomist John Thompson at the Southern Agricultural Experiment Station at Waseca grew three kinds of crops—oats, alfalfa for hay, and timothy for hay. These crops were plowed under and the area planted to corn the next 3 years. Zero, 20, 40, 60, and 80 pounds of nitrogen were applied per acre each year before planting. The whole area received adequate phosphate and potash over the experimental period to insure that no deficiency of phosphorous or potassium developed.

In 1955, the first year of corn after oats, grass and alfalfa, yields were not as high as normal due to the dry season (figure 1). It took about 40 pounds of nitrogen on the oats and grass areas to equal corn yields following alfalfa without any nitrogen added. In 1956, better moisture conditions prevailed, and it took 80 pounds of nitrogen on the oats and grass areas to raise yields equal to those following alfalfa without nitrogen. In the third year (1957), with good moisture available, it required 40 pounds of nitrogen on the plots following oats and grass to equal corn yields following alfalfa without nitrogen. Thus the total nitrogen contribution of the alfalfa for the 3 years was about 160 pounds.

Corn yields following grass in 1956-57 tended to be slightly higher than corn yields following oats. This may mean that, in addition to nitrogen, other factors are responsible in increasing yields since grasses such as timothy do not add nitrogen to the soil as does alfalfa.

Wheat Yields

The experiment at Crookston under the direction of O. C. Soine was very similar to the one at Waseca—except that wheat was grown for 3 successive years following the oats, grass, and alfalfa. Applications of fertilizer were used to supply adequate phosphate and potash. Five nitrogen rates were applied each spring before seeding the wheat.

The first year following oats, grass, and alfalfa it took 40 to 80 pounds of nitrogen on the oats area to approach the high yield following alfalfa without any nitrogen added (figure 2). Yields following grass were somewhat lower than yields following oats. In 1956 it required about 80 pounds and in 1957 20 to 40 of nitrogen to bring wheat yields following oats and grass equal to those following alfalfa without nitrogen added.

The total of nitrogen contribution of the alfalfa for the 3 years was about 150 pounds per acre.

Rosemount Experiments

At Rosemount, experiments were started in 1951 to determine not only the effect of oats, grass, and alfalfa on succeeding crops of corn but also the effects of different kinds of legumes and legume-grass combinations. Also at Rosemount the effects on succeeding crops of corn of 2-year meadows were compared to effects of 1-year meadows.

A 1-year hay crop of red clover was almost as effective in increasing corn yields as 1 year of alfalfa. The nitrogen contribution of red clover and alfalfa amounted to approximately 140 pounds of nitrogen per acre over the 3-year period.

The yield of corn after 2-year alfalfa meadows was practically the same as after 1-year meadows. In both cases, the first year of corn following alfalfa yielded as well as corn following oats with 80 pounds of nitrogen added. During the second year, corn yields following alfalfa were somewhat lower than those following oats with 80 pounds of nitrogen—but alfalfa was still contributing about 60 pounds of nitrogen. The third year of corn following alfalfa yielded no better than corn following

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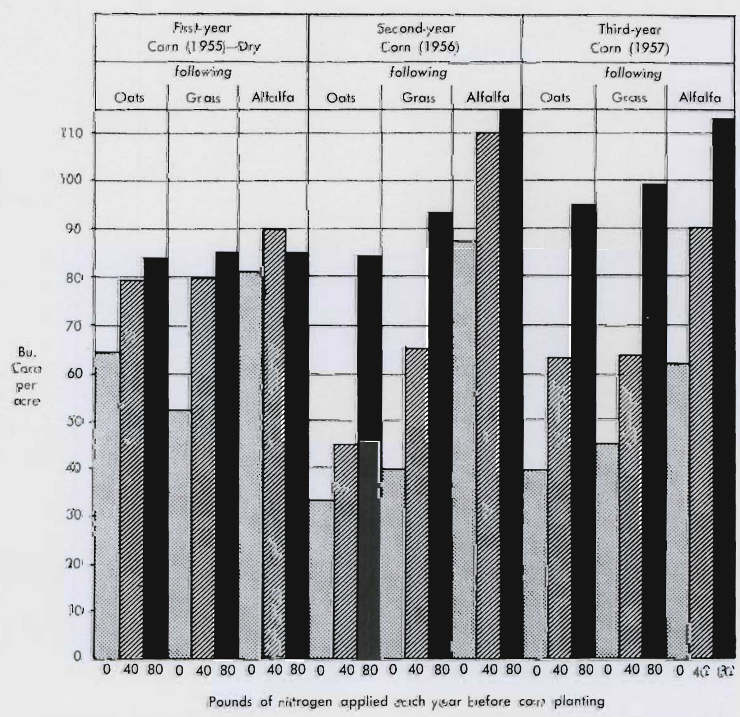

Fig. 1. CORN YIELDS, three years in a row, following oats and two kinds of hay, Waseca, 1955-57.

A. R. Schmid and R. A. Briggs are both associate professors, Department of Agronomy and Plant Genetics. A. C. Caldwell is professor, Department of Soils.

YOUNG ADULTS

(Continued from page 3)

munity or the county. Likewise, one-half felt that there were enough young men and women in their immediate local community to make for a good organization. Three out of four indicated that there were enough such persons in the trade area and county.

The young adults felt that the desirable size of group for good organization ranged from less than 25 to over 50. Only one-third of the men and one-fourth of the women were willing to travel more than 15 miles to organizational meetings.

The October 1958 issue of MINNESOTA FARM AND HOME SCIENCE reported several other attitudes. Single young men and women prefer to belong to groups of single men and women involving both sexes. Young married people prefer groups of married couples. On the whole, they all favored combining farm and town young adults. "Although the older ones (24 to 30) do not object so strenuously to including the younger members in their groups, the younger members (18-23) definitely prefer to restrict the upper age limit. Furthermore, many young adults shy away from associating with groups oriented toward either adolescence or older adults."

Implications

The practical problem for those who wish to involve young adults in worthwhile educational and group activities is to understand more fully the major interests and needs of young adults. It is not sufficient to design a program for established and mature adults and try to persuade young adults to take advantage of it.

The impact of organization and improved communications have changed rural communities greatly. The setting in which rural young adults find themselves is vastly different from the communities in which their parents and grandparents grew to adulthood. There are fewer guideposts for present-day young adults. Traditional social and vocational patterns of previous generations are inadequate. This has brought attention to young adults 18 to 30 years of age as somewhat of a problem group.

Until young adults have achieved full adult stature in their own eyes and in the eyes of the older adults, they are denied the satisfaction of full community participation and the feeling of belonging. They lack a sense of responsibility for the communities in which they live and do not use their energies for community improvement. It is in the community that the opportunities must be provided—and that largely by key older adults. The energies, enthusiasms, and abilities of this age group, if fitted into local communities throughout Minnesota, can help to build a greater state in the years ahead.

Young adults want to participate more actively in group activities. They want organizations to which they can belong with other young men and women of their own age. They recognize their need for more training and experience, more education, improved personal qualities, and credit to get ahead. Many are looking forward to better jobs which require additional training, but only a fourth are participating in any form of organized educational effort.

NITROGEN . . . LEGUMES

(Continued from page 5)

oats without nitrogen. At Rosemount the effect of alfalfa and red clover was primarily a nitrogen effect for a period of 2 years.

A good stand of birdsfoot trefoil in the 2-year meadow experiment had the same effect on succeeding crops of corn as alfalfa.

Summary

The experiments conducted at Waseca, Crookston, and Rosemount emphasize the high value which should be placed on legumes and legume-grass mixtures such as alfalfa or alfalfa-brome. If we add the value of the nitrogen contributed to succeeding crops to the value of alfalfa hay, we have a high-return crop. The 140 pounds of nitrogen (when expressed as a fertilizer such as ammonium nitrate) amounts to 420 pounds of ammonium nitrate, worth about $20.

The livestock farmer who uses alfalfa or alfalfa-grass and rotates his acreage of these rapidly around the farm has an "Ace in the Hole." He has a high-return feed crop to begin with and he obtains this free nitrogen.

Other advantages of alfalfa should not be overlooked. The ability of alfalfa to open up tight soils, to make the soil easier to work, and to aid in control of weeds, diseases, and insects are important considerations.

There is no doubt that highly profitable yields can be grown with a continuous cropping system (corn-corn-corn, etc.), on level lands using adequate application of fertilizer and good soil and crop management. However, high yields can be obtained with less nitrogen following good legume crops, and this system is applicable to all soils.

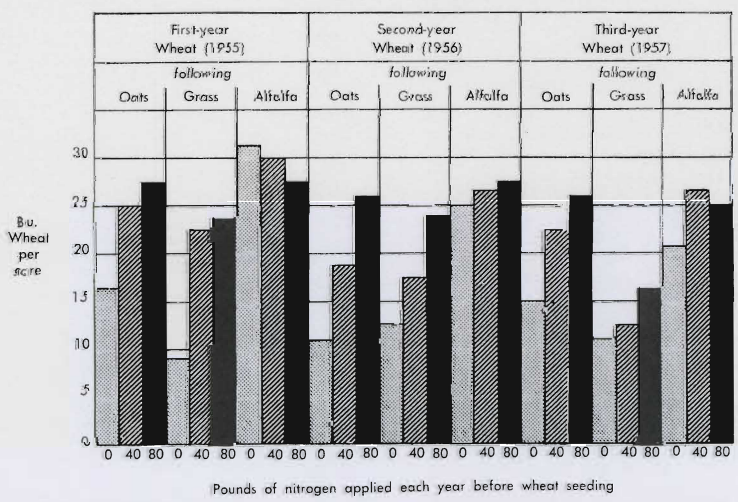

Fig. 2. WHEAT YIELDS, three years in a row, following oats and two kinds of hay, Crookston, 1955-57.

Packaging Bread and Sponge Cake for the Home Freezer

SHIRLEY R. TRANTANELLA and J. D. WINTER

WITH THE INCREASING attention being given to the freezing of foods, by no means have bread and cake been overlooked. Many homemakers enjoy baking and freezing their own cakes and breads, but probably a greater number of home-freezer owners are freezing commercially baked products, especially bread.

As a large proportion of bread sold over the retail counter is wrapped at the bakery, homemakers may give little thought to overwrapping (putting on another wrapper) the bread before placing it in the home food freezer. In a study that we recently completed, baked, sliced, and commercially wrapped white bread was frozen. All but one lot was overwrapped. Four different plastic films and heavy duty aluminum foil, 0.001 inch thick, were used as overwraps on the other five lots.

The bread was frozen and stored at approximately 8°F. for 3 storage periods of 4, 6, and 10 months. At the end of the 4- and 6-months storage periods, there were little differences in flavor or crumb firmness among the loaves of bread stored in any of the packaging materials used. However, after 10 months in storage, the scores for the bread that was frozen in only the commercial wrap and not overwrapped were decidedly lower (see table 1).

When homemakers freeze commercially baked bread, most likely they do not anticipate keeping it frozen for more than a few weeks. Even though bread is a food that is eaten every day, it is not uncommon for it to get "hidden" or "tucked" away in the home food freezer many months beyond the time expected. Therefore, it would be advisable to overwrap all commercially wrapped bread before freezing so as to keep it at the highest quality possible. It is wise to remember that for the most economical use of the home food freezer, it is best to develop the habit of rapidly "turning over" the bulky frozen foods that are stored.

Almost all cakes and cup-cakes that are baked may be frozen satisfactorily. Sponge cakes and angel food cakes lend themselves particularly well to freezing. They take a short time to thaw and they can be used in combination with fresh and frozen fruits, ice cream and whipping cream, making an "extra special" dessert that can be prepared quickly. However, whether sponge cakes or angel food cakes are prepared at home or purchased at the bakery, they will need to be wrapped before freezing.

Sponge cakes being so similar to angel food cakes and more susceptible to "off-flavors," we experimented with sponge cakes, using three different types of packaging materials. The cakes were baked, cooled, and packaged. Two of the lots were placed in two different types of plastic film bags and one lot was placed in bakery cartons without an overwrap. The cakes were frozen at −10° F. and then stored at a temperature of approxi-

(Continued on page 8)

Table 1. Palatability and crumb firmness scores of frozen white bread in various packaging materials at 8° to 12° F.

Description of packaging material*	Storage period (months)	Scores: Flavor freshness† (average)	Scores: Desirability of crumb firmness† (average)
Polyethylene bag, 0.0015 in. thick	4	7.1	7.1
	6	6.9	7.0
	10	6.8	6.5
Polyethylene bag, 0.0015 in., inside treated with Tenox II	4	7.2	7.1
	6	6.9	7.1
	10	6.9	6.5
300 MSAD cellophane coated with 0.0015 in. polyethylene	4	6.8	6.9
	6	6.7	7.2
	10	6.8	6.3
300 MSAD cellophane coated with 0.0015 in. polyethylene, inside treated with Tenox II	4	7.0	7.2
	6	7.0	7.0
	10	6.7	6.4
Commercial bread wrapper: 24-lb. ream weight opaque sulfite, coated with polyethylene-wax blend	4	6.9	6.9
	6	6.7	6.3
	10	5.5	4.5
Aluminum foil, heavy duty, 0.001 in. thick	4	6.9	7.1
	6	7.2	7.1
	10	6.8	6.6

* With the exception of the commercial bread wrapper lot, each packaging material was used as an overwrap for the commercial bread wrapper.
† The scores for the fresh sample were 7.0 at each judging period—scores below 5 indicate a commercially unacceptable product.

Table 2. Palatability and crumb firmness scores of frozen sponge cake in various packaging materials stored at 8° to 12° F.

Description of packaging material	Storage period (months)	Scores: Flavor freshness* (average)	Scores: Desirability of crumb firmness† (average)
Unwaxed bakery carton, no overwrap	3	6.3	6.8
	7	1.8	1.4
300 MSAD cellophane coated with 0.0015 in. polyethylene	3	9.0	9.1
	7	7.6	8.0
Polyethylene bag, 0.0015 in. thick	3	8.8	8.8
	7	7.3	7.7

* The score for the fresh sample was 10.0 at each judging period.
† The score for the fresh sample was 9.7 at the first judging period and 10.0 at the last one.

Shirley R. Trantanella is instructor, and J. D. Winter, associate professor, Department of Horticulture.

Weather and Plant Diseases

ROY D. WILCOXSON and T. H. KING

GENERALLY, Minnesota farmers expect to sustain some loss due to plant diseases. They know that rust of small grains, potato late blight, alfalfa leaf spot, and other diseases of our farm crops may be so severe that little will be harvested. Fortunately, severe losses do not occur every year. For example, extensive surveys indicated that plant diseases were not generally a serious problem in Minnesota in 1958.

A relatively cool, dry summer was one of the major reasons why plant disease was not important in Minnesota in 1958. Temperature and moisture are often limiting factors in the seasonal and regional development of plant diseases—and not only was 1958 a cool summer generally, it was also the fourth driest of record.

But the unusually cool summer permitted a new disease, which normally occurs at high altitudes or in cooler regions, to develop in Minnesota last year. Our hot summer weather usually prevents stripe rust of wheat from establishing itself. Last year, however, it was found in virtually all the wheat-growing areas of the midwest as well as in Minnesota, for the first time.

Wheat stem rust is one of the most important plant diseases in Minnesota. In some years it nearly ruins the wheat-growing industry, but in other years it is found in such small amounts that little damage occurs. Whether it becomes epidemic depends on the occurrence of a chain of events involving the weather in the region stretching from Mexico to Canada.

The essential features of this chain of events are as follows. Occurrence of a late, mild fall in the north central region permits the abundant production of "urediospores" (red spore and summer spore stage) on grasses and late wheat. Huge quantities of these urediospores are then blown southward into Texas and Mexico. There, if the fall and winter weather is mild, the rust fungus survives and grows on grasses and winter wheat. The spring season in the south should be warm and moist to permit abundant production of urediospores, which will then be blown northward by the wind. The weather in the northern areas should also be warm and moist for infection of grasses and wheat to occur. When plants become heavily infected, hot and dry weather increases the amount of damage. Naturally susceptible wheat varieties must be grown in all of this vast region.

Thus we see that for stem rust to become epidemic in our state, weather must be favorable in Minnesota as well as in far-away regions. In this vast area, weather was not favorable for rust during the fall and winter of 1957 and summer of 1958—and rust did not occur in Minnesota except in very small amounts.

Other diseases require that weather in our own state only must be favorable. The period when infection first occurs in the spring is a critical time in the development of many plant diseases, as illustrated by the apple scab. This disease is most severe in areas where the spring season is cool and rainy. The fungus which causes the disease lives through the winter on dead apple leaves lying on the ground. In the spring when the young apple leaves and flowers are unfolding, the scab fungus produces spores, which are shot into the air and blown to the young susceptible plant parts. Infection results.

These processes of spore production, liberation, and infection require cool, wet weather during the time when flowers and leaves appear. If the rainy weather comes too early, the fungus shoots most of the spores into the air before the susceptible plant parts appear. Only a few infections of scab then occur. If the rain comes late or does not come at all, the fungus cannot shoot its spores in time to damage the trees severely. When only a few early infections of scab occur the disease spreads very little during the rest of the season unless weather conditions become extremely favorable for the pathogen.

During 1958, the spring season was unusually dry and very little rain fell later in the summer. Apple scab was practically absent from Minnesota apple orchards.

The previous examples illustrate the effects of weather acting largely on the plant pathogen. Weather may also affect the host plants so that they may be either resistant or susceptible. Such an example is provided by the seedling blight disease of corn and wheat caused by the fungus, *Gibberella zeae*.

Corn seedling blight occurs when the soil temperatures range below about 70° F. It becomes progressively less severe as soil temperatures are increased. At 75° F. very little corn seedling blight develops.

Wheat seedling blight develops under conditions quite different. Soil temperatures below 55° F. do not permit the disease to occur; but as soil temperatures are raised, seedling blight also becomes more severe. The explanation is that when temperatures retard the development of the host plant, resistance is poor and disease results.

Corn grows best at 75° F. or higher, while wheat grows best at about 55° F. The practical result is that seedling blight of wheat occurs in the southern part of the Wheat Belt and corn seedling blight occurs mostly in the northern part of the Corn Belt.

Roy D. Wilcoxson is assistant professor and T. H. King is professor, Department of Plant Pathology and Botany.

PACKAGING...

(Continued from page 7)

mately 8° F. for two storage periods of 3 and 7 months.

At the end of the first storage period of 3 months, the sponge cakes packaged in the plastic film bags were far more desirable in flavor freshness and crumb firmness than the samples stored in bakery cartons. In fact, even through the 7 months of storage, the sponge cakes which were in the plastic film bags received relatively high scores, although there was a noticeable decrease in palatability at this time. However, the cakes stored in the bakery cartons were not palatable at the end of the 7 months (see table 2).

As with freezing bread, a homemaker may anticipate storing a cake for a very short time; but due to unforseen events, the cake may not be used for many months after the time expected. Many changes occur in the best planning for the use of food in the home freezer; therefore, it would be wise to package cakes, as well as bread, so that they will remain palatable during maximum storage.

Pumping Plants Are Proving Their Worth as Tile Outlets

CURTIS L. LARSON

THE USE OF AN AUTOMATIC pumping plant as a tile outlet is no longer an experiment but an accepted practice. A recent survey showed that Minnesota has about 100 pump-drainage systems. Most are individually owned, draining areas of less than 100 acres. Farm pumping plants are becoming common in other upper Midwest states, too—especially in Michigan, which has over 100.

Pumping plants are used as tile outlets where there isn't enough fall for a gravity outlet, or to replace a long tile main or deep outlet ditch. According to a Minnesota Attorney General's opinion (dated March 25, 1959), pumping plants may be used for drainage purposes if the water is discharged into its natural watercourse, and if reasonable care is taken to avoid damage to lands below. Also, there must be a reasonable necessity for drainage and the benefits must reasonably outweigh the damages, if any. These same limitations apply to any type of drainage improvement in Minnesota.

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Design Features

A suggested design for a small pumping plant serving as a tile outlet is shown in figure 1. The tile main discharges into an enclosed sump, which must be of adequate size to prevent the pump from starting and stopping too frequently during moderate rates of tile flow.

The pump lifts the water from the sump to a ditch, lake, stream or other free outlet, usually a distance of 4 to 10 feet. Because of its large capacity for low lifts, the propeller-type pump is ideally suited for drainage pumping. Furthermore, it is self-priming, low in cost, and easy to maintain.

Those farmers who have purchased pumps of adequate size from experienced pump manufacturers have had very few pump problems. Although a drainage pump normally operates only a few minutes at a time, it must be capable of operating non-stop for several days. Thus it doesn't pay to take a chance on a second-hand or a "home-made" pump, which is of unknown capacity and apt to break down when needed the most.

Being suited to automatic operation, electric motors are used to drive the pump wherever possible. Vertical-shaft motors connected directly to the pump (see figure 1), have proved to be the most trouble-free and efficient type of driving unit. In most of the pumping plants inspected in the survey a single phase motor of 5 horsepower or less was used.

A float, float rod, and float switch are most commonly used to start and stop the pump automatically. Care must be taken with a float to avoid sticking, binding, or leaking. Dual electrode controls suspended in the stilling chamber have also been used with good results.

Most of the enclosed sumps are round and are made of concrete silo staves laid up without mortar. A floor is not necessary except in quicksand or peat. To reduce the depth to the footing, a short section of 36-inch diameter pipe can be sunk somewhere within the main sump to serve as a suction area for the pump.

Due to wet conditions, quicksand, or wrong procedures, a few owners have had trouble getting the sump built. With round sumps, care must be taken in setting the staves and backfilling must be done uniformly to keep the sump perfectly round. Where these precautions were taken during construction, there have been no failures of silo stave sumps.

Square sumps of concrete or concrete block can be used if heavily reinforced or braced. However, a round sump is generally cheaper to build. Open sumps are occasionally used, particularly where a large storage area is needed. The pump is mounted either on poles over the open sump or in a small enclosed sump alongside.

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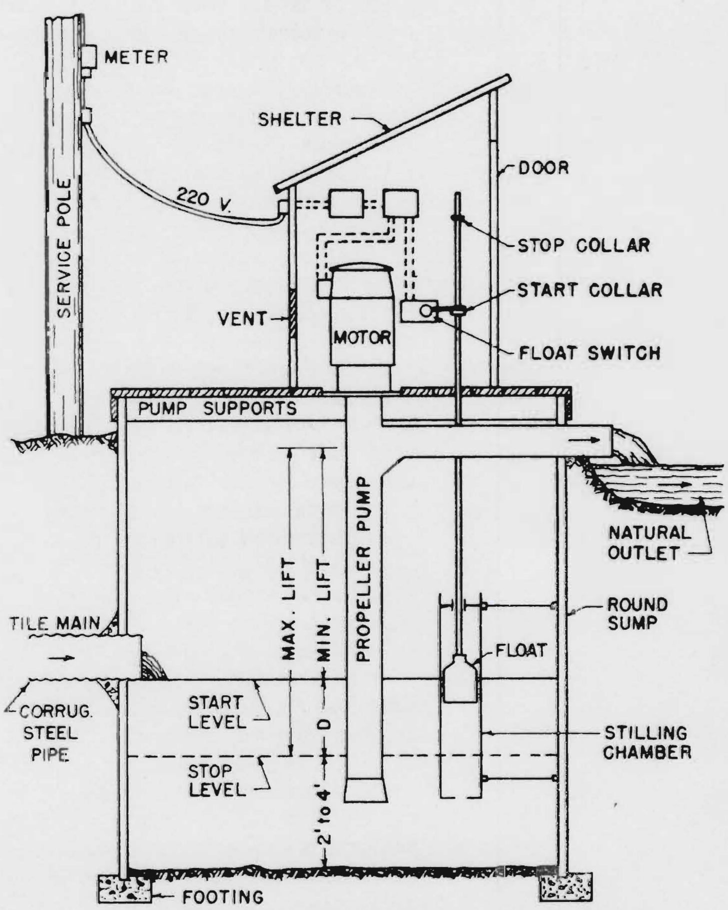


Fig. 1. Suggested design for a pumping plant serving as a tile outlet.

Bacteria 'Growth Temperatures' Affect Food Preservation

J. J. JEZESKI

TO MOST EVERYONE, the word "bacteria" is associated with disease. However, there are many species of bacteria which do not cause disease yet still are important because they can grow in foods and cause deterioration. Some of the defects caused by bacteria include off-odors and flavors, discolorations, and the appearance of slime.

What are bacteria? Commonly they are referred to as "bugs". Actually they are little plants—so tiny that it takes approximately 15,000 to 25,000 of them laid end to end to cover an inch. They do not have roots, stems, leaves, or a green color but are classified as plants because of the way they grow, the way in which they take up food, and the way they multiply.

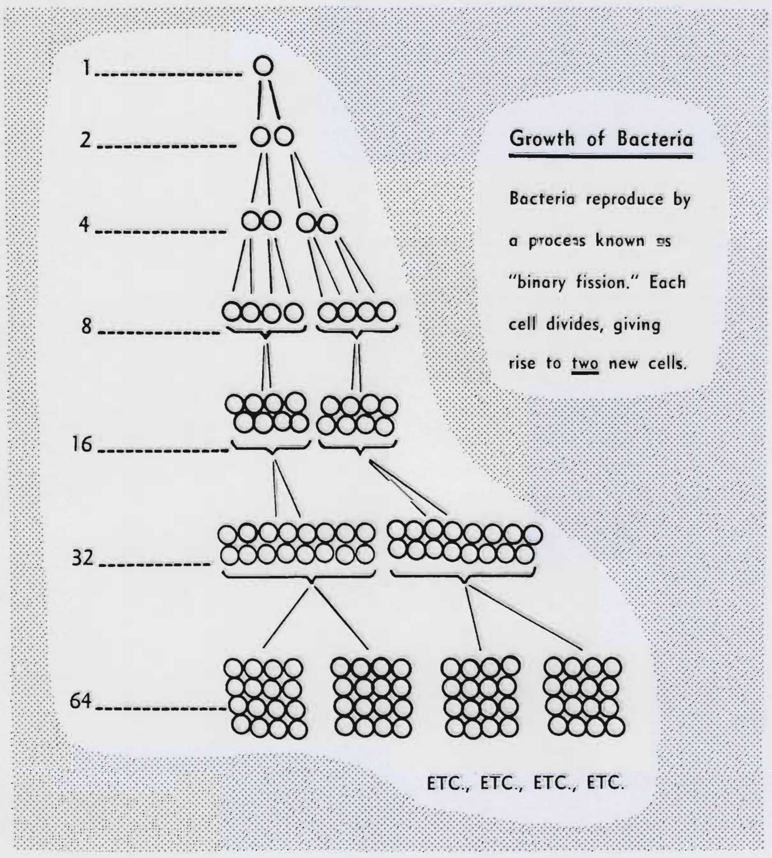
Being so small, why are they so important? The answer is because of the peculiar way they grow. Bacteria grow extremely rapidly—so fast that there will be thousands of progeny from a single cell held under ideal conditions for a few hours.

Bacteria generally reproduce by a process known as "binary fission." That is, each cell divides to form two individual cells. Starting with one cell, it divides into two, the two divide into four, the four into eight, and so on and on. Actual percentage increases in numbers are not huge at every cell division. But this doubling in numbers doesn't take a year, a month, or a day; it occurs in the space of only a few minutes—commonly 20 to 30 under optimum conditions of temperature and other factors. This time period is generally known as the "generation time."

Factors Influencing Growth

Some of the factors that influence the growth of bacteria and the rate at which they multiply are temperature, moisture, and the nutrients or food supply available. In many types of raw food materials (such as milk or cream, meat, fish, fruits, and vegetables) and processed or cooked foods (such as bottled cream and milk, cooked fish, meat, custards, cream pies, stews, soups, and a variety of home-prepared dishes), there are always ample amounts of nutrients and moisture to permit good growth of bacteria. Consequently, the only factor we can control to limit bacterial growth is temperature.

Perishable foods must be kept cool to preserve them, and even when kept cold (not frozen) they will keep only for a limited time. Why does refrigeration result in preservation of foods? What are the important considerations in preventing deterioration in perishable foods?



Effect of Temperature

To show the influence of temperature on the growth of bacteria, let's assume they are under ideal conditions for growth. We can then make some calculations on how changes in incubation temperature affect the final populations after 8 hours. (See table 1.) At 95° F., the generation time of many common bacteria is about one-half hour. In other words, it takes a half-hour for one cell to divide into two, or for the population to double. Consequently, after 8 hours at 95° F. there would be 16 generations. Or, for every cell present at the beginning, there would be approximately 65,000 at the end of 8 hours.

If the temperature is decreased to 77° F., the generation time is increased to 1 hour. Under these conditions, things have cooled off a little bit and the bacteria grow somewhat more slowly. For every cell at the beginning, 8 hours (or 8 generations) later there are 256. We've decreased the temperature by 18° F.—and instead of 65,000 bacteria for each cell originally present, there are 256.

If the incubation temperature is decreased another 18° F., down to 59° F., the generation time is lengthened to 2 hours. For every cell present at the beginning, there are only 16 at the end of 8 hours. There have been only 4 generations in 8 hours at 59° F., whereas there were 16 generations at 95° F.

Decreasing the temperature to 50° F. results in a generation time of 4

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hours. Now there are only 4 cells after 8 hours for every one originally present, since there was time only for two generations at this low temperature. This is a striking example of how temperature affects bacterial growth and how important it is to cool all perishable foods quickly and to low temperatures.

Table 2. Development of a pure culture of bacteria in sterile skim milk*

Temperature	Generation time	Original population	Population after 8 hours
35° F.	40 hrs.	10,000	11,500
40°	12	10,000	15,800
50°	4	10,000	40,000
60°	2	10,000	160,000
70°	1	10,000	1,500,000
80°	0.5	10,000	630,000,000

* Pure culture of *A. Aerogenes;* data of V. W. Greene and J. J. Jezeski.

Laboratory Experiment Verifies Calculations

In an actual laboratory experiment utilizing a pure culture of bacteria growing in skim milk (table 2), our results agreed very closely with those presented above. The effect of incubation temperatures in the range of 35° F. to 80° F. was tested on the rate of growth during an 8-hour incubation period. Very little growth ocurred at 35° F. The generation time was about 40 hours, because the original population of about 10,000 bacteria per milliliter increased to 11,500. When the temperature was increased to 40° F., the generation time became 12 hours and final population of 16,000 per milliliter resulted.

Table 1. Calculated population increases of bacteria at selected temperatures

Storage time in hours	Temperature and Generation time 95° F. 0.5 hr.	77° F. 1.0 hr.	59° F. 2.0 hrs.	50° F. 4.0 hrs.
0.0	1	1	1	1
0.5	2			
1.0	4	2		
1.5	8			
2.0	16	4	2	
2.5	32			
3.0	64	8		
3.5	128			
4.0	256	16	4	2
4.5	512			
5.0	1,024	32		
5.5	2,048			
6.0	4,096	64	8	
6.5	8,192			
7.0	16,384	128		
7.5	32,768			
8.0	65,536	256	16	4

On increasing the temperature to 50° F., the final population of 40,000 indicated the generation time was 4 hours. At 60° F., a 2-hour generation time resulted in a final population of 160,000 per ml. At 70° F., a generation time of 1 hour produced a population of 2,500,000 bacteria per ml.; at 80° F. the final population was 630,000,000 per ml. with a half-hour generation time. These data show the actual response to temperature of an organism commonly associated with spoilage defects in milk, cream, and cottage cheese.

Not How Much Temperature Drop But Where on Scale

Some of these results show how the generation time varies as the temperature changes. Starting at 80° F., reducing the temperature doesn't increase the generation time significantly until the temperature drops below 70° F. Consequently, such a temperature change does not accomplish anything for food preservation because the growth of bacteria is not inhibited much.

The important effects become evident below 70° F., with the very important ones taking place below 50° F. For instance, if the temperature is decreased from 70° F. to 60° F., about 1-hour increase in generation time results. But, if the temperature is decreased from 50° F. to 40° F., the generation time increases from about 4 to 12 hours. In other words, generation time was increased 8 hours by a similar 10° drop in temperature, but what counted was the part of the temperature scale in which the reduction took place. The lower the temperature, the greater the effect on the growth of bacteria.

Whether we are talking about raw milk in the cooler in the milk house, market milk, cottage cheese, custard, cream pie, or left-overs from a meal in the household refrigerator, the same principles apply. The greatest effect from refrigeration is not at the warmer temperatures but at the colder temperatures just above freezing. Therefore, it must be emphasized that for lower bacterial counts in raw milk delivered to the dairy processing plant, for maximum shelflife of finished dairy products and all fresh and pre-packaged perishable foodstuffs, it is necessary to cool promptly, rapidly and completely. It is going just the few degrees lower that is so important.

PUMPING PLANTS

(Continued from page 9)

A large percentage of the 76 pumping plants inspected in the survey were of adequate capacity and were working satisfactorily, However, some were too small, poorly constructed, or had a pump unsuited to the job. In a few cases, the pump and motor size could have been reduced by diverting or by-passing part of the surface water. Most of these shortcomings could have been avoided by making use of the technical assistance that is available from soil conservation engineers, technicians, and contractors.

Installation and Operating Costs

Data on cost of installation were obtained for 56 pumping plants. Initial costs were found to vary widely with the size of the area drained. The "area drained" refers to the area from which water is collected, which may be larger than the area benefited if surface water has to be pumped. Initial costs increase with the area drained but not in direct proportion. Thus, on a per acre basis, a pumping plant for a large area is cheaper to build than a small one.

Approximate costs of installation for various areas, based on the 1958 survey, are given in table 1. To allow for increased costs and other variables, the actual costs obtained in the survey were increased by 25 percent. Values in the table are suitable for preliminary estimates. For a particular installation, of course, the final cost may run considerably more or less.

Table 1. Approximate costs of installation for pumping plants serving as tile outlets

Acres drained	Cost of installation	Acres drained	Cost of installation
10	$ 630	100	$1,620
20	850	125	1,750
30	1,020	150	1,850
40	1,150	175	1,920
50	1,250	200	1,970
60	1,330	250	2,030
80	1,490	300	2,080

(Continued on page 17)

Using Meteorological Data in Calculating Soil Water Losses

DONALD G. BAKER

TWO PROCESSES remove valuable plant-available water from the soil. One is **transpiration** in which water within the plant (originally obtained from soil water) is lost to the air from the plant surface. **Evaporation** of water from the soil surface is the other. Since both processes are involved, the coined term **evapo-transpiration** is now used to describe losses of plant-available soil water. The single term is quite suitable since both evaporation and transpiration are fundamentally dependent on one factor, weather.

Effect of Sun and Wind

Both the sun and the wind help cause soil water losses. The sun provides the energy necessary for both plant growth processes and evaporation; it is also the driving force that produces weather. Therefore, evapo-transpiration is greater and more water is required for proper plant growth in areas where sunshine intensity is high. It is also greater in the summer months, when the sun is more directly overhead and days are longer.

The wind creates air movement which increases evapo-transpiration losses. The temperature and humidity of the air are also important.

Evapo-transpiration losses do not vary greatly among Minnesota's major agricultural crops. Differences that do occur are essentially a matter of different rooting depths, which may be taken into account in the calculation method used.

Four methods can be used to determine evapo-transpiration losses, but three of them involve elaborate gauging and instrumentation systems. For the present at least, they are too laborious and time-consuming for any rapid estimation.

Calculation Method

The fourth method is based upon the extensive cooperative weather-observer network established by the U. S. Weather Bureau. By applying certain meteorological data from weather-observing stations throughout the state, we can make reasonable estimates of the water losses.

Quite extensive comparisons have been made between actual field moisture measurements and calculated evapo-transpiration losses. Calculations were based entirely on data from weather-observing stations, located within the same county where possible. (See table 1.)

Discrepancies between measured and calculated losses are not due to a fault in the method. The differences are due to a weather-observing network of insufficient density. Summer showers, for example, may be very spotty; the distance of a mile or less may mean the difference between rain and no rain. Consequently, when the calculated results are applied to a field not directly at the site of the weather-observing station, there is a possibility that it has rained at one place but not the other.

Reliable Results

Unfortunately, there are still some counties in Minnesota which have no weather observer. Nevertheless, the accuracy obtained indicates that this method is quite reliable, even for general application. Moreover, even when two different crops are being considered, the calculation method gives equally valid results. This is accomplished by taking the rooting depths into account and, therefore, the volume of soil available for water extraction.

Other Applications

In addition to calculating moisture lost from the soil during the crop season, this method could be useful in estimating two other things:

1. The moisture remaining within the soil. This can be estimated by a simple bookkeeping procedure, thus offering a relatively easy method for a statewide soil moisture survey. It could eliminate the long work of actually sampling the soil. Very often by the time such sampling is completed, the information is out of date.

2. The water supply and balance within the state. Table 2 is an example of calculations for stations in the four corners of the state. Several things of importance are evident from table 2.

Note first the total precipitation that falls during the growing season. The large amount is important to Minnesota agriculture. Note also the amount of water used by the vegetation ("annual evapo-transpiration"); at Hallock, in Kittson County, it almost equals the total precipitation. Keep in mind, however, that less water will be consumed if crops are planted late in the spring, or har-

(Continued on page 17)

Table 1. Comparison of measured and calculated evapo-transpiration losses of two crops, 1955 and 1956

Location	Soil type	Crop	Period	Measured loss	Calculated loss
				(inches)	*(inches)*
Dakota County	Waukegan silt loam	Peas	6/22–7/26	6.35	6.57
Dakota County	Waukegan silt loam	Corn	6/20–8/16	11.10	10.69
Sibley County	Nicollet clay loam	Corn	7/5–8/13	5.94	6.38
Sibley County	Nicollet clay loam	Peas	6/25–7/28	4.84	5.55
Sibley County	Nicollet clay loam	Corn	7/29–9/24	7.28	7.68
LaCrosse, Wisconsin	Fayette silt loam	Corn	5/25–10/2	16.73	16.98
LaCrosse, Wisconsin	Fayette silt loam	Corn	5/19–10/3	18.58	19.46

Table 2. Average measured precipitation received, and average calculated water use and loss, at four Minnesota weather-observing stations, 1926-55

	Weather-observing station			
	Grand Marais (Lake County)	Hallock (Kittson County)	Pipestone (Pipestone County)	Winona (Winona County)
		(inches)		
Annual precipitation	27.89	19.76	24.66	30.56
Growing season precipitation*	20.17	16.40	20.28	23.92
Annual evapo-transpiration	20.40	19.70	23.50	25.40
Surplus†	7.49	0.06	1.16	5.16
Annual potential evapo-transpiration‡	20.50	22.30	24.40	25.40

* Considered as that period when average monthly temperature is 40° F. or more.
† Subject to runoff, groundwater additions, or both.
‡ Amount of water that vegetation would use if soil water is always in sufficient supply.

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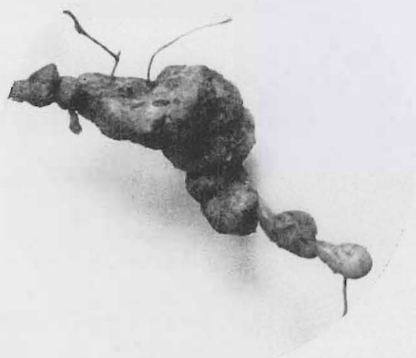
Root Knot—A Nematode Disease of Plants

DONALD P. TAYLOR



The type of root knot nematodes causing these heavy galls on a Jerusalem cherry can't over-winter in Minnesota, except in greenhouses. The one species that can over-winter produces tiny galls easily overlooked on the root systems of carrot, strawberry, and other plants.

ROOT KNOT is one of the oldest known diseases of plants caused by nematodes. Growers and research workers alike have recognized it for many years by the presence of conspicuous galls or "knots" on infected roots. Galls may be either small and numerous or very large and fused.

The disease cycle starts in the soil when a small, immature root knot nematode, less than 1/50 inch long, is attracted to a root of a host plant. Penetration of the root occurs rapidly, and within 48 hours a slight swelling is observed at the invasion site. The young nematode migrates within the root to the conductive tissues. Root cells near the nematode's head are stimulated to grow abnormally by the action of the nematode's digestive enzymes.

This worm-like animal, feeding exclusively on the enlarged cells, grows rapidly, becoming first sausage-shaped and finally spherical. By this time it has grown to such an extent that its posterior end reaches the root surface, where a mass of 300-600 eggs is laid. The cycle is completed when young nematodes hatch from the eggs, then migrate into the soil where they can infect other plants.

Like other animals, nematodes cannot produce their own food and must obtain it from other animals or plants. Plant parasitic nematodes obtain it from cells of the plant root. Loss of food materials to parasitic nematodes weakens the plant, causing above ground symptoms of starvation, i.e., stunting, reduced vigor, decreased yield, and chlorosis (yellowing). In addition to loss of food, nematodes affect plants by disorganizing the anatomy of root conductive tissues, thus interfering with mineral and water movement from roots to leaves. Therefore, tops of root knot-infected plants often have symptoms of mineral deficiencies and may wilt more readily than healthy plants.

Nematode feeding wounds may serve as avenues of attack for soil-borne bacteria, fungi, and viruses. Many diseases caused by these organisms become more severe when the plants are also attacked by root knot nematodes. This effect may cause more damage than direct feeding injury. In some varieties of crop plants, root knot nematodes are also known to break resistance to a fungus disease. Thus, a resistant variety can grow in a field infested with the fungus alone; however, in a field containing both the fungus and root knot nematodes, the crop becomes susceptible and dies.

Although once believed to be only a problem in warmer climates and in greenhouses, root knot has recently been shown to cause losses in Minnesota fields and gardens. Root knot nematodes comprise a group of about eight closely related species or varieties, most of which cannot survive low temperatures of Minnesota winters. However, at least one species—the northern root knot nematode—can and does overwinter here. Thus far it has been observed to cause losses on carrot, parsnip, sugar beet, strawberry, and several ornamental plants. This species produces small galls and in light infections can be easily overlooked unless the root system is examined carefully.

It is very important to know if root knot is present in a field or garden, because root knot nematodes can attack and cause damage to several hundred different plants. Since so many plants are susceptible, it is very difficult to eradicate these nematodes once they are present.

How can root knot be controlled? There is no easy, inexpensive, foolproof method, but several alternatives exist. Chemical soil treatment (soil fumigation) with materials toxic to nematodes (nematocides) is one of the most widely used methods. It gives the most satisfactory control under a wide range of soil, weather, and crop conditions. Most of the materials used —such as methyl bromide, chloropicrin, ethylene dibromide, and dichloropropenes—are toxic to plants and must be applied to the soil at least 2 weeks before planting to allow time for the toxic gases to leave the soil. Some of the newer materials, such as dibromochloropropane, are not toxic to many crops and will kill nematodes feeding on actively growing plants.

Often, on high-value crops, the effects of root knot can be overcome by heavy fertilizer applications and supplemental irrigation. Unfortunately, the nematodes increase rapidly in numbers under these conditions, and after a few years there are so many nematodes present that this method will no longer overcome the effects of root knot.

Root knot can be controlled also by using crops in the rotation that are not hosts. However, caution must be used to be certain that the plants are *not* hosts and that nematode-susceptible weeds are eradicated.

Use of resistant varieties would control root knot nematodes; however, little effort has gone into breeding crops for nematode resistance. As a result only a few nematode-resistant varieties are known, none of which can be used in Minnesota. Nevertheless this method of control offers much promise in the future.

Whether in the field, garden, or greenhouse root knot should always be controlled. If this disease is allowed to proceed unchecked, crops can be completly ruined. To avoid a root knot problem, purchase only plants free of this nematode. Secondly, when nematode-free plants are obtained they should be planted in land free from root knot nematodes or in soil treated to kill those already present. If these two measures were always followed, root knot would never be a problem. It is only through failure to obtain nematode-free plants or failure to treat infested soil that this nematode disease becomes a serious problem in Minnesota.

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Are Minnesota Waters Suitable for Irrigation?

E. R. ALLRED, R. A. YOUNG, and D. H. PETERSEN

WITH THE STEADY INCREASE in interest in irrigation in Minnesota, problems of water supply frequently arise. These may be concerned with getting enough water at a reasonable cost, obtaining a legal right to use the water, or determining whether the water is of suitable quality. Here we will discuss only the problem of water quality, as it pertains to irrigation uses.

Is water from one source better for irrigation than that from another? Many who hold such a theory are sincere in their opinions that crops grow better when irrigated with water from a pond or lake, rather than from a stream or well. While it may be true that some lake or pond waters are of a slightly higher temperature than well water, this alone has not proved to be important for field-grown crops. Nor, as is frequently supposed, do lake or pond waters contain beneficial amounts of algae and other organic substances to be preferred over well water.

What Is a Good Quality Irrigation Water?

To be of acceptable quality, irrigation water should not adversely affect crop growth, impair crop quality, or damage the soil. This depends on the impurities in the water, usually carried in solution but in some cases carried in suspension.

In general, those carried in suspension—such as silt or small particles of organic matter—do not seriously affect the quality of irrigation water in Minnesota. Such suspended materials may, in severe cases, become a nuisance by temporarily clogging small nozzles, intake screens, and the like, but usually don't occur in sufficient amounts to be of major concern.

Of greater importance is the amount and nature of the salt constituents carried in solution. Those which appear to be most important to irrigation water quality are: (1) total concentration of soluble salts, (2) relative proportion of sodium to other salts, and (3) concentration of boron. High sodium concentrations cause severe damage to plant growth and are most objectionable.

Boron is found in practically all natural waters, in concentrations varying from a trace to several parts per million. Though essential to plant growth, it is extremely toxic when present at concentrations only slightly above the optimum. The amount of boron in an irrigation water is thus an important factor in quality studies.

Allowable upper limits of each of the above conditions vary with the type of crop, climatic conditions, and type and drainability of the soil. In general, for average Minnesota conditions, water should be considered of questionable quality for irrigation if (a) the total concentration of soluble salts exceeds 2,000 parts per million (p.p.m.), (b) 70 percent or more of the total concentration is exchangeable sodium, or (c) the boron content exceeds 3 p.p.m.

Quality of Surface Waters

Moisture falling as precipitation is relatively free of dissolved salts. But on striking the ground it immediately picks up such impurities—the amount depending on the chemical make-up of the soil and degree of contact between the water and the soil. Thus surface waters such as lakes, ponds, streams, and runoff from freshly fallen rains—waters that have had relatively little contact with the soil—generally are of good quality for irrigation. Only when a stream or lake is fed from springs, or other groundwater flow, does its mineral and salt content increase appreciably.

As part of a recent study at the Minnesota Agricultural Experiment Station, we obtained samples from surface water sources of all types. These were taken at approximately 150 selected sites, widely scattered throughout the state. Sodium and boron concentrations were found to be low in all samples. Total concentrations of salt ranged from a trace to 1,600 p.p.m., but all were acceptable for irrigation purposes. Interestingly, the two samples containing the highest concentration of total salts were taken from the Mustinka River—one in southern Grant County and the other near Wheaton, in Traverse County. From our results it would appear that quality is not a problem in Minnesota when surface waters are used for irrigation.

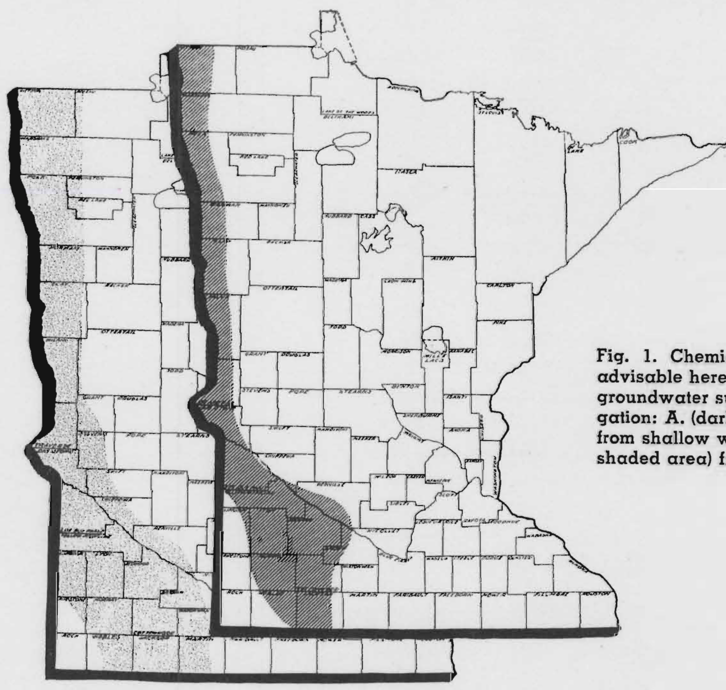

Fig. 1. Chemical analysis is advisable here before using groundwater supplies for irrigation: A. (dark lined area) from shallow wells; B. (light shaded area) from deep wells.

Quality of Groundwater Supplies

Many years may elapse between the time water falls as precipitation and when it is pumped from a well as groundwater. In that time it may

(Continued on page 17)

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Diseases of the Stomach and Intestine of Swine

H. C. H. KERNKAMP

DISEASES AND DISORDERS of the stomach and intestines represent a large proportion of swine ailments. Some are comparatively mild and do not disrupt growth and development; others may even cause death.

One prominent sign of these disorders is diarrhea and scours. The color of a stool—white, gray, yellow, green, bloody, or an admixture of these—sometimes helps to establish the cause and nature of the disease. Vomiting is another symptom. Consistency and color of the vomitus often helps in the diagnosis.

Other symptoms include intermittent abdominal cramps, distention of the abdomen, partial to complete loss of appetite, and increased desire for water. Fever accompanies some of these diseases, is present only at certain stages in others, and in still others may not even be involved.

There are also other factors that help us distinguish between these diseases. The pig's environment—eating, sleeping, drinking, exercising facilities, etc.—may contribute to the disease's development and progress. Age must also be considered, even though no iron-clad rule says that some diseases must occur within certain age limits. Also important in understanding these diseases are number of pigs in the pen, number sick, and how long the sickness has been present. Conditions responsible for some of these disorders may be so much alike and symptoms so similar that distinguishing between them often becomes difficult.

Differences between the diseases of the digestive organs depend largely upon their cause. Determining these makes treatment, prevention, and control easier. For the most part, causes fall in four general categories:

1. Infectious agents—including bacteria, viruses, protozoa, and parasites. These are the most common causes.
2. Nutritional deficiencies.
3. Chemical poisons.
4. Unknown.

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Baby Pig Diarrhea and Baby Pig Scours

First and principal sign of trouble in baby pig diarrhea and baby pig scours is passage of gray to yellow-colored, soft or watery feces. The pigs become very thin and weak within 24 to 36 hours; if left unattended, they will die within 3 to 4 days. Usually all pigs in the litter are affected, showing symptoms as early as 8 to 10 hours after birth and some even as early as 1 hour after birth. The specific cause of this disease is not known. However, it is reported that oxytetracycline administered to the sow has a very beneficial effect upon the pigs getting her milk.

Colibacillosis

In many respects, colibacillosis resembles baby pig scours. But the cause is known; it is an organism that can be isolated from the intestines of normal pigs. Apparently some "stress" factor must be present to "set up" conditions favoring injurious activity of the bacteria. Chilling, overheating, dampness, and metabolic disturbances may be involved. Pigs seldom show symptoms before 3 or 4 days after birth and then live only about 10 days more. Few cases recover without treatment.

Colibacillosis may effect one, two, or three pigs, or even an entire litter. Also, only one litter may be involved or it may spread to others—depending somewhat on how virulent the organism is and what preventive measures are taken. Intramuscular injections of sulfa-methazine or sulfathalidine have given good results. In some cases, two or more doses every day are necessary.

Transmissible Gastroenteritis (T.G.E.)

Transmissible gastroenteritis, commonly called "T.G.E.", is caused by a virus with a special affinity for the membrane lining the stomach and intestines. It is very contagious. Swine of all ages are affected. Death loss is very high in pigs under 10 days old, but seldom occurs in those older than that. This feature of T.G.E. is important and helps to distinguish it from some of the other diseases of the stomach and intestines.

Clinical signs in baby pigs are diarrhea, white, yellow, or greenish; vomiting; marked thirst; and dehydration, with loss in weight and death. Age at onset varies between 2 and 8 days. T.G.E. runs a clinical course of 5 to 7 days, but some of the baby pigs may die as early as the second day after first signs of sickness. Usually the entire litter is involved and the disease spreads readily to all close-by litters.

In feeder pigs, older sows, and boars, symptoms include a profuse diarrhea, vomiting, and reduced appetite. Severity in older swine varies; some become very sick, while in others the disease may pass unnoticed.

No treatments are known that have real merit, especially for baby pigs. Prevention and control are suggested. Sows that have had T.G.E. may develop some immunity, and apparently their colostral milk contains sufficient immune substances to protect the pigs who obtain it. So it usually is advisable to keep sows who have recovered to breed them for later litters.

When an outbreak of T.G.E. occurs and there are unexposed sows in the herd due to farrow within 2 or 3 weeks, remove them to an area away from the disease. Also, have someone not in contact with the sick swine attend them. The virus is destroyed by common disinfectants; so a thorough cleaning and disinfection of the disease area, and removal of the exposed swine, gives reasonable assurance that the area is free of the infection.

Edema Disease

In a high proportion of cases, edema disease is one in which abnormal amounts of fluid (edema) accumulate in the walls of the stomach and/or the large bowel. It occurs chiefly in pigs 6 to 20 years old and in good physical condition. It may occur at any time, although most cases reported in Minnesota occur in late spring and summer.

This disease usually occurs suddenly and runs its course rapidly. Pigs that appear normal in every respect may be critically ill or dead 2 or 3 hours later. Usually it lasts 1 to 2 days, though some pigs may live 5 to 7 days. There is no sure way of pre-

(Continued on page 19)

Dairy Cattle Breeding Research

CARL M. CLIFTON and CLIFFORD L. WILCOX

IT ISN'T EASY for the dairyman to improve the breeding of his dairy cows. Selection methods for the animal itself or for milk production are not too predictable. The University, USDA, and colleges in the North Central States, however, are seeking clues to guide farmers in better selection. This article deals with some of the background and some of the research carried on.

The average cow, in her lifetime, produces only about 1.3 female herd replacements. Thus, the dairyman must keep a high proportion of the females to maintain his herd size. This means that less desirable individuals often remain in the herd.

There's no accurate way to evaluate dairy heifers before they come into production. This means that the cow is about 3 years old before she can be evaluated concretely. Even then, the evaluation is not very accurate because, over a period of years, variations in environmental conditions account for about 75 percent of the differences among the individual cows in the same herd. When herd differences are also taken into account, the real differences among single lactation records may be as little as 10 percent.

The dairy bull cannot be evaluated at all except through the production of his female ancestors, collateral relatives, or daughters. In the case of the latter, the sire is about 6 years old when this information becomes available. At this point only about one-third of his useful life remains. Furthermore, this evaluation may err considerably. This is particularly true if the progeny-tested sire is to be used in a different herd or in an artificial insemination service, where his mates are different genetically and his progeny perform under different environments.

The normal feeding program for dairy cattle includes seasonal use of pasture and other forms of forage, all subject to variations due to weather, soil, climate, and management. This makes it extremely difficult to standardize conditions for production records. Various studies indicate that, on the average, a single production record is 60 to 65 percent related to the current herd production level, and only 35 to 40 percent related to another record of the same cow.

These are facts important to dairy cattle breeding programs. Results from a small experiment in one area may not be applicable to other areas, other breeds, or even to other herds of the same breed. This makes clear the value of cooperative research, involving several states working on a common problem.

Regional Breeding Project

Agricultural experiment stations throughout the country are cooperating on regional dairy research projects. Stations in the North Central Region, including Minnesota, are concentrating on dairy cattle breeding problems. This project, started in 1947, has these general objectives:

1. To develop and improve techniques for predicting and measuring the producing ability.
2. To investigate inbreeding (closed line mating), coupled with selection as a means of establishing improved strains.
3. To investigate crossbreeding, line crossing, and other forms of outbreeding as means of producing improved dairy cattle.
4. To determine how certain physical and physiological characters, especially lethals and other abnormalities, are inherited.
5. To develop applied breeding programs with special reference to artificial breeding associations, using the information obtained in the project.

Inbreeding

Minnesota has and is investigating inbreeding (objective 2), using the Holstein herds at the Rosemount and Morris stations and the Guernsey herd at the Grand Rapids station. These programs involved fairly close inbreeding (half sib matings) in comparatively small herds. After several years outcrosses were needed to correct physical weaknesses, primarily in feet and udders. An inherited reproductive deficiency (ovarian hypoplasia) had appeared in the Rosemount herd, almost eliminating one line.

Selection Work

Recently this project has been reorganized and renewed with somewhat less emphasis on inbreeding and more emphasis on selection. Three lines are being developed: one Holstein line at the Rosemount station, one Holstein line jointly at Morris and Crookston stations, and one Guernsey line jointly at the Grand Rapids and Duluth stations. Each line will have at least 100 breeding age females. The Dairy Cattle Research Branch, Agricultural Research Service, U.S. Department of Agriculture, is cooperating.

Obviously, it takes many years for dairy breeding experiments. In the meantime, various short term studies can be made with the same herds. One study involves taking several body measurements at standard ages to evaluate growth. The developing mammary glands of heifers have been measured and evaluated to determine whether this information can be used to predict future milk and butterfat production. This technique is called "udder palpation."

Another study attacks the problem of the solids-not-fat content of cow's milk. Minnesota already is testing more than 700 Guernsey and Holstein cows each month. These data will be used to study effects of hereditary and environmental factors upon the production of milk solids. With the decline in emphasis on butterfat, the other nutrients in milk take on added significance.

Mating Systems

The University Dairy Department is conducting another major study. This one is in cooperation with the State Department of Public Welfare and the Dairy Cattle Research Branch, ARS, USDA.

Here comparisons of different mating systems well adapted to artificial breeding service are being observed. The Anoka State Hospital and the Stillwater Prison Farm herds are comparing linebreeding with outcrossing. The Hastings and Rochester State Hospitals are comparing the use of selected young sires with that of "proven" sires. The Faribault State School herd is being used for a study of selective mating of individual cows to individually selected bulls.

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The Willmar and Moose Lake State Hospital herds are comparing the use of Holstein and Brown Swiss sires on Holstein cows. The Fergus Falls State Hospital herd is being started on a long-term linebreeding program. The first offspring from these projects are now coming into production. Conclusive results will come slowly.

It is unlikely that any one kind of cow will fit well into conditions which are encountered in different parts of our country. We are only beginning to learn something of the magnitude of the interactions between heredity and environment.

The most important question of all may be the efficiency of the cow in converting feed energy into milk energy. This factor has been given very little attention in our "horsepower race" for larger and larger lactation records. Fortunately, there appears to be a high correlation between production level and efficiency. However, once good levels of production are attained efficiency appears to take on added significance.

The greatest need at this time seems to be that for basic facts upon which to build breeding programs, and our research is being pointed toward this end.

SUITABLE IRRIGATION WATERS

(Continued from page 14)

have traveled a considerable distance through the earth. Having been in contact with the earth formations over a long period, such groundwater usually contains a relatively high concentration of salts.

The quality of the water from a particular well depends upon the chemical make-up of the earth formations through which the water flows. Obviously then, to use groundwater as a source for irrigation, we must first have a suitable water-bearing geological formation. Moreover, the formation must not contain excessive amounts of soluble salts (sodium and boron) known to be detrimental to plant growth. Even though total salt concentration of the groundwater is high, we may find that the specific constituents are not harmful from the standpoint of irrigation use.

Shallow Wells

Groundwater conditions in Minnesota vary widely because of wide geological variations. In many areas, plentiful supplies of irrigation water can be obtained from shallow wells. Such water is usually pumped from sand or gravel pockets near the surface, and ordinarily is of high quality. But occasionally, analysis shows objectionable concentrations of sodium in waters taken from shallow wells along the western edge of the state. These conditions are usually localized in nature, however, and do not occur over wide areas.

On the basis of approximately 250 samples taken from shallow wells at widely scattered points throughout Minnesota, it appears that precaution is necessary only in the area shaded in figure 1A. If you are located within that area and wish to use water from a shallow well for irrigation, it would be advisable to have an analysis made by a commercial chemist. Even within the area, however, many shallow wells will be found completely acceptable for irrigation uses.

Deep Wells

Judging from our analysis of abuot 750 samples from deep wells throughout the state, water quality becomes more of a problem with deep wells than for shallow wells. However, waters from deep wells were found to be of objectionable quality only in those areas shaded in figure 1B. Poor quality water was not found in all deep wells of the area, but the number was great enough to justify precaution. The most difficult conditions were noted in Kittson and Marshall Counties. But waters of questionable quality—many high in concentration of total salts and sodium—were found throughout the entire shaded area. Those planning to use irrigation water from deep wells in that area should check the quality of the water before proceeding too far.

SOIL WATER LOSSES

(Continued from page 12)

vested early. The reason is that only evaporation takes place on fallow land; transpiration is eliminated.

The calculations in table 2 are based upon water used by the native vegetation, which has a longer growing season than agricultural crops. If agricultural crops only are considered, the evapo-transpiration is reduced (by about 1½ inches at Hallock, for example) with a corresponding increase in surplus water.

Values given under "annual potential evapo-transpiration" are the amounts that most vegetation would use under conditions of optimum moisture supply. Only at Grand Marais is the precipitation distributed so that plants can obtain nearly their potential growth, with respect to water supplies. The precarious water supply situation in western Minnesota is indicated by the Hallock and Pipestone data.

Summing up, this calculation method based upon meteorological data (a) is quite successful in estimating soil water losses, (b) could be used to estimate the soil moisture conditions, and (c) is useful in determining how water is used.

PUMPING PLANTS

(Continued from page 11)

Data on power consumption for a number of typical pumping plants in Southern Minnesota are given in table 2. The number of kilowatt hours per acre drained varied from year to year with the amount of rainfall, but was also affected somewhat by the distribution of rainfall during the growing season.

The cost of the electric power depends on whether or not a separate transformer and meter are needed. If so there is a minimum monthly charge which is not always exceeded. In most cases, a separate connection is needed and the annual power cost runs from $1 to $2 per acre drained.

Table 2. Annual power consumption for several pumping plants serving as tile outlets

Year	Number of plants	Average KWH per acre	Average precipitation departure*
1953	3	30.1	+ 5.15 in.
1954	4	30.3	+ 2.62
1955	5	20.2	— 5.62
1956	5	19.5	+ 1.50
1957	5	21.2	+ 2.75
1958	5	9.6	— 4.40
Average		21.8	+ 0.33

* For period April 1-August 31, inclusive.

Where the pumping plant is near the farmstead, it can be connected to the farmstead transformer to take advantage of the lower rates. Annual power cost in then almost always less than $1 per acre drained.

Minnesota Farmers Are Making Good Silage

WILLIAM F. HUEG, JR., and RODNEY A. BRIGGS

YOU CAN MAKE good silage year after year by following certain well-established practices. Many Minnesota farmers have proved this, but others have variable results one year to the next. To find out the reasons for these differences, the University started in 1956 to survey the quality of silage shown at the annual silage show held during Farm and Home Week. This report deals with the 777 samples that were entered and scored, 1956 through 1958.

Each silage entry was accompanied by a detailed information blank. Each sample was evaluated against the scorecard developed by the National Silage Evaluation Committee as "Excellent, Good, Fair, or Poor." Most common in the show were corn and legume silages. Oats were fairly common and there were other combinations less important (table 1).

These samples have shown definite relationships between quality and specific handling and storage practies. High-quality silage is dependent on many factors, all of which can be controlled to some degree by good management. Three major requirements for making high-quality silage are:

1. Harvesting forages when the nutritive value is high.
2. Controlling amount of oxygen.
3. Providing for proper preservation.

Time of Cutting Important

High-quality corn silage has a high proportion of grain. Harvesting at the dent stage insures this higher quality. Of the whole-plant corn silage samples, 90 percent had been harvested in the early to late dent stages. Sixty-three percent scored "Excellent" or "Good." Those samples harvested in the immature stages resulted in only fair or poor silage.

With oats silage and oats-and-pea silage, 67 percent of the samples were harvested in the late milk to early dough stages, as recommended by the University of Minnesota. Sixty-three percent of these scored "Excellent" or "Good." The other third were harvested in early milk but allowed to wilt. These samples all scored "Good."

Typical samples of different kinds of silage entered for judging in annual silage show.

In the legume-grass group, 36 percent contained 90-100 percent legume. Two-thirds of these samples were harvested in at early stages of growth. However, only half of them had had preservatives added.

Are Preservatives Worthwhile?

Proper fermentation requires a good supply of sugars or fermentable carbohydrates. Because corn has a good supply of sugar when harvested at the mid-dent stage, normally we get a suitable fermentation. This is also true of oats at the early to mid-dough stages.

Immature forage grasses and legumes are high in protein but low in the necessary carbohydrates, making a proper fermentation difficult or impossible to achieve. Also, high moisture content increases that difficulty. Preservatives provide for some leeway in silage operations but do not guarantee good silage.

Two types of preservatives are available, carbohydrate and chemical additives. Of the preservatives used, 40 percent were carbohydrates—molasses, ground grain, and whey. The other 60 percent were chemical—sodium metabisulphite. Table 2 shows the importance of using the preservatives in recommended amounts.

Improper mixing of the chemical preservative may result in poor silage. It is easier to blend 150 to 250 pounds of ground grain, or 60 to 100 pounds of molasses, into a ton of green chopped material than to blend in 8 to 10 pounds of chemicals.

Silo Has a Dual Function

The silo is both a processing and storage structure. In the processing of silage, the silo serves as a barrier to air. Table 3 shows the relation of the structure to silage quality. Of the samples from upright structures, 64 percent scored either "Excellent" or "Good." Conversely, 58, 68, and 60 percent of the samples from the trench, bunker, and stack, respectively, were "Fair" or "Poor."

Conventional upright tower silos were producing better silage. This

Table 1. Crops used for silage, according to number of samples exhibited, 1956-58

Crop	1956	1957	1958	Total	Percent
Corn	80	96	117	293	37.7
Oats	36	51	27	114	14.7
Oats and Peas	12	15	14	41	5.2
					62.0
Miscellaneous supplements*	6	8	20	34	4.4
Legume	93	82	77	256	33.0
Grass	10	2	13	25	3.2
Miscellaneous†	10	2	2	14	1.8
					38.0
Total	247	260	270	777	100.0

* Sorghums, sorghum-soybeans, corn-sorghum-soybean combinations, etc.
† Sundangrass, millets, etc.

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Table 2. Performance of preservatives as shown in silage evaluation, 1956-58

Preservative	Amount	Total samples	Evaluation: Excellent	Good	Fair	Poor
Carbohydrates	Recommended	28	8	15	5	0
			(82%)			
	Less than recommended	28	3	10	9	6
			(54%)			
Chemical	Recommended	63	21	20	13	9
			(65%)			
	Less than recommended	16	0	7	3	6
			(38%)			

does not indicate that other structures cannot produce high-quality silage. It indicates instead that more care must be taken to reduce exposure to air. The use of plastic covers in all types of structures was effective in upgrading silage quality.

From the evaluation of 777 silage samples of all types at three silage shows during Farm and Home Week, it is clear that Minnesota farmers can make good silage when they give attention to the important details of silage-making. Of the sample studied, 14 percent scored "Excellent," 45 percent "Good," 32 percent "Fair," and 9 percent "Poor." Silage evaluation points out places for improvement and emphasizes the relationship between use of recommended practices and high-quality silage.

Table 3. Types of silage structures, 1956-58

Type of silo	Number	Evaluation in percent: Excellent or Good	Fair or Poor
Upright	534	64	36
Trench	75	42	58
Bunker	52	32	68
Stack	35	40	60
Not reporting	81		
Total	777		

INSECT COLLECTIONS

(Continued from back cover)

student to acquire some idea of the great diversity of the world's insects directly rather than indirectly from books. Thus, a collection is also essential in training future entomologists.

Without these collections, our knowledge of the insects, the largest part of the animal kingdom, would be incomplete. The enormous amount of information available concerning insects would be difficult, if not impossible, to use. And our attempts at control of pest species would be haphazard, possibly even causing more harm than good.

Such are the practical reasons for the maintenance of insect collections. However, it probably should be repeated that one of the most important reasons for collections is that they are the source of material for research by specialists on the classification of insects and their evolution. This provides the foundation on which all of our knowledge of insects, their biology, and their distribution rests.

STOMACH DISEASES OF SWINE

(Continued from page 15)

dicting how many pigs in a herd will be affected.

While most of the tissue alterations that characterize this disease occur in the stomach and intestines, the more typical symptoms indicate involvement of the brain and spinal cord. A very characteristic symptom is a wobbly, incoordinate gait. The pigs move forward in an aimless and confused manner. It is not unusual for the pig to walk in circles, keeping it up for some time. Another symptom is so-called "paddling"—the pig lies on its side and makes running motions with its legs. It is also not uncommon to find pigs in a state of stupor, so that they can be moved about, rolled over, and prodded without resisting.

The specific cause of edema disease has not been determined. Some research workers believe it is due to a bacterial agent, but others are not so fully convinced. No specific and regularly effective treatment has been developed that will cure pigs in the more advanced stages of the disease. On the other hand, some of the sulfonamide types of medication have been reported to be beneficial in selected cases.

Swine Dysentery

Swine dysentery is an infectious disease affecting the digestive tract. Since the stools almost always contain noticeable amounts of blood, it is also called "bloody diarrhea" and "bloody scours." It is caused by a micro-organism present in large numbers in the bowels and feces of infected swine.

Dysentery affects swine of all ages, but it most destructive at the feeder pig age. Death loss sometimes runs 60 percent or more at that age. It is less deadly among older swine. Soft and semi-liquid stools that contain mucus and/or blood is a very prominent symptom. This may continue for a week or more and, in the late stage, the feces contain grayish colored, flaky shreds.

As the disease progresses, the pigs lose weight, their hair coat becomes shaggy and dry, and their skin dry and harsh. Appetite is usually diminished. The disease may last a few days or it may last 3 weeks or more.

The medical treatment of swine dysentery is highly commendable. Arsenical preparations, compounded to provide about 10 grains of elemental arsenic to each gallon of drinking water, have been very beneficial. But it is very important that any preparation containing arsenic in therapeutic amounts must not be available to the swine for more than 5 or 6 days, because of the arsenic's toxicity.

Summing Up

Though symptoms of the diseases affecting the stomach and intestines of swine often or similar, there are many other ailments which must be recognized when making the diagnosis and prescribing treatment. Some examples are: hog cholera, swine erysipelas, leptospirosis, Salmonellosis, "uremia-toxemia," certain of the parasitic and protozoan diseases, and some of the nutritional deficiency diseases.

Since it is easy to confuse the diseases and disorders affecting these organs in swine, consult a veterinarian for a specific diagnosis. Early recognition and prompt treatment will reduce losses from some of them.

Insect Collections Serve Many Purposes in Research

EDWIN F. COOK

INSECTS are the most numerous of all animals in numbers of kinds or species. There are at least 800,000 species already known and they are still being described at the rate of around 6,000 new species each year. There are probably 15,000 different kinds of insects in Minnesota alone. It is impossible, therefore, for one man to know the identity of more than a small fraction of the species of insects in the world, let alone know anything about their biology.

Aid Systematic Classification

In the course of many years of research, using insect collections as a source of material, entomologists have developed a classification of insects. Those who specialize in the study of particular groups of insects have written "keys" that will enable other entomologists to identify larger groups, and even identify insects to species. This work, despite all the effort that has gone into it, has still barely begun. Even when a particular specimen has been identified by use of a key, a direct comparison with specimens identified by experts is usually necessary. This is because many species are distinguishable only by characteristics that are of a seemingly minor nature and because there is a great deal of variation within any one species. This makes keys only useful for making approximate identifications. A properly identified, carefully organized collection of insects is essential, then, for even the best trained entomologist if he wants to identify insects correctly.

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Here, then, are two uses for insect collections, both eminently practical: First, for the research necessary in developing an insect classification which helps in identification; second, for the preservation of properly identified specimens for comparison with unknown insects we wish to identify.

Why we do need proper identication of an insect? This is because every kind or species of insect, no matter how little difference is physically apparent, has its own particular habits and biology, its own capacity for causing damage or being useful, and its own geographical distribution. If we do not identify an insect properly, we might waste large amounts of money attempting to control perfectly harmless kinds or cause real damage by destroying a useful species.

Aid Control Planning

As an example here might be cited the case of mosquitoes. Some of our local species bite man and some species don't ever bite. Money spent in controlling the non-biting species, even if they are abundant, is entirely wasted. Another example is in the case of ladybird beetles. Most of these predatory insects that feed on such pests as aphids and scale insects are often very abundant on some crops. Occasionally someone will assume that the ladybirds are feeding on crops and will want to spray them. This would be the worst kind of folly, since the ladybird beetles are busy destroying truly harmful insects. There is one group of ladybirds, however, that are serious pests of agricultural crops and these require control measures.

The value of an insect collection to a university or to the public may not be evident to most people. It might be assumed that trained entomologists should be able to identify important pest species of insects without having to refer to identified specimens for comparisons. In general this is true, but it is also true that in most instances direct comparisons are absolutely necessary before we can properly identify an insect.

Proper identification of insects is important for another reason. A vast amount of information is available in the literature on the biology of insects, but this is only available to those who know the proper scientific name of the insect.

Another reason for insect collections is that they provide us with records of the geographical distribution of insects. This may be important in the case of imported insect pests. Since properly prepared specimens in insect collections have labels indicating where and when the specimens were collected, we can discover what geographical area an insect is from. This helps also if we want to obtain parasites and predators to help control the insect. These are to be found in the area where the insect is native.

If we have what seems to be a new pest, we might also be able to determine whether it truly is new to the area or not. This will have importance in the event we consider the use of quarantines to keep a pest insect out of any given area. It is rather pointless to maintain a quarantine against a foreign insect pest if this pest is already well established. This error has been made in the past in some states owing to a lack of contact between those working with collections and those working in applied fields of entomology.

Aid in Training Entomologists

If a collection is large enough and has a varied geographical origin, it permits a student to become acquainted with insects of distant regions as well as local ones. It permits a student to study insects at his own convenience rather than when the insects are abundant, and it permits a

(Continued on preceding page)