

6-1903

I. Pasture and Forage Plants for South Dakota II.  
Feeding Dairy Cows III. Flies IV. The Artesian  
Waters of South Dakota V. Some Destructive  
Insects VI. Elements of Prairie Horticulture

E.C. Chilcott

*South Dakota Agricultural College*

J.W. Wilson

*South Dakota Agricultural College*

H.G. Skinner

*South Dakota Agricultural College*

E.L. Moore

*South Dakota Agricultural College*

Follow this and additional works at: [http://openprairie.sdstate.edu/agexperimentsta\\_bulletins](http://openprairie.sdstate.edu/agexperimentsta_bulletins)

---

#### Recommended Citation

Chilcott, E.C.; Wilson, J.W.; Skinner, H.G.; and Moore, E.L., "I. Pasture and Forage Plants for South Dakota II. Feeding Dairy Cows III. Flies IV. The Artesian Waters of South Dakota V. Some Destructive Insects VI. Elements of Prairie Horticulture" (1903). *Bulletins*. Paper 81.

[http://openprairie.sdstate.edu/agexperimentsta\\_bulletins/81](http://openprairie.sdstate.edu/agexperimentsta_bulletins/81)

This Bulletin is brought to you for free and open access by the SDSU Agricultural Experiment Station at Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. It has been accepted for inclusion in Bulletins by an authorized administrator of Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. For more information, please contact [michael.biondo@sdstate.edu](mailto:michael.biondo@sdstate.edu).

---

SOUTH DAKOTA

AGRICULTURAL COLLEGE

---

EXPERIMENT STATION

---

BROOKINGS, SOUTH DAKOTA

---

- I. Pasture and Forage Plants for South Dakota
  - II. Feeding Dairy Cows
  - III. Flies
  - IV. The Artesian Waters of South Dakota
  - V. Some Destructive Insects
  - VI. Elements of Prairie Horticulture
-

## GOVERNING BOARD

---

### Regents of Education

Hon. I. W. Goodner, President.....	Pierre, S. D.
Hon. F. A. Spafford.....	Flandreau, S. D.
Hon. R. M. Slocum.....	Herreid, S. D.
Hon. A. W. Burt.....	Huron, S. D.
Hon. M. F. Greeley.....	Gary, S. D.
Hon. I. D. Aldrich (Secretary of Regents)....	Big Stone, S. D.

---

### STATION COUNCIL

F. A. Spafford.....	} Regent Members
R. M. Slocum.....	
J. W. Heston, President of the College	
James W. Wilson, Director and Professor of Animal Husbandry	
E. C. Chilcott, Vice-Director.....	Agriculturist
Jas. H. Shepard.....	Chemist
N. E. Hansen.....	Horticulturist
D. A. Saunders.....	Botanist and Entomologist
E. L. Moore.....	Veterinarian and Zoologist
R. A. Larson.....	Secretary and Accountant

### Assistants

A. H. Wheaton.....	Dairy Husbandry
A. B. Holm.....	Soil Physics
W. S. Thornber.....	Botany and Horticulture
H. G. Skinner.....	Animal Husbandry
F. E. Hepner.....	Chemistry
Wm. West.....	Agriculture
Chas. Haralson.....	Horticulture
Lillian Langdon.....	Stenographer

---

Any farmer of the state can have the Bulletins of this Station free upon application to the Director.

# PASTURE AND FORAGE PLANTS FOR SOUTH DAKOTA

E. C. CHILCOTT, Agriculturist

The natural advantages of the state of South Dakota as a stock country have long been recognized. Our range beef and mutton is regarded as second to none in its class. Our wool has earned an enviable reputation in all of the wool centers of America. And last in order of development, but by no means least in importance, our dairy products have established a name for themselves among the very best on this continent. All of these achievements have been won almost entirely without the aid of cultivated grains and grasses. Our native prairie grasses have, in nearly all cases, been the principal, and in many instances, the only food of our stock.

In some parts of our state the system which has produced such satisfactory results in the past can be continued for a considerable time to come, with but slight modifications, while in other portions, particularly in the older and more thickly settled districts, conditions have so changed, and are still changing, that a very different system must eventually be instituted. In these localities our native grasses, which have been the basis of nearly all of our success in the past, are fast disappearing and being replaced by inferior introduced grasses and worthless weeds. The causes which have brought about this undesirable but inevitable result are not hard to discover. Overstocking and tramping, which seem almost unavoidable during some portions of the season, if enough stock be kept to utilize the feed during flush times, is one of the most potent, and also the most difficult to avoid. For if only such an amount of stock is kept during flush feed as can subsist upon the pasture without overstocking during the dry parts of the season, the grass will make such a rank growth during the spring and

early summer that stock will not eat it during the dry periods. Another only slightly less potent, but more universal factor, and one still less amenable to any known methods of prevention, is the gradual migration of hardy, worthless weedy grasses and plants from the older to the newer settled portions of the country. This migration is greatly accelerated by the agency of man. Weed seeds are scattered along railroads and highways, and are introduced by grain shipped in from neighboring states for seed. These weed seeds first find lodgment along railroad embankments and in cultivated fields, but they soon spread to the prairies and there crowd out the less hardy but more valuable native grasses.

The only practical method of remedying this very unsatisfactory condition of our native pastures, yet discovered at this Station, is that of using

### **SHEEP FOR RENOVATING PASTURES**

The pastures on the College farm are located on low bottom land, through which two small creeks with water in holes meander. There are also many blind sloughs, which afford a very luxuriant growth of rather coarse, weedy grass. The ridges or divides between these creeks and sloughs produce native prairie grass, with some introduced grasses, such as blue grass, fescues, etc. These pastures had been stocked for about fifteen years with cattle and horses and had become very badly infested with weeds, particularly on the higher portions. In the spring of 1899 about one hundred and fifty head of sheep were turned into these pastures, which include about eighty acres, together with about twenty-five head of cattle. In 1900 the sheep were increased to about two hundred and the cattle reduced to about fifteen head. In 1901 there were about two hundred and eighty sheep and no cattle, but there were ten head of horses in the pasture. In 1902 there were about two hundred and sixty sheep and thirty-four head of cattle and eight horses.

Although the pasture suffered somewhat from the overstocking of last season, it is now in far better condition than

it was in 1899. The weeds have nearly all been exterminated and the grass is much thicker and better. From this and other experience and observation we are convinced that the addition of five or six head of sheep for each cow will tend to increase the productiveness of a very weedy pasture, such as ours was, nearly if not quite to the extent of the amount consumed by the sheep. After a few years, when the weeds have been exterminated, the relative number of cows may be increased, but of course the proportion of cows to sheep, as well as the total amount of stock that can be profitably kept upon a given area, will depend upon the nature of the soil and the vegetation, the locality, the climatic conditions, etc.

We will not attempt to lay down any hard and fast rule as to how many sheep should be kept upon any farm, but we are firmly of the opinion that some sheep could be profitably kept upon nearly all farms in the state. They will not only serve to keep the pastures free from weeds, but they will also prove excellent scavengers for cleaning up the stubble fields after harvest and the odd corners on the farm. And, moreover, they will yield a handsome profit on the investment, as well as providing the most wholesome kind of fresh meat for the farmer's family whenever it is desired.

A mistake often made by farmers who start in with a small flock of sheep to act as scavengers is to buy anything that any one may choose to call a sheep, has a little wool on its back and will eat weeds, and then to treat them as meanly as their appearance seems to deserve. This does not pay. Good blood, individual merit and good care are as necessary for profitable sheep raising as with any other kind of stock.

Buy a few good, pure bred, registered sheep of any one of half a dozen of the standard breeds, treat them right, and they will do the handsome thing by you. They will earn their keep during the summer by destroying weeds, but they must have good care and feed during the winter. Where a considerable number of sheep are required and pure breeds cannot be obtained at satisfactory prices, good grade ewes will do, but

nothing but registered rams of high individual merit should ever be used.

Such a flock of sheep of appropriate size will in a few years exterminate the weeds and greatly improve the grass of any good native pasture. Top dressing with manure and sowing blue grass upon the bare spots will also be found beneficial. If, however, the native grasses are too badly run out, it may pay better to break the sod up, crop it for two or three years, and then seed it down again.

We have found no other grass equal to

### BROME GRASS FOR PASTURE

We have been raising brome grass (*Bromus inermis*) at this Station for about twelve years. During the earlier years we used it exclusively for meadow and seed, but for the last three years we have given it a very thorough trial as a pasture grass, and we are fully convinced that it is much the best grass yet tried here for that purpose. It starts early in the spring, makes a very tough sod, is not easily killed out either by close feeding or tramping, occupies the ground so fully as to drive out all weeds and inferior grasses, remains green later in the fall than any other grass, and is greedily eaten by all kinds of stock.

This spring (1903) has been a very cold, backward one, and the other pasture grasses have only fairly started on this 11th day of May, while the brome grass on meadows that were closely pastured last fall stands about six to eight inches high, while some fields that were seeded last year stand ten inches high. In fact this brome grass of last year's seeding would afford more feed at this time than an equal area of winter rye on an adjoining field, and this rye did not winter-kill and is better than an average crop for this time of the year.

This Station has raised and sold large quantities of brome grass seed to the farmers of the state for the last ten years, and has sent out many letters of inquiry to its customers, and in no single instance where it has been given a fair trial

for pasture has there been any complaint. As a meadow grass it has not proved so universally satisfactory; for while a large majority have reported favorably, some have complained that it made a thick, compact sod, but did not grow tall enough to yield a satisfactory crop of hay. We have had no difficulty in this respect, nor have any of the farmers in this vicinity, so far as we know. Most of these complaints have come from those who sowed it on rather light, sandy land with water near the surface, on land well adapted to the growth of the common bluejoint and alfalfa. We have grown it on both upland and bottom land with good results, but we find that it usually becomes turf-bound about the third or fourth year after sowing, and believe that it will usually be found desirable to either break it up or use it for pasture after cutting three or four crops for seed and hay. (See Bulletin No. 79 of this Station, under discussion of Rotation Nos. 23 and 24.)

Brome grass should be sown broadcast or with a drill upon well prepared land, at the rate of fifteen to twenty pounds per acre, either with or without a nurse crop. If sown with a nurse crop about one-half bushel of wheat should be used, and it should be sown with the rest of the wheat crop as early in April as the soil is in good condition. If sown broadcast it should be covered by a light dragging. If sown with a drill, no dragging will be needed after sowing, but a good firm seed-bed should be prepared by thorough dragging before sowing. Some difficulty has been experienced in sowing with a drill, as the seed is so light and chaffy that it does not feed well. If sown without a nurse crop, it is better to delay sowing until about the first of June, sowing in the same manner as with a nurse crop. It usually produces a good crop of seed the first year after sowing, and an excellent crop of either seed or hay the second and third years. We have frequently obtained a good yield of both seed and hay by allowing the seed to ripen, cutting the seed with a binder set high enough to pass over the thick mat of bottom grass and following with a mower. The seed shells badly if allowed to



stand for even a day after it is ripe, so it should be closely watched and promptly cut as soon as the seed hardens.

Brome grass should not be pastured the first year after sowing, and it is much safer to wait until the third year, when it will have become so thoroughly established that it will stand any reasonable amount of pasturing and tramping.

### ALFALFA FOR PASTURE OR MEADOW

Experience has shown that alfalfa can be successfully grown in nearly all parts of the state east of the Missouri River, as well as in the agricultural districts of the Black Hills. It is possible that there are areas within what is generally known as the range district lying west of the Missouri River where it can be successfully grown. Alfalfa seems to do best on a somewhat light and sandy soil with a loose, open subsoil, and with water within twenty feet or less of the surface. It is highly important that the lay of the land be such that water will not stand upon it during any part of the year. While it is quite possible to obtain a fair stand of alfalfa upon the higher uplands underlaid by a hard, clayey subsoil, the crops grown under such conditions seldom prove satisfactory. It would seem that the mechanical difficulties which the roots have to overcome in penetrating this hard subsoil and the great distance to which they have to go to obtain a sufficient supply of water require a greater effort than the plants are able to maintain.

It is of the first importance to have the soil in a first class state of cultivation and free from weeds. This is best accomplished by raising some hoed crop, such as corn, potatoes or roots, upon the land for one or two years before it is seeded to alfalfa. A good alfalfa field should last for many years, and therefore the time and labor involved in preparing the soil is well expended. The land should be plowed either in the fall or early in the spring. It should be thoroughly cultivated with a harrow or cultivator, or both, from the time that the soil is in fit condition in the spring until the seeding is done. There is some difference of opinion as to the best time of year

for sowing the seed. Our experience and observation leads us to believe that about the first of June is the most favorable time for most parts of the state. If thorough cultivation has been kept up during May so as to keep the weeds from getting a start, the seed bed ought to be in good condition by the first of June. The probability of sufficient rains to germinate the seed and give the alfalfa plants a good start is better at this time than at most other periods of the year. If seasonable rains occur soon after the seed is sown the young alfalfa plants should be able to keep ahead of the weeds during the remainder of the season. About twenty pounds of seed per acre is usually sown, although some farmers advocate as high as thirty pounds per acre. The seed may be sown either broadcast or with a drill. Slightly heavier seeding is advisable where the seed is sown broadcast, and the seed should be covered with a light harrow. If the seed is sown with a drill, care should be taken not to have it covered too deeply. No nurse crop should be sown with the alfalfa and all weeds that spring up should be cut down by going over the field with a mower set high enough so as not to cut the small alfalfa plants. Unless the growth of weeds is very heavy they may be left on the ground as they are cut. They will afford a shade to the alfalfa plants, but should not be sufficiently heavy to smother them. A great deal has been said and written about Turkestan alfalfa, and there is good reason for believing that there are certain strains of Turkestan alfalfa that are fully equal and possibly superior to any of the various varieties of alfalfa grown in this country, but it is also equally true that there are strains of Turkestan alfalfa that are decidedly inferior to some American grown varieties. Such being the case, we believe that it is much safer for farmers of this state to obtain seed grown in Montana, Wyoming, Colorado or Minnesota, than to depend upon the Turkestan seed for sale by the seedsmen. This Station has several small plats of alfalfa grown from seeds obtained in Turkestan and from various parts of this country, but it has not yet been able to raise seed in sufficient quantities of any of these varieties for sale or distribution.

If the foregoing suggestions are acted upon, the yields from native pastures can be greatly increased, and new pastures can be established, but there are very few pastures that will supply a sufficient quantity of feed during the drier portions of the season to maintain dairy cattle in a full flow of milk if the pasture is stocked to its full capacity in the times of flush feed. In order, then, to obtain the best results from pastures, it will generally be found desirable to supplement them by providing forage crops for soiling, that is, cutting and hauling the green forage to the pastures or stables, or allowing the stock to graze them off by turning it on to limited areas for a portion of the time each day, when the pastures do not afford sufficient feed. In the eastern states, where land is higher in price and labor lower, soiling is being quite generally adopted. But in the west, where these conditions are reversed, it will frequently be found more profitable to allow the stock to consume the crops on the land without cutting. The principal objection to this method is that a considerable portion of the forage is destroyed by the tramping of the stock. Another objection is the increased amount of fencing required where the forage is fed off.

Dr. Jordan in his work, "The Feeding of Animals," says: "It is no longer a debatable question whether or not soiling is profitable under most conditions. Unlimited testimony can be furnished showing great gain from every point of view of even partial soiling as an amendment to the pasture. Whether soiling should be substituted entirely for grazing is a business matter which should be decided according to the conditions involved."

"In the first place much more food is produced per unit of area by soiling than by pasturage. Armsby found that two soiling crops in one season, for instance rye followed by corn, yielded five times as much digestible organic matter as pasture sod when the whole growth on the latter was plucked without waste, the quantities being respectively 5,845 pounds and 1,125 pounds. It is variously estimated from observa-

tion and practice that three to five times as many animals can be supported on a given area by soiling as by grazing.”

Whether the supplementary forage crops are to be used for soiling, grazing, curing or siloing, is a problem that will have to be solved by each individual farmer according to his peculiar conditions. The kinds of crops to be raised will also depend somewhat upon local conditions, but it is believed that the results of the experiments that have been carried on at this Station for the last ten years will be of value to the farmers in helping them to decide what crops to raise for the purpose and how to raise them.

It is of the greatest importance that an uninterrupted succession of green forage crops be provided throughout the season, and the following scheme is suggested as one likely to be adapted to the conditions in this state:

SPECIES OF CROP	Time of Seeding	Approximate Time of Feeding
Winter rye.....	August 20	} May and June
Brome grass (from meadow).....		
Alfalfa (from meadow).....		
Oats and peas.....	April 10	} July
Oats and peas.....	April 20	
Oats and peas.....	April 30	
Rape .....	May 15	
Alfalfa (from meadow).....		
Brome grass (from meadow).....		
Corn .....	May 12	
Corn .....	May 12	} August
Rape .....	June 1-20	
Alfalfa (from meadow).....		
Brome grass (from meadow).....		
Millet .....	June 1	
Oats and peas.....	June 1	
Sorghum .....	June 1	
Corn .....	May 20	} September
Sorghum .....	June 1	
Rape .....	July 1	
Alfalfa (from meadow).....		
Brome grass (from meadow).....		} October
Brome grass (from meadow).....		
Rape sown with corn or grain.....		
Winter rye.....	July 1	
Turnips .....	June 1	} Winter feed in addition to hay
Mangolds .....	June 1	
Sugar beets.....	June 1	
Potatoes .....	May 1	
Corn silage.....	May 20	
Sorghum silage.....	June 1	
Shredded corn.....	May 20	
Shredded sorghum.....	June 1	

The date of seeding and the time required for development, as well as the yield of the above mentioned crops, will depend to some extent upon the conditions of soil and weather, but it is believed that the dates given will be found approximately correct for average conditions in this state. It is well to provide rather more than is likely to be needed, as all except rape can be preserved for winter feed if not needed in the summer and fall.

In selecting crops for forage or winter feed the amount of **digestible dry matter** per acre yielded by the several crops should be given due consideration. In order to guide the farmer in making his estimates the following is quoted from Dr. Jordan's work on *The Feeding of Animals*, page 261 :

"The most that it is possible to show is the relative productive capacity of different crops when the yield is what is regarded as highly satisfactory in favorable localities under good culture. This is done in the accompanying table. Attention is again called to the fact that judgment should be based upon the amount of **digestible dry matter** :

	Yield per Acre Fresh Material Pounds	Dry Matter per cent	Dry Matter per Acre Pounds	Dry Matter Digestible per cent	Digestible Dry Matter per Acre Pounds
Alfalfa .....	35000	25	8750	59	5162
Maize, whole plant.....	30000	25	7500	61	5025
Red clover.....	18000	30	5400	57	3070
Oats and peas.....	20000	16.2	3240	65	2106
Timothy .....	11500	38.4	4416	57	2517
Hungarian grass.....	19000	25	4750	67	3182
Mangolds .....	60000	10	6000	88	5200
Sugar beets.....	32000	20	6400	88	5632
Potatoes .....	18000	25	4500	85	3825

"The estimates here given may not coincide with the views of all as to what constitutes a fair crop, but from the data shown any one can easily make a calculation on the basis of his own estimates."

Having, as we believe, shown the importance of the subject, we will now proceed to the discussion of some of the various

forage, root and silage crops that have been grown at this Station.

## GENERAL PLAN OF EXPERIMENT

This work has been under way during the last ten years, but it does not seem advisable to give exact results for each of the ten seasons. But although in some instances the exact results of but a single year are given, these results are consistent with those of other years and the conclusions drawn are based upon the general results of ten years' experience, and are therefore of much greater value than if based upon one year's work.

In experiments with various forage plants the usual plan has been to put in one-quarter acre plats of each species or variety under identically the same conditions, to treat them alike during the season, and to weigh the product at the end of the season. Besides the quarter-acre plats we have generally raised larger tracts of many of the crops to furnish feed for our stock, and in the following discussions we shall often give results obtained from these fields as well as those from our experimental plats.

## INDIAN CORN

This is unquestionably the most valuable forage plant yet discovered, adapted as it is to such a wide range of conditions, and possessing, as it does, the quality of producing such a large yield of valuable feed at a low cost of production.

There are other plants that seem able to fill certain wants, but there is none that is so well known and universally used from the Atlantic to the Pacific and from North Dakota to Texas as Indian corn. Volumes have been written upon the use of corn as a forage crop. Hundreds of tests have been made to determine the best variety, quantity of seed, manner of planting, harvesting, preserving, and manner of feeding, until it would seem as though every one engaged in farming, or familiar with agricultural literature, must appreciate the

value of Indian corn as a forage crop and have a fair idea as to the best method of cultivation, etc. This does not, however, seem to be the case. There are hundreds of farmers in the state who are attempting to make a success of stockraising and dairying, who utterly ignore this valuable plant as a forage crop. In no state in the Union have the farmers yet succeeded in making a success of dairying until they have recognized the value of "sowed corn" both for soiling during the summer and fall and for winter feed, either as dry fodder or as silage. And I do not believe that Dakota farmers will be able to dispense with it.

Considerable quantities of corn for forage or "sowed corn" have been raised at the Station every year for the dairy stock. A large number of varieties have been tested and different methods of planting and different quantities of seed have been tried. Yields ranging from three tons to twenty-five tons of green fodder per acre have been obtained. On the Hunter farm, in the season of 1896 the yield of Salzer's Superior fodder corn was 25.6 tons of green, or 9.2 tons of dry fodder per acre. Early Adams fodder corn yielded 17.28 tons of green, or 9.6 tons of dry fodder per acre. These results were obtained under irrigation. As good results, however, have been had on the Station farm, without irrigation. While no attempt will be made at this point (see Table I) to go into the details of the experiments, the following are some of the conclusions arrived at:

**Varieties**—Every seedsman's new catalogue contains the names of new "varieties" of fodder corn recommended as far superior to anything yet introduced in that line. In some instances the names are new, but the corn is usually the same as that sold the previous year under some other name. Then again there are those who attempt to keep their seed corn pure, and possibly they succeed so far as the admixture of any other variety is concerned, but corn is so susceptible to the influence of environment that as soon as the conditions under which it is raised are changed the characteristics change, and we therefore often meet with samples of corn differing



very widely in their general characteristics, that are known by the same name, so that on the whole very little dependence can be placed upon the mere name of a variety.

For the purpose of this article we can divide the corn usually grown for fodder into three classes, as follows:

1. Large leafy southern Dent, which never reaches maturity in this latitude and seldom forms ears, but furnishes a large amount of fodder.

2. Medium Dent, which will form ears under favorable conditions and may nearly reach maturity under the most favorable conditions.

3. Small early Dent, which will ripen under average conditions in this latitude.

In selecting a variety, and also choosing the method of planting, the purpose for which the crop is intended and the facilities for harvesting and handling should be taken into consideration.

When the forage is to be cut early, for soiling, or when the stalks are to be preserved for dry fodder, the large southern variety (Class 1) should be selected, and the seeding should be so thick that the stalks will not become coarse. The most satisfactory method of planting tried here is to use a two-horse corn planter with drill attachment, making the rows just one-half the usual distance apart, i. e., with a 3 foot 8 inch planter make the rows twenty-two inches apart, which can be done by "straddling" every other row, and sowing about one and one-half bushels of seed per acre.

If care is taken to make the rows perfectly straight and a uniform distance apart, the corn can be cultivated with a small drag-tooth, one-horse cultivator. The ground should be dragged as soon as planted and at frequent intervals until the corn has reached a height of six or eight inches, when one or two cultivations will be all that is necessary to carry it to a stage when it will completely shade the ground and make any further cultivation unnecessary. Corn sown in this way can be cut with a mowing machine or with a binder, and the stalks will be fine enough so that cattle will eat most of them.

If the product is intended for silage, varieties should be selected from Class 2, or preferably from Class 3, and the planting and the cultivation should be about the same as though the corn were to be husked. It has been found that the nutritive value of the product of a given area is greatest when the planting is thick enough and the variety such that the ears will, at least, reach the "roasting ear" and preferably the glazing stage by the time the corn is cut.

The most economical way of harvesting such corn is with a corn harvester and binder, several of which are now on the market. There are also several corn harvesters which cut the corn but require the binding to be done by hand, the binders riding on the harvester. Most of these work well and are a great improvement upon the old method of cutting by hand, and where only a small quantity of corn is grown it is probable that many farmers will find these machines better suited to their wants than the larger and much more expensive harvesters and binders.

## SORGHUMS

Sorghums can be divided into two classes—saccharine and non-saccharine. This division is purely arbitrary and simply means that those varieties which are classed as saccharine contain enough sugar in their juices to make them profitable as a syrup or sugar producing plant, while in those classed as non-saccharine sugar does not occur in sufficient quantity and in proper form to make them of value for those purposes. All kinds of sorghums contain considerable quantities of sugar in their juices.

### SACCHARINE SORGHUMS

**Amber Cane**—Among the saccharine sorghums, probably Early Amber is best adapted to the requirements of a forage plant for this latitude, as it has been grown more extensively and longer in the northern states than most other varieties. and has therefore become better acclimated than the more southern varieties.

Next to Indian corn, Amber cane is probably the most valuable forage plant that can be grown. It requires much the same soil and treatment as Indian corn, except that it should be sown with a grain drill instead of a corn planter. It may be sown in rows twenty-eight to thirty-five inches apart by allowing every fourth or fifth hopper to feed, or it can be sown the same as oats or wheat. When a thick growth of fine stalks, which can be cut with a mower and raked and handled like hay, is desired, a bushel of seed to an acre is not too much. But where the largest yield of nutritive matter is desired for silage, thin sowing, in rows twenty-eight to thirty-five inches apart, with thorough cultivation, will give the best results.

### NON-SACCHARINE SORGHUMS

Kaffir Corn, Jerusalem Corn, Brown Doura Corn and Yellow Milo Maize are best known among the non-saccharine sorghums. All of these have been grown at the Station for several years, but in no instance have any of them proved equal to Indian corn or Amber cane, when the cost of production is taken into consideration.

The principal obstacle to the profitable production of these sorghums is the fact that they germinate very slowly, and make a very feeble growth during the first month after planting. In the spring of 1896 the conditions for germination and growth were very favorable, but upon June 16th, twenty-four days after planting, they had only made a weak and spindling growth of about two inches, while two varieties of Indian corn, planted at the same time and under the same conditions, had made a strong and vigorous growth of about six inches. This habit of growth on the part of these sorghums makes hand hoeing and weeding necessary in order to keep down the weeds, while the Indian corn can be tended with a drag and cultivator.

In the drier and warmer parts of Kansas these sorghums, particularly Red Kaffir corn and Jerusalem corn, are raised in large quantities, both for forage and for the grain, and by many are considered equal or superior to Indian corn for both

these purposes. But experiments conducted at this Station so far do not indicate that any of them are as well adapted to our conditions as Indian corn or Amber cane. It may be, however, that in time a variety will be developed suited to our conditions.

### EXPERIMENTS WITH INDIAN CORN AND SORGHUMS FOR SILAGE

In the spring of 1896 six plats were prepared and sown to Indian corn, Amber cane, Kaffir corn, Jerusalem corn and Milo maize, as indicated in Table I. The sowing was done on May 22d with a "New Model" garden drill, set as follows: For Kaffir corn, Jerusalem corn and Milo maize, set for parsnips; for Indian corn, set for peas, for Amber cane, set for carrots. A good stand was obtained in every instance, and the plats all received thorough cultivation during the season, and were cut August 26th with a corn harvester, the produce weighed and put into the silo. The following, Table I, will show the results obtained:

TABLE I

NAME	Pounds Seed per Plat	Weight of Green Produce per Plat	Yield per Acre Tons
Kaffir corn .....	4	4075	8.15
Jerusalem corn .....	3	3675	5.35
Indian corn—"Pride of the North".....	13	4500	9.00
Amber cane .....	1	6850	13.70
Indian corn—"Salzer's Earliest Fodder".....	10½	3750	7.10
Yellow Milo maize.....	2¼	4700	9.40

As will be seen from the foregoing table, Amber cane yielded the most feed by weight, Jerusalem corn the least, and Indian corn about an average between the two. If we consider the weight of the fodder alone, regardless of its feeding value, Amber cane is much the most profitable to raise, but when we

take into consideration the fact that both of the varieties of Indian corn were small, native Dents, and that they had reached a much more advanced stage of maturity than any of the sorghums tested, and that they were well eared with corn in the "roasting ear" stage, while the seed of the sorghums was very immature, it is probable that the real value of the corn was equal to, or even greater than that of any of the sorghums. Had some large, coarse growing, leafy southern variety of corn been grown, it is fair to assume from the results of former trials that a yield fully equal to that of the Amber cane would have been obtained, but the quality would have been inferior to the forage obtained from the smaller Dent.

#### **COMPARATIVE VALUE OF KAFFIR CORN, JERUSALEM CORN AND INDIAN CORN RAISED FOR SEED**

May 21, 1896, three plats of one-quarter acre each were planted respectively to Kaffir corn, Jerusalem corn and Indian corn in rows three feet eight inches apart and hills three feet apart in the rows. The Indian corn was of the "Pride of the North" variety. The Kaffir corn was the Red Kaffir corn, from the John A. Salzer Seed Company, and the Jerusalem corn came from the same seedsman. The plats were all kept in thorough cultivation during the season, and a good stand and growth were obtained. The plats were all cut on September 18th, and it was our intention to thresh out the sorghum seed and to husk and shell the corn in order to obtain a comparison between the crops of seed; but it was found that the blackbirds had done so much damage that it was impossible to obtain any reliable results as to the yields. This much, however, was discovered: The Indian corn showed a good crop of well matured ears, while the seed of both the Kaffir corn and Jerusalem corn was very immature and much shrunken.

#### **RAPE**

Rape has been grown at this Station for the last ten years, and we have never failed to obtain a good stand and crop,

when sown in drills. We have raised some good crops from broadcast seeding, but if the weather is at all dry at the time of seeding, the surface soil, to the depth of an inch or two, is likely to become so dry during the preparation of the seed bed that the seed, which should not be covered more than an inch, will not germinate. We have usually adopted the practice of sowing with a garden drill, in rows about two feet apart, using about three pounds of seed per acre. When sown in this way it can be cultivated until it grows large enough to shade the ground and keep the weeds down. This plan works well for small fields, but for large ones the common grain drill can be used, and if the ground is clean it will not be necessary to have the rows far enough apart for cultivation, but all the shoes can be allowed to seed. If, however, the ground is foul, it will be advisable to stop up some of the feed hoppers so as to make the rows twenty-eight to thirty inches apart. In using a grain drill not less than five pounds of seed per acre should be used, and a little experimenting will be necessary in order to discover how to set the drill. Rape can be sown any time after danger of severe frosts in the spring is over, and until September 1st. Severe frosts will injure the young plants when they first appear, but do not seriously affect the more mature leaves. In this respect it resembles cabbage, to which it is closely related. For providing feed during the summer and fall, a succession of sowings should be made at intervals of about two weeks, beginning as early in the spring as practicable and continuing at intervals of about two weeks until September 1st, which is about as late as it can be sown.

Very large yields of green rape are often obtained. In 1899 the yield at Mellette was  $74\frac{1}{4}$  tons of green rape from a single cutting on August 18th. This crop was sown May 20th, and was not irrigated until August 22d, after the first cutting. It made a considerable second growth, and was again cut on October 12th, but the yield was not recorded. A considerable amount of fall feed is often obtained by sowing rape in corn fields just after the last cultivation, and in grain fields soon after the grain is sown. The rape will not make

a very vigorous growth in the grain fields until after the grain crop is harvested, but if the weather is then favorable it grows very rapidly.

Rape can either be fed off in the field by sheep, cattle or hogs, or it can be cut and used as a soiling crop. It is especially valuable as a food for young lambs at weaning time. Seed can be obtained from any seedsman at a reasonable price, and we believe that if every farmer in the state who is raising stock would try a small patch, many of these would find that it is worthy of a permanent place among the farm crops. Early Essex and Victoria are the only varieties yet tried at this Station, and both are equally good.

### OATS AND PEAS

Mixed oats and peas have been grown very extensively, both in this country and in Europe, for soiling, forage, and as a substitute for hay, and the produce is highly esteemed for all these purposes. This crop should be sown on rich, well prepared soil as early in the spring as the land can be gotten into proper condition. We have found a press drill the best implement for sowing, as it insures a deep covering of seed. The amount of seed required per acre varies with varying conditions.

In the spring of 1895 a field, which had been plowed deeply the previous year and well manured during the winter, was sown to oats and peas, mixed at the rate of two bushels of peas to  $1\frac{1}{2}$  bushels of oats. Through a mistake in setting the drill this mixture was sown at the rate of  $4\frac{3}{4}$  bushels per acre. The season was a favorable one, and we cut from this field  $11\frac{1}{4}$  tons of green fodder per acre. In 1896 a yield of  $7\frac{1}{4}$  tons of green fodder per acre was obtained when three bushels per acre of an equal mixture of peas and oats were used. In 1896 a yield of  $1\frac{1}{2}$  tons of dry hay per acre was obtained from a seeding of two bushels per acre of a mixture of one bushel of peas and three-fourths bushel of oats. This is the lightest yield obtained, but it is not believed that the light seeding was the controlling factor, as the oats were badly rusted.

From our experience at the Station, it is believed that on

rich soil four bushels per acre of a mixture of two bushels of peas to  $1\frac{1}{2}$  bushels of oats will not be found too much. On a poorer soil three bushels per acre of such a mixture would give better results. In selecting seed for this purpose, an early variety of peas and a late variety of oats should be selected, otherwise the oats will ripen before the peas reach the best stage for cutting. The best stage for cutting for hay is when the oats are in the milk stage and the first pods are beginning to fill in the peas. Hay made from this mixture, when cut at this stage, is readily eaten by all kinds of stock, and has a high nutritive value. It also makes a fine feed cut green for soiling, or it can be pastured off.

### SAND VETCHES

Sand vetches have been grown at this Station for several years, and have invariably given a good yield of excellent forage, whether sown alone or mixed with oats.

When mixed with oats, which is the best way when the crop is to be cut for hay, owing to the low, vine-like habit of the vetch, the seed should be mixed at the rate of two bushels of vetch to one bushel of oats, and sown with a common seed drill, set to sow  $2\frac{1}{2}$  bushels of wheat, which will sow about 120 pounds of the mixture per acre.

When vetches are sown alone the drill should be set to sow two bushels of wheat; it will then sow about 120 pounds of vetch seed per acre.

In 1895 the yield when sown with oats (April 29th and cut July 8th) as described above, was 9 tons and 440 pounds per acre of green forage.

In 1896 the yield was 3,360 pounds of dry hay per acre, but the general yield was very much lessened by rust attacking the oats.

In 1896 the yield of green forage from vetches sown alone was five tons per acre, which, when dried into hay, amounted to 2,532 pounds of dry hay of excellent quality. The plot was sown May 21st, and was not cut until September 16th, although the vetches had reached a height of twelve inches



and had begun to blossom July 1st. Had they been cut about July 15th they could, undoubtedly, have been cut a second time before October 1st, and would have made a much better showing as to yield. They would have afforded a large amount of pasturage, as they remained green and in blossom, until severe freezing weather set in.

### SPURRY

Giant spurry has been successfully grown at this Station, and while it is not considered as an especially valuable forage plant, it has some characteristics which may render it of value to the farmers of the state, under certain conditions. Among these are the following:

1. It grows very rapidly and will yield two or three cuttings in a season.
2. It stands drouth well.
3. It seeds very abundantly, and therefore the seed can be grown very cheaply.

On the other hand, it is a very low growing plant, with a tendency to lodge down in a mat, which renders it very difficult to cut. When cut and dried for hay it becomes very dry and brittle and many of the leaves drop off when handled.

In 1895 one cutting, seven weeks after sowing, yielded 18,680 pounds green, or 2,920 pounds dry feed per acre.

As a pasture plant it has not been sufficiently tested to enable us to give an opinion; but it is to be hoped that it may prove of value for that purpose. The seed is very small and is best sown broadcast, either with a grass seeder or by hand, and should be only very lightly covered with a roller or plank.

### MILLET

Millet is so generally grown and its merits are so universally recognized by the farmers of the state, that it seems hardly necessary to recommend its cultivation here. On the other hand, a bulletin on forage plants would be incomplete without some mention of so valuable a plant.

Although millet has been grown chiefly as a hay crop in the past, it is equally good for green fodder and has been very successfully used at this Station to furnish pasturage during the dry months, when the pasture grass has failed. When used for this purpose, the pasture should be divided into two or more parts, so that when one portion is being fed off the other will be growing.

There are many varieties of millet, but "common" millet has given best satisfaction here when grown for forage or hay. As a grain crop, Broom Corn millet is best.

Millet can be sown at any time during May or June when the soil is in proper condition to insure prompt and even germination. One-half bushel of seed per acre is about the proper quantity.

It is believed that much loss in the feeding value of the hay is caused by allowing the millet to become too ripe before cutting. There is also much less danger of bad effects to animals from eating early cut millet than there is when the seed is allowed to ripen before cutting.

The best time to cut millet for hay is when a majority of the heads have distinctly appeared. We have fed large quantities of millet hay here to all kinds of stock and have never experienced any bad effects from it. We have, however, always cut our millet early, as recommended above.

## WINTER RYE

Winter rye can be successfully grown in most parts of the state, if the right kind of seed is used. While there are some localities where it has been grown for a number of years there have been many failures. It is believed that the failures have generally been due to using seed from other localities, where the climatic conditions were quite different from those in this state. When the grains winter kill badly there are almost invariably some stools that survive. These should be harvested and the grain from them sown the next year, for they have shown their ability to live under our con-

ditions. A few years of such selection will produce a strain hardy enough for even our worst winters.

A perfect stand was obtained in the spring of 1902 from seed obtained from the Minnesota Experiment Station, and also from some Russian seed. The yields of grain and straw were as follows:

	Yield of Grain bu.	Yield of Straw lbs.
Minn. No. 1.....	39.16	2500
Minn. No. 2.....	46.80	3540
No. 5905.....	33.75	3225

The seed was sown again in the fall of 1902, and all varieties came through the winter in almost perfect condition, although last winter was one of the hardest on all kinds of winter grain, clover, alfalfa and grass that we have experienced for many years.

Rye should be sown at the rate of about two bushels per acre, during the latter part of August, so that it will make a good growth before it freezes up.

Winter rye is a crop that should receive more attention than it has in the past, both as a forage and as a grain crop.

## ROOT CROPS

Mangolds, sugar beets and carrots have all been very successfully grown at this Station and by the farmers of nearly all parts of the state. The principal reason for their not being more extensively raised is the general opinion among farmers that a larger amount of digestible dry matter can be produced at a less cost for labor by raising corn or some other forage crop. This is probably true, but it should be borne in mind that succulent roots have a considerable value as a relish when fed with dry hay, apart from their actual food value. When silage is used for winter food, roots are not so essential, but where all the roughage is fed in a dry state, roots should be provided in sufficient quantity for at least an occasional feed.

## FEEDING DAIRY COWS.

James W. Wilson

H. G. Skinner

During the summer of 1902 the College purchased a herd of common dairy cows. These cows were selected from herds in three different dairy localities, DeSmet, Iroquois and Brookings, and were about an average of the cows kept in these vicinities for dairying purposes. Outside of appearance it was impossible to know anything of their breeding, but the majority were Short-Horn grades. An effort was made to select only those that came nearest conforming to the requirements of the well known wedge-shape dairy type. At the same time they also purchased representatives of the pure-bred Holstein-Friesian and Jersey breeds of dairy cattle.

An experiment was planned for the following winter to test the feeding value of some of the feeding stuffs, when fed to the pure-bred and the grade, and also to note the comparative feeding value of ensilage, Turkestan alfalfa and *Bromus inermis* hay, with the same kind of a grain ration and under the same conditions.

For the purpose of this test fifteen head of cows were selected, and divided into lots of five each, attention being given to have them as uniform as possible as to breed, flow of milk and per cent of butter fat, and weighed up for the experiment.

Two weeks time was taken to get them accustomed to their fodders and on a full feed of grain, when they were weighed three days in succession and the average weight deduced, as given in the following table.

This experiment was divided into three periods, which are designated as A, B and C. The first period, A, was a test of the fodders, and extended from December 25th to January 20th, inclusive, a period of twenty-seven days. The second period, B, was a test of the feeding value of speltz, barley and corn when fed with the same kind of roughage, and included a period of twenty-one days. The third period, C, was a test of the same grains as in period B, with the same

kind of roughage, but Lot I in period B was fed speltz, and in period C barley; Lot II in period B was fed corn and in period C speltz, and Lot III in period B barley, and in period C corn, and continued for twenty-one days. In these two latter periods the same cows were used as in the former, with the exception of three head, which were fresh. One of these cows was added to each lot for the purpose of having them more uniform as to breed and period of lactation. This transposition of the lots was made to eliminate the individuality of the cows as far as possible.

The ensilage was made from corn that was partly in the milk and partly in the dough stage, but it was cut a little earlier than the usual time for cutting corn for ensilage on account of being caught by frost.

The grain ration for period A consisted of ground oats, ground barley and bran mixed in the following proportions: Two-fifths oats, two-fifths barley and one-fifth bran, by weight. They were fed from twelve to sixteen pounds per head of this daily, depending on live weight, and all of the roughage they could be induced to eat. Both the roughage and the grains were carefully weighed, fed to them separately, and any uneaten was weighed back and deducted. No effort was made to furnish a balanced ration, as the nutritive value of some of these feeds used has never been determined. These cows were kept in a well lighted and ventilated barn, and although the weather was quite cold, the temperature in the barn was never allowed to go above 60° F. Too frequently do we find the barns at this time of the year steaming, or the stock standing in a draft, which are both injurious to the health of the animals and should, therefore, be avoided. The water was warmed by placing a tank-heater in the center of the tank, and they were turned out to drink in the morning and evening, but allowed to remain outside only on pleasant days for exercise. It has been demonstrated by experiments that cows will give an increased yield of about six per cent of milk when the water is warmed. From practical experience we have found that fattening steers will drink more water

when the chill has been taken off in cold weather than when ice cold. This is a feature which should receive more attention in feeding all kinds of live stock in cold weather.

In addition to the grain rations already mentioned as being fed during periods B and C, each lot was given three pounds of bran daily to lighten and narrow the ration, as these grains are all rich in carbohydrates. Experimenters have found that the cow produces a larger quantity of milk when her ration is of a more proteinaceous nature than those used in this test. Each cow was fed all the grain she would eat up clean, and it was found that they consumed about the following quantities per head daily, respectively: Speltz twelve, corn nine and barley nine pounds. The cows were weighed at the beginning and at the end of each period, in order to ascertain the loss or gain for that period, and an interval of about two weeks was allowed between the several periods, to get them accustomed to their feed for the next trial:

TABLE I—PERIOD A

Test of the Relative Feeding Value of Ensilage, Bromus  
Inermis and Turkestan Alfalfa Hay

## Lot I—Ensilage and Grain

No. of Cow	BREED	Weight at	Pounds	Pounds	Pounds of Milk	Test		Pounds	Pounds of Feed	Pounds of Grain	Cost of Pound	Weight at Close	Gain—Pounds
		Beginning	Grain	Roughage		Pounds of Milk	Pounds Butter-fat	for Pound of Butter-fat	for Pound of Butter-fat	of Butter-fat Cents	of Period		
89	Grade Short-Horn.....	900	310	1323	466.9	5.00	23.35	57	13	13.64	950	50	
87	Grade Jersey.....	885	319	1647	473.5	5.16	24.44	67	13	14.33	950	65	
95	Pure-bred Holstein-Friesian ...	1132	424	1997	937.7	4.04	37.92	52	11	11.82	1190	58	
79	Grade Short-Horn.....	839	304	1514	423.6	4.40	18.64	81	16	17.50	983	84	
98	Pure-bred Jersey.....	860	319	1394	361.6	6.10	22.07	63	14	14.80	927	67	
	Averages .....	935	335	1575	533.6	4.94	25.28	64	13	14.45	1000	65	

## Lot II—Bromus Inermis Hay and Grain

No. of Cow	BREED	Weight at	Pounds	Pounds	Pounds of Milk	Test		Pounds	Pounds of Feed	Pounds of Grain	Cost of Pound	Weight at Close	Gain—Pounds
		Beginning	Grain	Roughage		Pounds of Milk	Pounds Butter-fat	for Pound of Butter-fat	for Pound of Butter-fat	of Butter-fat Cents	of Period		
84	Grade Jersey .....	936	388	562	582	4.94	28.78	20	13	13.86	960	24	
72	Grade Short-Horn.....	904	315	580	428	5.54	23.74	24	13	12.36	950	46	
85	Grade Short-Horn.....	966	367	582	615	3.66	22.54	25	16	17.14	1020	54	
96	Pure-bred Holstein-Friesian ...	975	316	597	671	3.49	23.48	25	14	15.70	1006	31	
74	Grade Short-Horn.....	1105	315	560	508	4.79	24.38	23	13	14.53	1155	50	
	Averages.....	977	340	576	560	4.48	24.58	23	14	14.72	1018	41	

## Lot III—Alfalfa and Grain

No. of Cow	BREED	Weight at	Pounds	Pounds	Pounds of Milk	Test		Pounds	Pounds of Feed	Pounds of Grain	Cost of Pound	Weight at Close	Gain—Pounds
		Beginning	Grain	Roughage		Pounds of Milk	Pounds Butter-fat	for Pound of Butter-fat	for Pound of Butter-fat	of Butter-fat Cents	of Period		
88	Grade Jersey.....	766	321	379	439	5.07	22.25	17	14	13.90	815	49	
97	Pure-bred Holstein-Friesian ...	868	364	385	652	3.64	23.78	16	13	12.96	905	37	
71	Grade Short-Horn.....	853	315	375	430	3.65	15.72	24	20	17.40	900	47	
78	Grade Short-Horn.....	860	315	389	487	3.97	19.35	20	16	16.02	921	61	
86	Grade Short-Horn.....	1057	367	420	394	4.20	16.55	25	22	21.46	1120	63	
	Averages.....	881	336	389	480	4.11	19.53	20	17	16.35	932	51	

## VALUATION OF FEEDS USED

We find that three tons of ensilage is about equal to one ton of alfalfa or *Bromus inermis* hay. Estimating ensilage at \$1.50 and hay at \$4.50 per ton would therefore give a common basis for comparison. These values are probably in excess of the actual cost of production, but on the other hand they are somewhat less than the prices that may be obtained when a market can be found for them.

We have adopted as a fair average market price for the grains, twenty-four cents per bushel for oats and thirty-six cents per bushel for barley, which would be three-fourths of a cent per pound for each. Bran can usually be obtained in most parts of the state for \$12 per ton, and frequently for less. We have, therefore, estimated the cost of bran at sixty cents per hundred, or .6 of a cent per pound. The prices of these commodities vary, but as the same basis is used for all the calculations in this table, it will serve to show the relative cost of producing a pound of butter-fat, and it will also enable any farmer to estimate the actual cost of producing a pound of butter-fat by substituting the actual values of the several feeds for the values we have used.

## INDIVIDUALITY OF THE COWS

As above stated, these cows were selected from appearances only and nothing whatever was known of their breeding, nor is it possible to state with any degree of accuracy what their progenitors were. They were all from three to six years old and the majority were undersize for their age, as may be seen by the above weights. This undersize may be due to several causes, among which are the following and most probable: First, the breeding to a scrub bull; second, improper care when young, and third, breeding too early. A scrub bull cannot be expected to impress his qualities on the offspring, as he is void of line breeding, but the progeny will take after the progenitors on either side for generations, and scrubs will be the result. Second, from many experiments



conducted at the stations it has been found that when corn meal is fed to the calf while receiving skim milk, that it is a valuable grain to supply the fat which has been extracted by the separator. It should be fed liberally and systematically, as loss in growth at this time can never be regained.

Third, experience has shown that heifers should not be bred until they are from eighteen to twenty months old, and if fed liberally up to this time they will be much larger and more profitable cows.

Too much emphasis cannot be placed on the importance of these three features, especially when a herd is serving in a dual purpose capacity for beef and milk. We had a few two-year-old Short-Horn grade heifers in our herd that were not selected for the experiment because they were not giving enough milk to pay for their feed.

Nos. 87, 84 and 88 were designated in the table as grade Jerseys on account of their possessing traits of the Jersey, but it is not believed that either sire or dam was pure bred, consequently they are not grades. The same is true of most of those called grade Short-Horns.

No. 98 did not prove to be a first-class pure-bred Jersey, as she developed a tendency to fatten rather than to convert her food into milk, as may be seen by table No. I.

No. 95 is the largest cow in the lot, consumed the greatest amount of food and produced butter-fat at the least cost. She ate from sixty to seventy-nine pounds of ensilage daily, or all she would eat, in addition to her grain ration.

The average cost to produce a pound of butter-fat with the dairy bred and beef bred cows in Lot I during period A, when fed on the fodders, was 13.49 cents for the Holsteins, 14.03 cents for the Jerseys and 16.29 cents for the grade Short-Horns, while the average gain in weight was 48, 51 and 57 pounds per head respectively, showing that the dairy bred cows used more of their feed for the production of milk than did the others.

The milk was weighed after each milking, a composite sample test kept, taken to the creamery and tested with the Babcock test. It may be seen by the following table that the per cent of butter-fat for individual cows varied quite considerably during the experiment. The cause of this variation cannot be accounted for, as the conditions were indentially the same in every instance.

The term butter-fat in the tables does not refer to the quantity of butter, but the dry fat, as is determined by the Babcock test. To reduce it to butter add to it one-sixth of its weight, as this is the amount that has been found to be the average increase after it has been made into the finished product:

**TABLE NO. II**  
**Tests of Individual Cows for Three Periods**

**Lot I**

No. of Cow	A	B	C	Range
79.....	4.40	4.35	4.40	.05
92.....	....	3.68	4.02	.34
95.....	4.04	3.36	3.26	.78
87.....	5.16	5.23	5.05	.18
98.....	6.10	5.94	5.72	.38

**Lot II**

No. of Cow	A	B	C	Range
84.....	4.94	4.72	4.66	.28
73.....	....	4.40	4.52	.12
85.....	3.66	3.33	3.60	.33
96.....	3.49	3.27	3.58	.31
74.....	4.79	4.47	4.93	.46

**Lot III**

No. of Cow	A	B	C	Range
88.....	5.07	5.10	5.00	.10
97.....	3.64	3.12	3.20	.52
99.....	....	4.84	4.88	.04
78.....	3.97	3.76	3.88	.21
86.....	4.20	4.16	4.00	.04

The above table is an average of the two tests made, each period for butter-fat, for individual cows extending over the entire time of the three experiments. It is presented for the purpose of showing what the range was in the test for butter-fat.

It may be seen in the six tests that they range from four hundredths to seventy-eight hundredths of one per cent, and that there was no uniform increase or decrease in the per cent of butter-fat during the period of lactation for the entire interval of sixty-nine days.

Professor Henry of the Wisconsin Station says: "It is now pretty well proved that the percentage of fat in a cow's milk depends upon the animal and not upon the feed. This seems reasonable when we reflect upon the purpose of milk in nature. If milk varied from season to season and from day to day, according to the feed of the animal, the life of the young would be constantly endangered by such changes. It is possible that a cow which has long been ill-nurtured and is in poor condition will give milk abnormally low in fat, and that the milk will increase in richness of fat with increased feed supply and the approach of the body to normal conditions."

From table No. I it will be noticed that the per cent of butter-fat is larger with the Jersey breed than the others, and if we desire to increase the per cent of butter-fat in our herd we must look to the breeds rather than to the feeds.

### **THE RELATIVE FEEDING VALUE OF ENSILAGE, BROMUS INERMIS AND ALFALFA HAY**

By table No. I it will be seen that it required less grain to produce a pound of butter-fat when fed with ensilage, the cheapest fodder, than when fed with other fodders. The palatability of ensilage as compared with the hays was greater, for after they were taught to eat it they ate it with greater greed than they did their grains, or the other lots did their *Bromus inermis* or alfalfa hays. That it took about one-sixth more of *Bromus inermis* hay than it did alfalfa hay, while on the other hand, the alfalfa lot required about one-fourth more of grain than the *Bromus inermis* lot to produce a pound of butter-fat. It cost nearly one-seventh more to produce a pound of butter-fat with alfalfa than it did with ensilage.

TABLE III—PERIOD B

## Test of the Relative Values of Speltz, Corn and Barley

## Lot I—Speltz

No. of Cow	BREED	Weight at	Pounds of Grain	Bromus Inermis	Ensilage	Pounds of Milk	Test	Pounds of	Pounds Rough-	Pounds of Grain	Weight at Close	Gain or Loss
		Beginning	Hay	Hay			Butter-fat	age for Pound	for Pound of	Butter-fat		
79	Grade Short-Horn.....	1008	267	299	228	244.4	4.35	10.65	49	25	1029	21
92	Grade Holstein.....	909	283	329	226	686.1	3.68	25.28	22	11	928	19
95	Pure-bred Holstein-Friesian ...	1155	407	329	244	671.5	3.36	22.62	25	18	1141	-14
87	Grade Jersey.....	931	384	329	235	301.6	5.23	15.78	35	24	928	-3
98	Pure-bred Jersey.....	941	268	329	235	243.1	5.94	14.45	39	18	933	-8
Averages.....		989	322	323	234	429.3	4.51	17.76	34	19	992	3

## Lot II—Corn

No. of Cow	BREED	Weight at	Pounds of Grain	Bromus Inermis	Ensilage	Pounds of Milk	Test	Pounds of	Pounds Rough-	Pounds of Grain	Weight at Close	Gain or Loss
		Beginning	Hay	Hay			Butter-fat	age for Pound	for Pound of	Butter-fat		
84	Grade Jersey.....	980	252	329	235	409.8	4.72	19.35	29	13	952	-28
73	Grade Short-Horn.....	993	252	329	235	571.4	4.40	25.15	22	10	931	-62
85	Grade Short-Horn.....	1002	245	329	235	397.9	3.35	13.33	42	19	1000	-2
96	Pure-bred Holstein-Friesian ...	1034	252	329	235	576.2	3.27	18.86	29	13	1024	-10
74	Grade Short-Horn.....	1166	252	329	235	394.9	4.47	17.67	32	14	1154	-12
Averages.....		1035	251	329	235	470	4.04	18.87	31	15	1012	-23

## Lot III—Barley

No. of Cow	BREED	Weight at	Pounds of Grain	Bromus Inermis	Ensilage	Pounds of Milk	Test	Pounds of	Pounds Rough-	Pounds of Grain	Weight at Close	Gain or Loss
		Beginning	Hay	Hay			Butter-fat	age for Pound	for Pound of	Butter-fat		
88	Grade Jersey.....	871	210	313	230	326.8	5.10	16.67	32	13	844	-27
97	Pure-bred Holstein-Friesian ...	947	252	329	235	496.8	3.12	15.52	36	16	967	20
99	Pure-bred Jersey.....	981	252	329	235	568.2	4.84	27.54	20	9	974	-8
78	Grade Short-Horn.....	971	252	329	235	394.7	3.76	14.89	37	16	950	-21
86	Grade Short-Horn.....	1155	252	329	235	329.6	4.16	13.64	41	18	1159	4
Averages.....		985	244	326	234	423.2	4.20	17.65	33	14	979	-6

TABLE IV—PERIOD C

Test of the Relative Values of Speltz, Corn and Barley

## Lot I—Barley

No. of Cow	BREED	Weight at	Pounds of Grain	Pounds of Roughage	Pounds of Milk	Test		Pounds Roughage for Pound of Butter-fat	Pounds of Grain for Pound of Butter-fat	Weight at Close	Gain or Loss
		Beginning				Pounds of Butter-fat					
79	Grade Short-Horn.....	1037	238	420	150	4.40	6.60	63	36	1070	33
92	Grade Holstein.....	912	245	420	633.3	4.02	29.52	14	8	937	25
95	Pure-bred Holstein-Friesian .....	1136	294	420	676.6	3.26	22.07	19	13	1127	-9
87	Grade Jersey.....	952	252	420	334	5.05	16.90	24	14	956	4
98	Pure-bred Jersey.....	944	210	420	236	5.72	13.51	31	16	968	24
Averages.....		996	247	420	405.9	4.49	17.72	30	17	1011	15

## Lot II—Speltz

No. of Cow	BREED	Weight at	Pounds of Grain	Pounds of Roughage	Pounds of Milk	Test		Pounds Roughage for Pound of Butter-fat	Pounds of Grain for Pound of Butter-fat	Weight at Close	Gain or Loss
		Beginning				Pounds of Butter-fat					
84	Grade Jersey.....	964	297	396	395	4.66	18.41	22	16	952	-12
73	Grade Short-Horn.....	1023	292	396	503	4.52	22.76	17	13	1008	-15
85	Grade Short-Horn.....	1029	288	396	408	3.60	14.72	27	20	1049	20
96	Pure-bred Holstein-Friesian .....	1030	293	420	567	3.58	20.32	26	14	1082	52
74	Grade Short-Horn.....	1127	297	396	365	4.93	18.01	22	16	1157	50
Averages.....		1034	293	400	417	4.25	18.84	23	16	1049	15

## Lot III—Corn

No. of Cow	BREED	Weight at	Pounds of Grain	Pounds of Roughage	Pounds of Milk	Test		Pounds Roughage for Pound of Butter-fat	Pounds of Grain for Pound of Butter-fat	Weight at Close	Gain or Loss
		Beginning				Pounds of Butter-fat					
88	Grade Jersey.....	888	252	401	291	5.00	14.55	27	17	905	17
97	Pure-bred Holstein-Friesian .....	961	252	402	527	3.20	16.91	24	15	972	11
99	Pure-bred Jersey.....	959	252	400	488	4.88	23.79	17	11	955	-4
78	Grade Short-Horn.....	982	252	402	409	3.88	15.88	25	16	961	-21
86	Grade Short-Horn.....	1191	252	402	289	4.00	11.54	34	21	1224	33
Averages.....		996	252	402	420	4.19	16.53	25	16	1003	7

## SECOND AND THIRD PERIODS B AND C

### Test of Relative Feeding Value of Corn, Barley and Speltz

The same cows were used in this experiment as in period A, except that one fresh cow was added to each lot, as follows: No. 92, a grade Holstein, was substituted for No. 89, a grade Short-Horn, in Lot I; No. 73, a grade Short-Horn, for No. 72, also a grade Short-Horn, in Lot II, and No. 99, a pure-bred Jersey, for No. 71, a grade Short-Horn, in Lot III.

These changes were made in order to render the lots more uniform for the comparison and to note the change, if any, in the per cent of butter-fat with fresh cows. From the results of the test, as may be seen by table No. II, during these four weeks there was a slight increase in the per cent of butter-fat for these three fresh cows. In each instance the cow proved superior to the one discarded, which indicates that more can be realized from the dry feeds when fed to fresh cows, than to those advanced in the period of lactation.

Feeding each of these lots a different grain ration in each of the two periods affords an opportunity to judge of their relative characteristics such as was not possible in period A. The following tables will show the number of pounds of grain required by each lot to produce a pound of butter-fat, and also gives the gain or loss of each lot for the two periods B and C:

### Pounds of Grain Required to Produce a Pound of Butter-fat by Each Lot, when Fed on Two Different Kinds of Grain

PERIOD B			PERIOD C		
Lot	Grain	Pounds Grain for One Pound Butter-fat	Grain	Pounds Grain for One Pound Butter-fat	Average
I	Speltz .....	19	Barley .....	17	18
II	Corn .....	16	Speltz .....	16	16
III	Barley .....	14	Corn .....	16	15

**Gain or Loss in Weight as Influenced by the Characteristics  
of the Different Lots**

PERIOD B			PERIOD C		TOTAL
Lot	Grain	Gain or Loss	Grain	Gain or Loss	Gain or Loss
I	Speltz .....	+3	Barley .....	+15	+18
II	Corn .....	-23	Speltz .....	+15	-8
III	Barley .....	-6	Corn .....	+7	+1

It may be seen from a study of this table that Lots II and III required about the same quantity of grain to produce a pound of butter-fat, while Lot I required eighteen pounds. From this we conclude that Lots II and III were about equal as butter producers, but that Lot I was inferior in this respect. On the other hand, Lot I gained in weight an average of eighteen pounds per head, where Lot II lost eight pounds and Lot III gained only one pound per head for the two periods.

In the test with ensilage in period A, Lot I gave better returns for the grain consumed than either Lots II or III, and the substitution of 92 for 87 certainly improved the quality of this lot. The only explanation we have to offer for the falling off in weight of Lot I in periods B and C is that this lot had become accustomed to the bulky succulent ensilage during period A, and the change to dry hay was the cause of the decreased butter production of Lot I during these two latter periods. Whatever the cause, it is evident that this lot was not equal to the other two as butter producers during periods B and C, as Lot I required more grain to produce a pound of butter-fat on the same ration than did either Lots II or III. This difference in the lots should be taken into consideration when judging of the relative value of the grains fed.

The following tables show in condensed form the net results of the tests, of the quantity of each of the grains required to produce a pound of butter-fat:

**Pounds of Each Kind of Grain Required to Produce a Pound  
of Butter-fat, for Periods B and C**

Grain Fed	Period B		Period C		Average
	Lot	Pounds Grain for One Pound Butter-fat	Lot	Pounds Grain for One Pound Butter-fat	
Speltz .....	I	19	II	16	17.5
Corn .....	II	15	III	16	15.5
Barley .....	III	14	I	17	15.5
Average for period.....		16		16.34	16.2

**Gain or Loss in Weight per Head as Influenced by the Grain  
Fed**

Grain Fed	Period B		Period C		Total of Two Periods
	Lot	Gain or Loss	Lot	Gain or Loss	
Speltz .....	I	+3	II	+15	+18
Corn .....	II	-23	III	+7	-16
Barley .....	III	-6	I	+15	+9

From the above table it will be seen that the averages of the number of pounds of grain for the production of a pound of butter-fat, with the two lots when fed corn and barley, are the same; that it required two pounds more of speltz, and when we consider the difference in the price of these grains on the market, conclusions can be drawn as to which is the most profitable to feed.

The effect of the different grains upon the weight of the animals was as follows:

Speltz produced a gain in weight of eighteen pounds per head.

Corn produced a loss in weight of eight pounds per head.

Barley produced a gain in weight of one pound per head.

These results were undoubtedly closely correlated with the production of butter-fat and were probably also influ-



enced by the different characteristics of the lots to which they were fed.

### THE VALUE OF ENSILAGE

Prior to the feeding of ensilage, Lot I was receiving all the upland prairie hay it could eat, and in addition a grain ration similar to the one fed during the experiment. Each cow in this lot increased in her flow of milk and gained in weight while she was receiving ensilage, but when gradually put back on to a part ensilage and hay ration in Lot I, period B, three of the five head lost in live weight and fell off over one-third in the production of butter-fat. This was a very expensive change of feeds, as the cost of the new feed was greater and the returns for the feed consumed were smaller.

### SUMMARY

1. Ensilage was more palatable than either alfalfa or *Bromus inermis* hay.
2. It required less grain to produce a pound of butter-fat when ensilage was fed as the sole roughage ration than with any other lot.
3. By feeding all of the ensilage the cows would eat a pound of butter-fat was produced cheaper than with either alfalfa or *Bromus inermis* hay.
4. *Bromus inermis* hay, when fed in conjunction with the same kind of a grain ration as was the alfalfa hay, produced a pound of butter-fat one and sixty-one hundredths cents cheaper, and twenty-seven hundredths cents more than the lot receiving ensilage.
5. A change from a succulent to a dry feed is not advisable, as the loss in the quantity of butter-fat and in the weight of the cows was greater than with the changes that were made in the lots getting the hays.
6. It required two pounds more of speltz to produce a pound of butter-fat than it did barley or corn under the same conditions.
7. The per cent of butter-fat is governed by the breed and not by the feed.
8. Fresh cows produced a pound of butter-fat with less grain than did those that were further advanced in the period of lactation.
9. During periods B and C it required one-third more grain to produce a pound of butter-fat with the beef-bred cows than it did with the dairy-bred cows.

# FLIES

E. L. MOORE, Veterinarian

Those insects that are parasitic in their adult stage to our domestic animals, recognized by scientists as diptera, commonly spoken of as flies, constitute a group of free-living, intermittent parasites which prove a source of annoyance to our animals while in the field or in the stable, disturb them awake or asleep, cause a loss of flesh or a decrease in the milk yield, and may even in some cases prove carriers of disease. Individually small, unimportant, collectively they cannot be ignored by the careful and humane attendant.

To prevent the annoyance of these insects various kinds of applications to the body have been employed. An ideal application should be of such a nature as to be easily and quickly applied and of a lasting character. The first requirement is best fulfilled by a liquid rather than an ointment, as it can be quickly sprayed upon the animals. No application yet used can be considered ideal, so far as durability of action is concerned. The materials employed must be odorous, bitter and nauseating. Thus we find recommended decoctions of tobacco, aloes, asafoetida, etc., mixtures containing fish oil, oil of tar and various empyreumatic oils, such as oil of cade, etc. Asafoetida possessed an odor too disagreeable to the attendants to allow of its use. Aloes possessed but little value. An infusion of dried walnut leaves in vinegar, highly spoken of by some, proved utterly worthless. Various other agents were used, and while compounds could readily be prepared of the same efficiency as many of the proprietary preparations on the market, they possessed no especial advantages in that important requirement of durability.

Incidentally it was also demonstrated that applications which would be of distinct advantage when applied to cattle possessed but a mediocre and fleeting efficiency for horses.

The following formula was most useful :

Fish oil.....	100 parts
Oil of tar.....	50 parts
Crude carbolic acid.....	1 part

The cost of this mixture was about 35 cents per gallon.

Applications were made by spraying the animals, using a small hand spray pump. One application proved efficient for two days. If applied every day, however, but a short time is necessary to lightly spray each animal in a moderate sized herd, while if applied less frequently each animal must be gone over more thoroughly, the operation thus occupying considerable time. No tainting of the milk through the absorption of odors was noted, yet it is well to call attention to the fact that the milk as soon as drawn from each cow was taken into a milk room closely partitioned off from the stable, where it was kept until the milking was finished. When we consider the intimate relationship existing between the milk yield and the physical comfort of the cow, no question can be raised as to the benefit obtained by mitigating so far as possible the annoyances of these pests.

To keep a stable free from flies the following plan has been recommended by Spence and is followed in Italy :

The outside of the windows is covered with a simple netting, the meshes of which are large enough to allow several flies to pass through at one time. If the light penetrates only from one side of the building the insects do not venture to pass through the netting into the building, but, on the other hand, those that are within do not hesitate to pass out through the netting to the light beyond.

# THE ARTESIAN WATERS OF SOUTH DAKOTA

James H. Shepard, Chemist

The artesian waters of South Dakota are used for three distinct purposes. In the first place they are used by cities as the source of water supply. When thus used they are employed for domestic use, for sprinkling lawns and gardens and for fire protection. Closely akin to these are the township or neighborhood wells where the water is used conjointly by communities for watering stock and for domestic use.

In the second place these waters are used for irrigating purposes mainly and for domestic use incidentally. In such cases the well may be owned by an individual or it may be owned by a stock company.

In the third place the waters of some wells are used wholly for power purposes; but the wells thus used are few in number. In any one of the cases mentioned the surplus waters may be used for the purpose of creating running streams or for creating artificial ponds or for irrigation. In some cases, however, the surplus water is discharged directly into some river or stream, where it flows to waste. Most of the wells have controlling devices whereby the surplus water is reduced to a minimum. But in case the well is faulty in construction it runs without control.

The analysis of these waters was undertaken in the interests of the first two uses for which the water is employed. It is scarcely necessary to state that a chemical analysis could have little or no value in the case of a water employed for power purposes only. But when it comes to a question of sanitation, or healthfulness, or a fitness of these waters for irrigation, the case is far different. No regular or systematic chemical investigation of the water supply of the great artesian basin has ever been made. It is true that a few partial analyses for special purposes have been made from time to time, but nothing like a complete examination has ever been undertaken.

In order to cover the field as completely as possible, wells were chosen which were geographically distributed as uniformly over the whole artesian basin in South Dakota as the circumstances in the case would permit. When several wells occurred at the same point, various considerations led to the choice made. Sometimes it was the vein or flow from which the water comes, and sometimes it was the purpose for which the water is employed that decided in the final selection. State Engineer of Irrigation, C. S. Fassett, gave valuable advice in locating the wells.

The samples were taken from each well by Mr. C. G. Hopkins, then Assistant Chemist of this Station. He also observed the temperature of each well and collected such data as he was able to obtain.

The samples collected were forwarded to the Station in sealed packages, and none of the seals were broken. Thus the authenticity of all the samples is unquestionable.

## SYSTEMIC EFFECTS OF ARTESIAN WATER SALTS

Among the questions most frequently asked are: "What are the medicinal values of the salts carried by these artesian waters, and what would be their effects upon the human system?" Perhaps no better opportunity will ever offer than the present to answer this question fully. Therefore each salt will be considered separately.

**Sodium Chloride, NaCl**—This compound is the well known common "salt" so widely used for domestic purposes. It is not necessary here to recall its varied uses in domestic economy nor to discuss its importance to animal life. All these facts are well understood. But its uses in medicine are not so commonly known.

In small doses of from ten grains to one drachm, or of .65 grams to four grams it is a stomachic tonic and an anthelmintic. In larger doses of from eight to fifteen grams it is a cathartic; still larger doses of from fifteen to thirty grams dissolved in a little water, in many cases, act as an emetic which invigo-

rates rather than depresses the system. It is also a styptic useful in checking internal hemorrhages or in stopping the flow of blood from external wounds.

Externally it is useful in sprains and bruises and its tonic value in the form of a "salt bath" is well understood.

Salt which has been taken into the system is rapidly removed by the kidneys. Sodium chloride is present in most of the drinking waters of this country, whether they are derived from surface wells, from springs, or from running streams.

**Sodium Bicarbonate,  $\text{NaHCO}_3$** —This is also a well known salt which is largely employed in preparing effervescent drinks and medicines. It is used in enormous quantities in preparing baking powders. In the analyses the compound formed between sodium and carbonic acid is given as the normal carbonate,  $\text{Na}_2\text{CO}_3$ . The bicarbonate passes into this form upon the application of heat to the dry salt. In medicine the bicarbonate is used as an antacid. It has been found valuable in cases where an excess of uric acid has caused calculous deposits. It has been found useful in diabetes, since it lessens the sugar in the urine. The dose for an adult is from .65 to four grams. It is further employed in cases of croup, pneumonia, and membranous angina.

This salt is not a common constituent of drinking waters either in this state or elsewhere.

**Sodium Sulphate,  $\text{Na}_2\text{SO}_4$** —This salt is commonly known as Glauber Salts. In doses of from fifteen to thirty-two grams it acts as a hydragogue cathartic. When it is taken in smaller doses it acts as an aperient and a diuretic. It is not much used in medicine at present, as most practitioners prefer magnesium sulphate instead. Veterinarians, however, employ it extensively in their practice.

This salt is not of uncommon occurrence in drinking waters.

**Calcium Carbonate,  $\text{CaCO}_3$** —This compound occurs abundantly in nature in impure forms known as limestone, chalk, marble, calcite, etc. The pure salt is used in medicine as an

antacid and it is especially useful in cases of diarrhoea when accompanied by an acid condition of the digestive tract. It is employed as a remedial agent for gout, dyspepsia and acidity of the stomach. Its use in scrofulous diseases is followed by good results. The dose for an adult is from .65 to three grams. Externally it is beneficially applied to burns and scalds.

This compound occurs in drinking waters nearly everywhere.

**Ferrous Carbonate,  $\text{FeCO}_3$** —In the analyses the iron is reported in the form of ferric oxide,  $\text{Fe}_2\text{O}_3$ . But as one would naturally infer, iron does not exist in the natural waters in this insoluble condition. As it occurs in solution it is in the form of ferrous carbonate, a tonic and chalybeate. When the water is evaporated or when it has stood for some time the ferrous carbonate is decomposed and the iron is thrown down as a reddish sediment consisting largely of the ferric oxide and hydroxide. Upon the application of heat the conversion to ferric oxide is completed.

Ferrous carbonate occurs in most drinking waters.

**Calcium Sulphate,  $\text{CaSO}_4$** —In an impure form this compound occurs as gypsum. When calcined it is known as plaster of paris. It probably exerts little effect upon the system; at least it is not given internally. It is a common constituent of drinking water.

**Magnesium Carbonate,  $\text{MgCO}_3$** —Magnesium carbonate is an antacid and in most cases a laxative. The dose is from one to two grams. It is largely used in the preparation of medicated waters.

**Magnesium Sulphate,  $\text{MgSO}_4$** —This salt is commonly known as Epsom Salts. It is an active but safe refrigerant cathartic, operating with little pain or nausea. It is more acceptable to the stomach than most medicines. It is useful in colic and in severe cases of constipation and operates without relaxing the stomach and bowels. A moderate dose is one ounce or about 31.1 grams. In smaller doses magnesium sul-

phate may act as a diuretic. It is a common constituent of drinking waters.

**Lithium Salts**—Lithium is a rare metal and its salts are seldom found in drinking waters. By a spectroscopic examination these salts have been found to exist in all the artesian waters analyzed. The lithium salts are valuable in treating rheumatism.

**Effect Produced by a Combination of Salts**—It is impossible, except in a general way, to predicate just what the effects of any combination of salts as they occur in natural waters would be. To a certain extent they each modify or accentuate the effect which any one would produce singly. If all the salts carried by any water had the same tendency the result might easily be foretold. But such waters are rare. It seems as if nature modifies and ameliorates the effects produced by the salts in mineral waters just as the skilled pharmacist ameliorates the effect of one drug by a skillful and judicious combination with others. In general it would be safe to say that the artesian waters as a rule are tonic-laxative in their effects upon the system.

All the artesian waters of this state carry a larger amount of salts than would be desired in a first-class potable water. But it nevertheless remains a fact that in some cities these waters are used with impunity for all domestic purposes, and in fact no other water is used at all. From these places no complaint comes as to any injurious effect. Moreover, wherever the water is used for watering stock no unfavorable results follow. In fact stock seems to thrive by its use. At any rate it is far preferable to the stagnant water which stock is so frequently compelled to drink in other sections of the country.

The explanation as to why water carrying a more than ordinary amount of salts may be used for drinking purposes without injurious results, especially in the case of these artesian waters, may not be difficult to find. The following ones suggest themselves most readily: In the first place these



waters are free from organic contamination and consequently carry no germs of contagious disease. Consequently the energies of the system are neither weakened nor prostrated at any time by these more to be dreaded agencies which are at work where organically impure waters are used for drinking purposes. It may be that the system finds it less difficult to eliminate the excess of saline compounds than it does to ward off the injurious effects of albuminoid poisons and disease germs. Then again it is a well known fact that one finally becomes accustomed to certain water and that the system finally thrives best upon it, even though at first it was not particularly palatable. In these cases it seems that the system actually adjusts itself to the elimination of any surplus that might by its accumulation prove detrimental. It is a well known fact that persons accustomed to the use of hard waters upon going into a country where soft waters prevail, actually find the soft waters flat and unpalatable. The water seems to lack something to the taste, and physiological symptoms seem to indicate that the system also misses some of the constituents of the hard waters.

The only complaints concerning the use of artesian waters as potable waters that have come to my knowledge are that at first they have proven laxative in some cases. But this effect soon passes off as a rule. Then again many complain that the water is too warm and consequently somewhat unpalatable, just as any water is under like conditions. This is usually remedied by cooling the water before it is used.

In some places where artesian water is used for other purposes, it is not used for drinking. In these places a supply of water with less salts is available and more palatable.

In this connection it might be well to say that in these towns where first-flow, soft artesian waters are used for drinking purposes, should any evil effects ensue, that the corrective which most readily suggests itself would be fruit acids. The acids of fresh fruits would certainly tend to neutralize the effects of the antacid salts the waters contain.

Another thought suggests itself here, and that is one would

need to drink an inordinate quantity of most of these artesian waters to get any other than a tonic effect from any of the salts held in solution. This will become apparent to any one who cares to take the trouble to make the necessary computation. It is probable that the laxative effects arise from the combined influence of the principal salts, and more especially from a cumulative effect produced by their continued use. It is not unreasonable to suppose that after the system has become adjusted to the water, that the cumulative effect ceases, owing to a prompt elimination of any excess of the salts in question.

### THE EFFECTS OF ARTESIAN WATER SALTS UPON SOILS AND PLANTS

To the irrigator there is no question of greater importance than those relating to the effects produced upon soils and plants by the saline constituents of the water which he is applying to his land. Waters may carry salts that act as fertilizers, or they may carry substances detrimental to soil and vegetation alike. Again they may carry such large amounts of salts, which of themselves in ordinary quantities are either beneficial or harmless to vegetation, that the soil may become overcharged and barren. And further, the salts, though small in quantity, may be such as to destroy the tilth of the land or they may cause crops to wither away and die.

In discussing the effect of any water upon soils and vegetation it will be necessary to take up each of its saline constituents in detail. There is one other fact, which should at the outset be set forth clearly, and which is true of every saline substance, however valuable it may be as a fertilizer or as a plant food, and that is, the addition of any salt to a soil will not increase the fertility of that soil provided there is already present a sufficient supply of the salt to meet all the requirements of plant growth.

**Sodium Chloride, NaCl**—This salt has been applied to land since time immemorial. It is more beneficial to inland soils where there is a deficiency of the salt. In soils where plenty of this compound exists further applications are not beneficial.

In its action common salt is not a direct fertilizer, since plants as a rule require little sodium; small quantities of chlorine also will meet all requirements. It is one of the so-called "indirect" fertilizers. Its value when applied to soils may be attributed to the following causes:

1. It acts upon the undecomposed rocky constituents of soil, liberating lime, magnesia and phosphoric acid for plant use. Its greatest action is upon lime and then upon the other substances in the order named. These substances, which in their undecomposed state were mostly combined as insoluble silicates, through the kindly offices of salt assume a soluble condition, in which form plants can readily assimilate them.

2. Salt also tends to check a too rank growth of stalks and straw; and it is often applied to over fertile soils for this purpose. It is also mixed with other powerful fertilizers, such as guano, to modify their action. It gives the best results upon grains, grasses, cotton, hemp, asparagus, cabbages, tomatoes, celery, onions, horseradish, cauliflowers, etc. It is not applicable to potatoes, since it diminishes the yield and makes the tubers waxy. The amount that is applied per acre varies from 200 to 600 pounds.

An overdose of salt is fatal to all vegetation. It is more destructive to young plants than it is to older ones, hence its frequent use for destroying young weeds where the crop has attained some size. As a germicide salt is supposed to possess some virtues. It is thought to be destructive to the spores of the fungus diseases of various plants.

3. Salt is also beneficial to the tilth of land, since it flocculates clay and prevents it from puddling. It is a commonly known fact that the addition of salt to the roily waters of a well will coagulate the suspended clay, causing it to settle and leaving the water clear.

An excess of salt is detrimental to the process of nitrification which is going on constantly during plant growth in fertile soils. An excess therefore prevents the plant from obtaining sufficient nitrogen to reach maturity. This action of salt might be readily surmised from its well known antiseptic properties, as illustrated in the use of brine in the preservation of meats and other substances.

The only remedy for a soil surcharged with common salt is efficient and thorough drainage.

**Sodium Sulphate,  $\text{Na}_2\text{SO}_4$** —This salt is a valuable fertilizer for cereals, potatoes, grasses, clovers, peas and other legumes. It is applied in doses of from 175 to 250 pounds per acre.

This sulphate, as well as those to be mentioned hereafter, act in soils as oxidizing agents. By this action nitrogen in nitrogen compounds is changed into ammonia, carbon into carbon dioxide, etc. The ammonia thus produced is now seized upon by the nitrifying organisms in the soil and converted into nitrites and nitrates. It is from these forms that plants largely secure nitrogen for building up their albuminoids. Moreover these albuminoids contain sulphur obtained from the breaking down of these same sulphates.

Sodium sulphate is one of the chief ingredients of the so-called "mild" or "bland" alkali which occurs as an incrustation on low places in various parts of this state. These places are mostly small, a few rods in diameter, and this salt can be removed from them by drainage. By means of deep plowing and by the admixture of much coarse manure to decrease the capillarity of the soil in these places, large crops of grasses may be obtained. But the permanent cure of all soils overcharged with this salt is drainage.

**Sodium Carbonate,  $\text{Na}_2\text{CO}_3$** —This compound has a favorable effect upon vegetation when it is present in small quantities in soils rich in organic matter. It furnishes a readily salifiable base to unite with the nitrous and nitric acids produced by the nitrifying organisms present in all fertile soils. The organisms convert this carbonate into sodium nitrite and nitrate, valuable fertilizers.

But when present in large quantities the sodium carbonates constitute the dreaded "black alkali" which occurs in undrained places in California, India and elsewhere. Black alkali is pernicious in its action upon both soils and plants. It puddles clayey soils, or as it is usually termed, turns them into "gumbo." It also dissolves the humus of fertile soils, which it leaves in black rings or patches as the water evaporates from places where it has been standing in puddles. It is owing to this circumstance that it has received the name of black alkali. Its action on plants is corrosive, actually eating off the plant at the crown. Moreover this salt, as well as all of the sodium salts, has a tendency to creep upward. The rising soil waters bring them up to the surface and leave them as a white incrustation on the surface of the soil. Waters carrying much sodium carbonate should not be used for irrigation, unless, indeed, the land is first thoroughly underdrained.

Analyses of the Rio Grande River waters covering a period from June 1 to November 1, 1893, show an average of .0036 parts of sodium carbonate per 1,000. (Bul. 12, N. M.) This water is considered excellent for irrigation.

Hilgard gives the analyses of two artesian waters from the San Bernardino Valley carrying respectively .0102 and .0021 parts of sodium carbonate per 1,000. (Waters and Water Supply, 1889.) He also reports in Warm Creek waters supplying the Riverside canal, .020 parts per 1,000. These waters are considered good for irrigating purposes. In the California report for 1888 and 1889 he gives the analysis of the artesian water used for irrigation at the San Joaquin Station. This water has .0334 parts of sodium carbonate per 1,000. He thinks this water would require a corrective such as gypsum.

But it would be difficult to state just how much of this salt might be considered safe for any particular section. An amount that would be safe to use in one place might prove disastrous in another. This uncertainty is due to many factors, such as the saline constituents already present in the soil, and various climatic conditions, such as rainfall, winds, hu-

midity of the atmosphere, etc. Moreover, the mechanical condition of the soil and subsoil, together with the natural drainage, constitute important factors in the problem. These will be discussed further on.

Soils containing an excess of sodium carbonate may be reclaimed by applications of gypsum or by drainage, or by both. There is a reaction between the gypsum and the sodium carbonate whereby the carbonate is converted into the sulphate, in which condition it becomes mild, while the gypsum is changed into lime. Drainage simply carries the salt away. Sometimes it is best to apply the gypsum first and then drain afterward. This would undoubtedly be the best plan for reclaiming the small gumbo patches which are found in a few places in this state. In this way the humus would be retained and the surplus of salts removed without detriment to the land. Such spots would then become exceedingly fertile and easy of cultivation.

It will be noticed that none of the second-flow wells contain sodium carbonate. In the Miller well, a first-flow well, sodium carbonate is also wanting. This is probably due to the fact that the water has come in contact with or has passed through deposits of gypsum occurring in the water bearing rock itself. This supposition is strengthened by the large amount of sodium sulphate present. Another striking case is found in the Aberdeen well, where the first and second flow waters are intermingled. Here the gypsum of the second flow well has transformed nearly all of the sodium carbonate of the first flow, only .010 parts of the carbonate per thousand remaining.

**Magnesium Sulphate,  $MgSO_4$** —Magnesium compounds are indispensable to plant life. They form an important part of the herbaceous and woody parts of plants and occur in the ashes of all seeds. It is in the seeds, however, that magnesium compounds occur most plentifully. It appears that calcium and magnesium salts act more favorably when they are used in conjunction.

Besides acting as a direct plant food magnesium compounds

also aid largely, and to a greater extent than sodium compounds do, in the decomposition of soils to liberate potash and phosphoric acid in soluble forms. Magnesium salts are applicable to all crops. Magnesium sulphate is used in compounding certain special manures. It also occurs to a considerable extent in the white incrustations of soils. In such cases, if it is too abundant, it can be rendered insoluble by applications of calcium carbonate or lime stone. The lime stone is thus changed to gypsum, while the magnesium sulphate is changed into the more insoluble magnesium carbonate.

**Magnesium Carbonate,  $MgCO_3$** —This compound of magnesium is usually preferable to the sulphates, especially where the soil already has sufficient sulphates, owing to its greater insolubility. This carbonate is frequently applied to lands where dolomite or magnesium limestone is used. Its action is beneficial to soil and crops alike.

**Calcium Carbonate,  $CaCO_3$** —Lime stone soils are famed for their fertility. It is not strange that this should be so. Lime improves the tilth of soils, prevents clay from puddling, promotes nitrification, assists in the decomposition of soils, and besides all this it is itself an important plant food. For our soils it is probable that the carbonate as it exists in our artesian waters is preferable to burned or quick lime. The amount that may be applied per acre is large, probably much larger than would be supplied by artesian waters for years to come. From two to ten tons per acre of quick lime are used, and in some countries this application is repeated every six or eight years. Lime may be applied to all crops and acts advantageously where the supply of organic matter is fully maintained. If the organic matter is not maintained, lime aids materially in the rapid exhaustion of soils.

Calcium carbonate is also an efficient agent in sweetening sour and boggy soils, a property possessed by no other salt of calcium.

**Calcium Sulphate,  $CaSO_4$** —Gypsum has been applied to land

for many years. Its probable effects upon soils and vegetation have been a cause of much writing and speculation by agricultural chemists. So much, indeed, has been written concerning gypsum, and so many different qualities have been assigned to it and so many theories as to its action have been advanced, that even a brief resume of all these here would be neither possible nor profitable. It is generally conceded that it may act in many respects like the common carbonate of lime, like the other sulphates previously mentioned, and that it may fix the volatile ammonium carbonate of soils by converting it into the nonvolatile sulphate, while the gypsum itself passes into calcium carbonate.

It acts as a stimulant to plant growth in soils where lime and sulphates are wanting, and it may be applied to any crop. But its best effects have been observed upon corn, grasses and clovers.

Some agriculturists maintain that gypsum aids crops to withstand drouth. There may be some reason in this, since gypsum contains two molecules of water of crystallization. From this water it is exceedingly loth to part. So great is the tenacity with which this water is held that some agriculturists maintain that the plant is unable to appropriate it. But it may be possible that powers of the plant in this direction have been underrated. One fact concerning it, however, is certain, and that is that when gypsum has been deprived of any or all of its water of crystallization it becomes exceedingly hygroscopic, so much so, in fact, that it will soon make good its loss from the atmosphere if necessary, or from dew, rain or soil moisture. No one is more painfully aware of the hygroscopic nature of gypsum than the chemist who is endeavoring to find the exact weight of the water free residue of a water carrying much gypsum. It does not seem wholly impossible, then, that gypsum might act as a water carrier between the plant and the atmosphere.

In this connection it might be well to mention that crystallized sodium sulphate contains ten molecules of water of crystallization, and crystallized magnesium sulphate contains



seven. They part with this water more readily than gypsum, and consequently they, too, might exert some influence in this direction.

**Silica,  $\text{SiO}_2$ , and Ferric Oxide,  $\text{Fe}_2\text{O}_3$** —In natural waters these substances do not occur in these insoluble forms. But when the water is evaporated they assume the forms given here. Our soils are abundantly supplied with both substances. Both are necessary to plant growth, and since they assume the insoluble condition so readily there is little danger of an injurious accumulation of them in our soils.

In the regular course of analysis alumina is thrown down with the iron; but the quantity of both in any of the artesian waters is so small that no separation was attempted. Both are reported as ferric oxide.

### SOME NUMERICAL CONSIDERATIONS

In the reports of the analyses which follow, the amount of each salt that each water carries is given in grams per litre, or approximately in parts per 1,000 at  $73^\circ$  F. There is no uniform practice followed by analysts in reporting results. Sometimes the results are given in parts per 10,000, or in parts of 100,000, or even in parts per 1,000,000. Should it be desired to reduce the results given in this bulletin to any one of the other ratios it would simply be necessary to multiply them by 10, 100, or 1,000, as the case might be.

Again some analysts report results in grains per Imperial gallon. The results as given here may be reduced to that scale by multiplying by 70. Again, if it be desired to reduce the results as here given to grains per U. S. gallon, that may be accomplished approximately by multiplying by the factor 58.3296, since the U. S. gallon of water at  $60^\circ$  F. weighs 58,329.6 grains.

But for some purposes it is simpler to report results in parts per 1,000, since it simplifies computations. For ex-

ample, if we wish to determine how many pounds of residue per acre the waters of a well will furnish the soil when a certain number of inches of water are used for irrigation purposes, the results may be obtained by multiplying the total solids of that water first by 2, then by 113.17, and then by the number of inches of water applied. The result obtained is so many pounds per acre.

The chemical terms employed in the analyses have been already explained. It might be well to say here that the salts are reported in the anhydrous condition. The following data are given to facilitate other computations that may be desired:

1 gram=15.432 grains=.03527 oz. avoirdupois=.03215 oz. troy.

1 litre=33.8149 fluid oz.=2.113 pints. The analyses follow:

# ARTESIAN WELLS OF SOUTH DAKOTA

## Salts of Deep Artesian Wells—Parts per 1,000

NAME OF WELL	NaCl Sodium Chloride	Na <sub>2</sub> SO <sub>4</sub> Sodium Sulphate	Na <sub>2</sub> CO <sub>3</sub> Sodium Carbonate	MgSO <sub>4</sub> Magnesium Sul- phate	MgCO <sub>3</sub> Magnesium Car- bonate	CaSO <sub>4</sub> Calcium Sulphate	CaCO <sub>3</sub> Calcium Carbonate	Fe <sub>2</sub> O <sub>3</sub> Ferric Oxide	SiO <sub>2</sub> Silica	Total
Yankton (Whiting) well.....	0.1643	0.1172	.....	0.3160	.....	0.8700	0.1246	0.0032	0.0070	1.6023
Tyndall city well.....	0.2438	0.1002	.....	0.4036	.....	1.1199	0.0905	0.0246	0.0076	1.9902
Armour city well.....	0.2879	0.1186	.....	0.5011	.....	1.0550	0.1554	0.0122	0.0090	2.1392
Chamberlain mill well.....	0.1800	0.3618	.....	0.4735	.....	0.8920	0.1573	0.0116	0.0088	2.0850
Kimball city well.....	0.1688	0.2211	.....	0.4834	.....	1.0592	0.1636	0.0090	0.0072	2.1123
Woonsocket city well.....	0.1128	0.7941	.....	0.3701	.....	0.5360	0.1630	0.0072	0.0256	2.0088
East Pierre Indian school well.....	2.8052	.....	0.5711	.....	0.0050	.....	0.0771	0.0054	0.0122	3.4760
Harrold city well.....	0.8029	0.4550	0.3817	.....	0.0575	.....	0.0286	.....	0.0122	1.7379
Miller township well.....	0.1501	1.2265	.....	0.2657	.....	0.1683	0.2125	.....	0.0092	2.0323
Huron (Risdon) well.....	0.2046	0.6083	.....	0.4261	.....	0.6020	0.1554	0.0290	0.0080	2.0334
Iroquois city well.....	0.2598	1.6153	0.2432	.....	0.0353	.....	0.0195	0.0040	0.0060	2.1832
Hitchcock city well.....	0.1595	0.6120	.....	0.4384	.....	0.6989	0.1534	0.0158	0.0088	2.0868
Faulkton city well.....	0.6610	0.7891	0.3814	.....	0.0716	.....	0.0471	0.0198	0.0096	1.9796
Redfield city well.....	0.2626	1.5701	0.0499	.....	0.0664	.....	0.0854	0.0088	0.0114	2.0546
Doland city well.....	0.3473	1.5091	0.2057	.....	0.0512	.....	0.0230	0.0070	0.0104	2.1537
Northville well.....	0.6396	0.1620	.....	0.3988	.....	0.2280	0.5580	0.0148	0.0368	2.0380
Ipswich city well.....	0.8083	0.5076	0.7079	.....	0.0557	.....	0.0239	0.0090	0.0050	2.1180
Aberdeen new deep city well.....	0.2381	1.6538	0.0108	.....	0.0811	.....	0.0879	0.0094	0.0098	2.0909
Andover well.....	0.3308	1.6573	0.2476	.....	0.0449	.....	0.0248	0.0088	0.0094	2.3236
Westport well.....	1.5031	0.4177	0.5479	.....	0.0386	.....	0.0200	0.0118	0.0114	2.5501

Salts of Shallow Artesian Wells—Parts per 1,000

NAME OF WELL	NaCl Sodium Chloride	Na <sub>2</sub> SO <sub>4</sub> Sodium Sulphate	Na <sub>2</sub> CO <sub>3</sub> Sodium Carbonate	MgSO <sub>4</sub> Magnesium Sul- phate	MgCO <sub>3</sub> Magnesium Car- bonate	CaSO <sub>4</sub> Calcium Sulphate	CaCO <sub>3</sub> Calcium Carbonate	Fe <sub>2</sub> O <sub>3</sub> Ferric Oxide	SiO <sub>2</sub> Silica	Total
The Grant County Basin—										
Twin Brooks well.....	0.0043	0.2037	.....	0.4965	.....	0.1183	0.3584	0.0100	0.0264	1.2176
Amsden well .....	0.0036	0.0446	.....	0.2716	.....	0.1521	0.2568	0.0110	0.0468	0.7865
Revilla well.....	0.0257	0.0643	.....	0.6255	.....	0.3082	0.3655	0.0206	0.0400	1.4498
The Hurley Basin—										
Hurley well .....	0.0117	0.0199	.....	0.5184	.....	0.8218	0.4296	0.0110	0.0248	1.8372
The Turkey Ridge Creek Basin—										
Buchanan well (Swan Lake).....	0.0684	0.1318	.....	0.4798	.....	0.3854	0.4770	0.0232	0.0324	1.4980
Irene well .....	0.0080	0.1636	.....	0.4989	.....	0.5287	0.3848	0.0220	0.0316	1.6376
Sanborn County Basin—										
Artesian city well (Sanborn county).....	0.1123	0.3941	.....	0.2687	.....	0.6739	0.1880	0.0246	0.0500	1.7116
Beaver well (Miner county).....	0.2449	0.4271	.....	0.4947	.....	0.7684	0.1496	0.0060	0.0420	2.1327
Redstone well (Hanson county).....	0.1910	0.4493	.....	0.4659	.....	0.7451	0.1446	0.0030	0.0124	2.0113
A surface well (location Brookings).....	0.0096	0.1458	.....	0.4311	0.0147	.....	0.3427	.....	0.0408	0.9847

## ARTESIAN WATERS FOR IRRIGATION

The question is frequently asked, "Will the artesian waters of the Dakota basin be injurious to the soil and to vegetation?" Different replies have been made. Some have thought that the waters carry too much mineral matter for safe application to crops and to soils. Comparisons have been made between this and other countries, especially India, where the soil is already loaded with soluble salts.

But there are still other differences which exist between the arid plains of India and the sub-humid plains of South Dakota. In the first place Dakota soils are not already loaded with soluble salts. It is true that some few low-lying gumbo patches do exist in some parts which are poorly drained. But these spots are of such limited extent, often but a few rods across, that they may be neglected. In the second place the rainfall of South Dakota is greater and more evenly distributed, as is always the case in sub-humid regions, and consequently there is less water needed for irrigation purposes. In the third place the natural drainage is far superior to that of India or of any of the countries where alkali has become troublesome. Indeed, the country is altogether too well drained, so much so that the storm waters find a too rapid and too easy exit from the borders of the state. Those who have given the subject the most thought are now seriously advocating the damming up of all runs, draws, sloughs, lake beds and creeks for the conservation of the natural storm waters. In the fourth place the subsoils of this state are porous and admit of the easy passage of storm waters to underground levels or reservoirs, whence they gradually find their exit by seepage into runs, creeks and rivers. Moreover, the open and loamy soils of this region would be less affected by saline residues than the stiffer clays of India.

In view of all these facts it is not permissible to draw inferences from conditions entirely dissimilar. In short, the conditions prevailing in South Dakota are such that all problems relating to artesian irrigation must be decided upon by taking

into account factors immediately concerned and factors that are unique to this region.

It is undoubtedly true that the artesian waters of the Dakota basin do carry large quantities of soluble constituents. The residues from these waters are larger than those of most waters used for irrigation; but when the various climatic conditions of the basin are taken into consideration, and when the drainage and soil conditions of the most favorable kind are considered, it is not unwarrantable to suppose that favorable results may be obtained by an economic and judicious application of the artesian waters. Especially is this true when one remembers that during many years no irrigation is at all desirable. And then again all parts of the basin are subject to such heavy falls of rain that any accumulating salts must of necessity be washed away. Then again, even in the driest years, the period when crops would be benefited by irrigation is short, so that only a limited application of water would be needed. All these facts would lead one to believe that such irrigation as needed here may be accomplished by artesian waters.

In all probability success may be confidently expected by a strict attention to the following details: Deep and thorough cultivation; a judicious use of only sufficient water to insure a crop; a careful conservation of all storm waters; the systematic planting of trees and shelter belts and the storage of all surplus artesian waters. Special care must be taken not to water-log the soil by excessive applications. The waters should be applied only to growing crops in quantities sufficient to ensure the crop under cultivation.

### **SOME HINTS ON ARTESIAN WELL CONSTRUCTION**

From some of the results obtained in the past some useful hints for future well construction may be gathered. The following are suggested:

1. The pipes used should be galvanized and should be connected by specially strong couplings.

2. An outside casing should be sunk and firmly seated in the rock below all sand and quicksands.

3. As soon as a flow is reached the drill should be closely followed by the casing in order that no washing or caving of the walls may occur.

4. The lower end of the inner pipe that is to penetrate the flow should be perforated to prevent any great rush of water at any point in the sand rock that carries the water.

5. The bore through the cap rock should be of such size that the casing will fit snugly in order to prevent the water from working up around the outside of the pipe and thus cutting the cap rock away.

6. All pipes used within the first or outside casing should come to the top of the well and should there be securely joined to the outer pipe.

It is true that some of the wells, in fact some of the oldest ones, have not been thus carefully constructed. But in some cases the cap rock and even the water bearing rock are very firm and hard. Hence no trouble has come as yet. But these wells will be found difficult to repair when their common iron pipes are worn and rusted out. Again, some wells have encountered no quicksand, but there is always danger that the casings may stick and thus entail needless expense and unnecessarily increase the cost of construction.

It must be borne in mind that the Dakota sand stone varies greatly in its nature. In some places it seems little more than loose sand, while in other localities it becomes quite hard and compact. And it is to the non-observance of some one or more of the foregoing precautions that what would otherwise have proven strong and durable wells have proven unsatisfactory and sometimes a complete failure.

## SOME DESTRUCTIVE INSECTS

D. A. Saunders

---

### PLANT LICE

No group of insects causes more trouble to the housewife's plants, gardens, vegetable crops, or occasionally to the farmer's fields than the plant lice. In size they are among the smallest of insects, being only slightly larger than the head of a pin, of a pale green color, with a small, pear-shaped body. The majority are wingless, but there is a winged form in many species. On the back part of the abdomen there is, in many species, a pair of tubes from which a sweet, transparent fluid is secreted. In some genera these organs are merely perforated tubercles, while in others they are entirely wanting. The fluid which is secreted from the abdominal tubercles is the substance known as "honey dew." It is sometimes produced in such quantities that it forms a glistening coating on the leaves of the branches below the plant lice, and the stone walks beneath shade trees are often densely spotted with it. This "honey dew" is fed upon by bees, wasps and ants. The bees and wasps take the food where they find it, paying little if any attention to its source, but the ants recognize in the plant lice useful auxiliaries, and even care for them as man cares for his herds. As plant lice draw their nourishment from below the surface of the plants they infest they are not endangered by the application of poisonous substances to the plants.

Some of the common plant lice are:

**The Wheat Aphis**—This insect occurs occasionally in great numbers and is very destructive to the wheat just before harvest time. At other times it is almost entirely absent.

**The Elm Coxcomb Gall**—This gall, which looks very much



like a coxcomb, occurs most commonly on young elm trees, rising abruptly in the upper surface of the leaves. It is usually an inch or so in height, compressed, with the seeds wrinkled, and it is somewhat irregular toothed. It is of a paler green color than the leaf, but is more or less red on the side exposed to the sun. The gall opens on the under side of the leaf by a slit-like orifice; inside it is wrinkled perpendicularly into deep plates. The gall is always found between two of the branching parallel veins and between which it grows, and are usually drawn closer together than the rest. The galls are always crowded with lice and white, succulent material, but as they become old and are deserted by their inhabitants they become darker and darker, greatly disfiguring the tree.

**The Vagabond Gall Louse**—This insect is very abundant on the common cottonwood and forms a large, irregular gall which greatly disfigures the tree. The galls should be removed while very green and burned.

**Treatment**—These pests are best destroyed by spraying or washing the infested plants with a strong solution of soap or with kerosene emulsion.

**The Hessian Fly**—For several years the Hessian fly has caused considerable damage to the wheat fields of the state. The insect is so small that usually the damage that it does is laid to rust, drought or other causes. The larva of the Hessian fly is a small, dark body about the size of a flax seed and is found inside the leaf sheath of the wheat and near the lower nodes or joints. The insect lives over the winter in the wheat straw and in the spring emerges as a fly, which lays its eggs on the young growing wheat, and soon dies. In the southern states this insect is double brooded and hibernates in the flax seed stage in winter wheat, volunteer wheat and other plants, including some of the larger grasses, but in the northwest there is only one brood in a season. The following suggestion by Professor Washburn may be carefully followed:

"1. Burn the stubble when possible. This is particularly desirable when, from any reason, shallow plowing is unavoidable. If the stubble is left long it will burn easier. Some farmers are willing to go to the trouble of spreading straw from threshing over the stubble, thus insuring the burning and at the same time getting rid of some 'flax seeds' which may have lodged on the surface of the straw pile at the time of threshing.

"2. Fall plowing of the stubble in such a way that the straw is completely turned under.

"3. All screenings and litter about the threshing machine should be cleaned up and either fed immediately or burned, leaving no litter from the threshing on the field. There is no absolute need of burning the straw pile. The flies emerging from 'flax seeds' in the center of the pile will never reach the surface.

"4. Since the fly lays its eggs as a rule near the locality where it emerges from the 'flax seed' it is best not to plant wheat on the same ground two years in succession where rotation is possible. Varieties of wheat that produce a stout stalk are the least affected by this pest.

"5. Co-operation is absolutely necessary, for however careful one man may be, if his neighbor is not equally so the latter's field will afford a supply of this pest for the former. Since this pest issues from the 'flax seed' early in May, a stubble field left for corn land and not plowed up to the 10th of May has probably discharged its quota of flies ready for mischief before plowing."

**The Plum Gouger**—This gouger does much damage to plums every year. It is a minute, reddish brown beetle, one-fourth the length of a pin. This beetle bores holes in the fruit by means of a long, curved snout. The eggs are laid singly in these holes. The puncture soon heals, closing in the egg. In a very short time the egg hatches and the young larva feeds not only on the flesh of the plum but bores into the pit and eats the kernel. It changes to a beetle in time to seek winter quarters in the ground near by.

**Treatment**—All plums that drop prematurely as a result of this injury should be collected and burned. Jarring the tree with a light wooden mallet early in the day, causing the beetles to drop onto a sheet which is spread under the tree, is almost always an effective remedy. Poultry if given the run of a plum orchard destroy myriads of these gougers.

# ELEMENTS OF PRAIRIE HORTICULTURE

N. E. HANSEN, Horticulturist

---

This subject will be briefly discussed under the following headings:

1. Pointers for New Settlers.
2. Fruit Culture: What Varieties Shall I Plant? Apples; Plums; Cherries; Other Orchard Fruits; Small Fruits; Grapes; Native Fruits; The Breeding of Native Fruits.
3. Windbreaks. Evergreens. Shade and Ornamental Trees.
4. Vegetables.
5. Ornamental Shrubs. Annual and Perennial Flowers. Bulbs.

## POINTERS FOR NEW SETTLERS

The many thousands of new settlers that have come into South Dakota during the past two or three years have given a great impetus to the work of planting fruit trees, small fruits, shade trees, vegetables and ornamentals, because these new settlers have come mainly from the east and south, where more attention is paid to gardening than is usual in the north. In short, horticultural operations will become more general than hitherto in the history of the state. Gardening is an essential part of home-making, and especially so on the open prairie. The extensive correspondence of this department indicates the topics concerning which there is most demand for information. It is deemed timely in this connection to give a brief outline covering this ground for the beginner.

The experience at this Station and in various parts of the state amply demonstrate that good fruits, trees, vegetables, shrubs and flowers can be raised successfully in all the farming regions of the state, provided only that proper care be given, and above all, varieties selected which are adapted

to the climate and soil. To plant only the varieties commonly grown east and south at the old home is usually only to invite failure. There is no need for the beginner at the present day to repeat the mistakes made ten, twenty and thirty years ago. He should profit by the experience of older settlers of the state up to this time. Above all things, remember that there is a sound financial basis for planting trees and even ornamental bushes and flowers, because anything that makes the prairie home more beautiful and home-like adds to the working capacity and the joy of living of the dwellers in that home. A dish of good home-grown vegetables, a few home-grown apples and plums, set off with a bouquet of home-grown flowers, will go far to making the beginner think that he is in an old settled country instead of one barely emerging from the unbroken prairie stage of development.

The thousands of new settlers who have recently come to the state may be divided into two classes: (1) Those who ask no advice of their neighbors and others with longer experience in South Dakota; (2) Those who think it best to get the experience of older planters, thus saving unnecessary loss. The first class can only learn by expensive experience. The second class will take pains to inform themselves, as far as possible, before planting, and will be willing to give the results of their experience to others.

This article will endeavor to present in condensed form the experience in horticulture in this department and elsewhere in the state during the past few years, as far as possible at this time. Hundreds of varieties of fruits, vegetables, trees, shrubs and flowers have been tested, and it would make too long a story to give full details, especially since these have already been published in the Bulletins of this Station.

### **WHAT VARIETIES OF FRUIT SHALL I PLANT?**

This question is the one most frequently asked in the numerous letters received by this department. It is impossible at present to give a full list. The state is too new to permit

of a list founded on actual experience in all cases. In a general way the experience, so far, indicates safety in following the Minnesota fruit list for the northern counties, while those doing well in northern Iowa will probably be best for the southern counties.

The available experience, up to date, has been summarized by the State Historical Society, in preparing the following fruit list, adopted at the thirteenth annual meeting January 23, 1902, at Sioux Falls. This society was incorporated under the state laws January 9, 1890. As the state makes no appropriation for the purpose, the society is unable at present to publish its annual proceedings. The fruit list is revised at the annual meeting as further experience renders it necessary. For convenience the state is divided into twelve fruit districts.

#### **District Boundaries**

District No. 1—All that portion of the state west of the Missouri River except the Black Hills.

District No. 2—Counties of Campbell, McPherson, Brown, Edmunds and Walworth.

District No. 3—Counties of Marshall, Roberts, Grant and Day.

District No. 4—Counties of Clark, Codington, Deuel and Hamlin.

District No. 5—Counties of Kingsbury, Brookings, Moody, Lake, Miner, Hanson and McCook.

District No. 6—Counties of Lincoln, Minnehaha, Turner and Hutchinson, and north part of counties in District No. 7.

District No. 7—Strip of country about fifteen miles wide, along the Missouri River, extending through the counties of Bon Homme, Yankton, Clay and Union.

District No. 8—Counties of Brule, Aurora, Davison, Douglas and Charles Mix.

District No. 9—Counties of Sanborn, Jerauld and Buffalo.

District No. 10—Counties of Spink and Beadle.

District No. 11—Counties of Potter, Faulk, Hand, Hyde, Hughes and Sully.

District No. 12—All the counties comprising the Black Hills.

## Apples

District No. 1—For each part of this district, the varieties recommended for the district next east are recommended for trial under irrigation.

Districts No. 2, 3, 4—For trial: Hibernal, Duchess, Charlamoff, Wealthy.

Districts Nos. 5 and 9—Of first degree of hardiness: Hibernal, Duchess, Charlamoff. Of second degree of hardiness: Wealthy, Tetofsky. For trial: Anisim, Patten Greening, Repka Malenka, Yellow Sweet.

District No. 6—Hibernal, Duchess, Charlamoff, Wealthy, Anisim, Patten Greening, Repka Malenka, Yellow Sweet, Longfield. For trial: Christmas, Cross, Northwestern Greening, Malinda, Plumb Cider.

District No. 7—Duchess, Charlamoff, Wealthy, Hibernal, Haas, Patten Greening, Longfield. Winter apples: Walbridge, Ben Davis, Iowa Blush, Malinda, Northwestern Greening. For trial: Plumb Cider, Willow Twig, Sheriff, Prices Sweet.

District No. 8—Hibernal, Duchess, Charlamoff, Wealthy, Tetofsky, Anisim, Patten Greening, Repka Malenka, Yellow Sweet, Malinda, Northwestern Greening.

Districts Nos. 10 and 11—For trial: Hibernal, Duchess, Charlamoff.

District No. 12—Duchess, Tetofsky, Wealthy, Ralls Genet, Prices Sweet, Patten Greening, Northwestern Greening.

## Crabs and Hybrids

For all Districts—Martha, Virginia, Whitney, Sweet Russet. For trial: Lyman Prolific, Brier Sweet, Mary.

## Plums

Districts Nos. 2, 3, 4, 5, 10, 11—On northern native plum roots: DeSoto, Wyant, Wolf, Forest Garden, Odegard. For trial: Aitkin.

Districts Nos. 6, 8, 9, 12—On northern native plum roots: DeSoto, Wyant, Odegard, Hawkeye, Wolf, Forest Garden. For trial: Olson, Aitkin.

District No. 7—On northern native plum roots: DeSoto, Miner, Hawkeye, Wolf, Wyant, Odegard. For trial: Olson, Stoddard.

### **Cherries**

Districts Nos. 6, 7, 8, and south tier of counties of District No. 5—Early Richmond, Wragg, English Morello, Ostheim.

### **Native Fruits**

Promising for trial: Sand Cherry, Juneberry, Buffalo-berry, Choke Cherry, Gooseberry. All selected plants.

### **Raspberries**

Districts Nos. 2, 3, 4, 5, 10, 11, 12—With winter protection—Reds: Loudon, Turner, Cuthbert. Black Caps: Older, Palmer, Nemaha. For trial: Columbian.

District No. 7—With winter protection—Reds: Loudon, Turner, Cuthbert. For trial: Miller, Philadelphia. Black Caps: Gregg, Older, Palmer, Nemaha, Kansas, Columbia.

### **Blackberries**

District No. 7—With winter protection: Snyder.

### **Currants**

All Districts—Red: Victoria, Red Dutch. White: White Grape.

### **Gooseberries**

For all Districts—Houghton. For trial: Champion, Pearl.

### **Strawberries**

For all Districts—Varieties with imperfect blossoms: Warfield, Crescent. With perfect blossoms: Bederwood. For trial—with perfect blossoms: Lovett, Woolverton, Brandywine.

### **Grapes**

Districts Nos. 6, 7, 8, 12—Concord, Worden, Janesville.

Districts 1, 2, 3, 4, 5, 9, 10, 11—For trial: Janesville, Beta.



## APPLES

The apple has been called the "king fruit of the temperate zone." No rural home is complete without an orchard. But it has cost considerably over one hundred million dollars to determine that the apples commonly grown in the southern and eastern states, which came originally from western Europe, cannot be successfully grown over a large area of the northern Mississippi valley. Many thousands of dollars are being spent annually in every state of this vast region in order to demonstrate this fact still further. It is now well established that certain varieties are sufficiently hardy to recommend for general culture, especially of summer and fall varieties. We still need more strictly hardy apples that will keep all winter and be of good size and quality. Some of the most promising varieties of apples are not as yet generally grown in the nurseries and it will be some time before they are available for the general planter. The present mode of selecting nursery stock is not favorable to certain good sorts which are of poor growth in the nurseries. Some of the best varieties are of crooked, uneven growth, while the average uninformed planter demands a large, straight tree, and he can always find some one who is willing to fill this demand by substituting stronger growing varieties.

The varieties safe to plant will vary according to the locality. Along the Missouri River, on the south border of the state, a few old orchards in fair condition are found, containing varieties of the grade of hardiness of Haas, Plumb Cider, Fameuse, Perry Russet, Utter, Willow Twig, Tolman Sweet, and even Ralls Genet and Ben Davis. This fact is shown in the annual fruit displays at the state fair. This strip of country is only a very few miles wide, and must not be taken as a guide for the rest of the state. Some of these varieties are not standing well on the open prairie a few miles south of the river. This strip of rolling land especially favorable to orcharding can be traced along the Missouri River from the south boundary of Iowa past Yankton into Bon Homme county.

It may be safely stated that no variety is safe to plant generally in the north half of the state that is less hardy than Duchess. And even in the south half it will be wise for beginners, who wish to plant only a few trees, to abide by this rule.

The recommended sorts of apples are more or less generally grown in northwestern nurseries, and if proper caution be exercised in buying apple trees, as much, for instance, as in buying and trading horses, there will be no difficulty in obtaining trees true to name. If the beginner is satisfied to find but a few varieties which are well known and well tested, he will have plenty of apples for a large part of the year. In the near future the question of a final list covering the whole year will, we trust, be settled.

### ROOT-KILLING

A common source of trouble is the winter-killing of the tender roots or stocks upon which apple, plum and cherry trees are grafted or budded in the nurseries. Trees should be protected by a mulch or layer of stable litter spread on the ground for several feet out beyond the branches. This prevents trouble from root-killing. Cultivate the mulch into the soil during the growing season, at least in young orchards, to prevent drawing the roots too near the surface. If plum trees are on our northern native plum roots, no trouble need be feared from root-killing. If the fall is dry, a heavy soaking of the roots with water is a great help, before mulching, as it prevents drying out during the winter. If we were always sure of a heavy snow this watering would not be necessary. We are testing the Siberian crabs as a stock for the apple, with good results so far.

### PLUMS

During the past generation a very interesting process of evolution has been going on in the prairie northwest. Plums from Japan, Russia, Germany, France, Persia and other countries of Europe and Asia have been tried here and found

wanting. The wild plums of the southern states early attracted attention, with similar unfavorable results. The result of these thousands of failures brought the wild plums of the northwest into prominence. People searched the native thickets and found choice plums. Our wild plums vary greatly in size and quality, some being small, with a tough, thick, acerb skin and a large pit, and the flesh of inferior quality. Occasionally the plums are large and luscious, comparing favorably, according to many tastes, with those received from California, coming originally to us from Europe and Japan. In such a manner came into cultivation DeSoto, a wild plum found on the Mississippi River near DeSoto, Wisconsin, about forty years ago; the Wyant, found in Janesville, northern Iowa, some thirty-five years ago; the Wolf, grown in Wapello county, Iowa, from wild pits in the neighborhood nearly fifty years ago; Rollingstone, found wild by O. M. Lord, Winona county, Minnesota, over forty years ago, and many more. Enthusiastic and skillful horticulturists, such as H. A. Terry of Crescent, Iowa, long ago believed in the possibilities of the wild plum and planted pits from the choicest wild varieties on a large scale. From the best of these seedlings seeds were planted, and so the good work was continued. In this way Mr. Terry has fruited considerably over twenty-five thousand seedlings, and many choice varieties are the result. The men who labored earnestly in this line in the early days of their life should be remembered in their old age for this pioneer work. It should be borne in mind that the native plums, as with most other fruits, do not come true to seed. From a thousand plum pits from one tree may come a thousand different varieties, differing widely in size, quality, season and all other characteristics. From the choicest plums may come by reversion the poorest seedlings, though usually a larger per cent of choice plums will come from larger fruited trees than from smaller fruited ones. "Like begets like," and the strong tendency is toward improvement if the seed is from choice varieties, especially if these trees are not near inferior fruited trees. If a choice

variety is obtained it may be propagated by sprouts or by budding or grafting on hardy seedlings. These should be raised only from seed of the native plums of the northwest.

The greatest obstacle at present to successful plum culture in the northwest is the tender roots or stocks which are used in the nurseries. The planters who set out such trees are as foolish as the man who "built his house upon the sand." When the storm came the foundation proved inadequate. Tens of thousands of plums are lost every year from this cause in the northwest—the seedling root being killed by the winter and the hardy top thereby left to die.

Trees of the desirable native varieties can often be obtained on their own roots. Such trees are very valuable, as the root is then equally as hardy as the top, and all suckers from them will bear the same fruit as the original tree. These suckers or root-sprouts should be carefully taken up early in the spring with a cross-piece of the main root from which they grew. If poorly rooted they should be grown in nursery row for a year or two to get a better system of roots. The question is often asked: "Are the suckers from my plum orchard of choice varieties of any value for planting?" If the trees are on their own roots the sprouts will of course bear the same fruit as the tree from which they grow. If the trees are budded or grafted, the value of the suckers depends upon whether they originate above or below the graft or bud. If from above, the sprouts will of course be of the same variety as the top; if from below, their value is uncertain, as they will then be the seedling of unknown value. This explains why plum trees of choice but tender varieties which have killed to the ground in a severe winter will often sprout up and bear different fruit.

The only reliable stock for our hardy northern native plum is the northern native plum itself (*Prunus Americana*). Some object to the sprouting tendency, but the sprouts are easily kept down by cultivation. As the orchard comes into heavy bearing the vitality of the tree will go to forming fruit and the sprouts will cease to be troublesome. It is considered

preferable that the pits to be planted for growing stocks for budding and grafting should be grown from large fruited trees and not picked up indiscriminately in the woods.

When once the planter understands that the only plums recommended for Dakota planters are wild ones, he will usually be ready to do a little experimental work for himself. It is very reasonable to suppose that in the plum thickets of South Dakota varieties will be found equal in size and quality to any of those already mentioned as natives from adjoining states south and east. Each state should develop its own wild plums. This work is now being done in many sections of the prairie northwest from Iowa to Manitoba. Several thousands of plum seedlings are now growing and fruiting on the grounds of this Station.

We find that seedlings of choice plums begin to bear the fourth year from seed, even when transplanted in the spring of the second year. The easiest way to fruit a large number of plum seedlings is to raise the seedlings the first year in nursery rows. In a small way this can be done in the garden. In the spring of the second year they are set in dead-furrows, eight feet apart and three feet apart in the row. The inferior ones can be chopped out as soon as they bear, although it should be remembered that seedling plums do not bear their best fruit until the second or third year after they begin to bear. If an especially choice variety is found that bears the fourth year from seed, scions can be taken from this one and top-grafted on the poorer ones, except where they must be removed to give more room. After many experiments in propagating native plums, I find that the best way is to set one year seedlings in nursery rows, four feet apart and ten inches apart in the row. In setting, be careful to cut back the roots and tops. The root-pruning is necessary to break up the tap-root and avoid doubling up the end of the root when planting in a dead-furrow made by plowing right back in the same furrow with an active boy pressing down on the plow beam. During the spring good cultivation is given. The following spring the earth is removed as soon as possible,

usually early in April, before the buds start in the least. A graft is inserted in a side cut two or three inches below the surface, using a wedge-shaped scion. The earth is replaced; no waxing is necessary except the exposed tip of the scion. The scion being only three buds long, is even with the surface of the ground. If the suckers or sprouts from below the grafts are removed when they appear and the young growth from the scion is tied to a lath or other support, the tree will make a good growth, sometimes five or six feet, and will be ready for setting in the orchard in the following spring. Some planters insist on heavy trees, and to meet such a demand the young whip is cut back about four feet high to cause branching and the formation of a symmetrical top.

In top-grafting it will be necessary to protect the point of union with grafting wax to prevent drying out by the wind. After waxing, strips of thin white muslin are wound around to keep the graft in place.

**Grafting Wax**—For all outdoor grafting and for covering cut surfaces in pruning the following is a good wax; it is called alcoholic plastic: One pound of white resin, one ounce beef tallow, one tablespoonful of turpentine, five or six ounces of alcohol. Melt resin and tallow slowly, take from fire and when a little cooled by stirring, add the turpentine, stirring constantly. When still cooler add alcohol. If the plastic becomes too thick to work well, add more alcohol. For outdoor grafting the plastic is kept slightly warm in a small tin pan set in the top of a cone-shaped tin box with a lamp inside, thus forming a portable heater. The wax should not be warmer than can be applied with the finger.

In planting a native plum orchard be sure to plant several varieties intermingled. It is a great mistake to plant an orchard of one variety only, as fertilization of the blossoms is best effected in a mixed plantation. Indeed, many of our native plums are notoriously unfruitful when planted in a block by themselves. Mixed orchards insure heavy crops. Some varieties are much inclined to set more fruit than they can properly mature; such trees should have the fruit se-

verely thinned; this work is usually neglected, but it will pay.

Plant on any land good enough for corn; rather high land on north slope is best to help guard against untimely frosts. Plant ten feet apart in rows north and south and rows eighteen feet apart east and west. This provides for needed air circulation, as well as fertilization of blossoms. Give good culture the first four or five years, after which they may be mulched sufficiently to keep down weeds. Head very low—not higher than two feet; high, exposed trunks are liable to disease. Trim very little, even less than with the apple, and at the same time. Protection is beneficial to give shelter from winds often prevalent at the time of blossoming. A good place for a few trees is in a poultry yard, as the curculios, which sometimes deposit eggs in the fruit, do not like such surroundings.

### HOW TO RAISE PLUM SEEDLINGS

As soon as picked the plums should be spread out in a thin layer and allowed to remain until they get a little soft. The seeds can now be washed clean, which can be done by putting into a pail with little water and pounding them carefully with a tamper or piece of scantling. As soon as the pits are washed clean they can be spread out in the sun for a day or two, and then mixed with moist sand in a small box, such as soap or crackers come in, first a layer of sand, then a layer of pits, then a layer of sand, and so on alternately until the box is full. The box should have holes bored in the bottom for free drainage. It should also be buried two inches below the surface of the ground out of doors in a well drained spot in the garden, and allowed to freeze all winter. If snow comes too early in the fall, shovel it away so that the seeds will be sure to freeze very hard. If the fall is very dry the box should be covered with a light mulch to prevent drying out. It is very essential that the seeds do not dry out before planting, and still they must not be in water all the time, as that would water-soak them. As early in the spring as possible the seeds should be planted. The land should be gotten in good condition by plowing and harrowing. If possible, use fall plowed

land. Make the rows three or four feet apart and plant the seeds two or three inches apart in the row and four inches deep. In a small way this can be done by opening up a shallow furrow with a hoe and stepping on the seeds, then fill up the furrow with a hoe. In case the spring is a very wet one so that it is impossible to get the seed planted early, the sand should be stirred every day to prevent the seeds in the bottom of the box from germinating sooner than those in the top of the box, and if possible the seeds should be gotten out before there is any show of their germinating. If good care is given, these young trees will be waist high by fall and can be planted into their permanent positions early the following spring.

### CHERRIES .

Cherries are as yet in the experimental stage. The general experience is unfavorable, especially in the northern part of the state, as indicated by the recommended fruit list. The writer is not prepared from the evidence at hand to recommend any list of cultivated cherries for general planting throughout the state. In the southern counties some of the older varieties, especially Early Richmond, have borne some good crops, but this experience is not reliable as a guide for the northern counties. Cherries are entirely omitted from the Minnesota fruit list. In the earlier years of this Station a large number of varieties of cherries were planted, especially the Russian sorts, but these went out in the winter of 1898-99 either from entire lack of hardiness or from root-killing of the tender Mazzard and Mahaleb stocks upon which they were worked. The stocks or roots used for cherries in commercial nurseries at present are Mazzard or the Mahaleb, both being wild cherries imported annually from France for that purpose. A hardy stock may be found in the wild red cherry (**Prunus Pennsylvanica**), a native of this state, but further experience is needed, and the plants are not obtainable in commercial quantities. Trees worked on Mahaleb or Mazzard should be set as deeply as possible so as to put the tender roots beneath



the surface and give the tree a chance to emit roots above the point of union with the stock, and these roots will soon sprout and give us own-rooted trees. If budded or grafted trees are set deep in the orchard, from four to six inches deeper than in the nursery, they will in time be practically on their own roots, and if the variety is hardy, the sprouts from the roots emitted by the scion will be valuable for planting.

In time we will probably insist on planting the hardier varieties on their own roots to avoid trouble from root-killing.

Trees on tender stocks should be mulched every fall with coarse manure, extending out at least two feet beyond the branches. This will prevent too severe freezing of the roots. The following spring this should be cultivated into the soil to prevent the roots coming too near the surface. A form of the Vladimir dwarf cherries from the province of the same name, east of Moscow, Russia, received in the spring of 1898, has so far proved hardy, but the whole matter is too far in the experimental stage for definite recommendations to be made. However, the prospects are that in time cherry culture will be extended considerably north of its present limit.

### OTHER ORCHARD FRUITS

Quinces are much too tender for this state. Apricots, peaches and pears have been planted from time to time in many places and specimens of the fruit obtained in the southern counties. These few exceptions only prove the rule that it is a waste of time and money to attempt the cultivation of either of these fruits. The Russian apricots appear hardy in the southern tier of counties, but the blossoms are caught by late frosts. Some of the Russian pears are perfectly hardy in tree, but are killed by blight. The European race of pears are killed both by winter and by blight. We are looking anxiously for some one to give us a preventive or cure for pear-blight. Peaches bear fruit the third year from seed, hence fruit has been obtained when planted to the leeward of a shelter belt where the snow lodges in winter. Peach trees

are dwarfed in size by working them on western sandcherry stocks. At this Station such trees were found easy to lay down for winter protection, but it was found difficult to get sufficient covering to prevent injury to the bud. Since then these trees have been grown in boxes and put in the cellar over winter, and three crops of fruit obtained, including that of the present year. This method is by no means recommended except for curiosity.

### SMALL FRUITS

A large number of varieties of raspberries, blackberries and dewberries, including all those common in the nurseries, have been tested and found wanting at this Station. Without winter protection of any kind, all were usually either killed outright or frozen to the ground each winter, so that no fruit was obtained. When laid down and carefully covered with earth, some would winter-kill entirely, others kill to the ground and bear a few scattering berries. The raspberries did better than the blackberries and dewberries. Last fall my opinion of the matter was summarized in the shape of a bonfire, comprising almost the entire patch. This lack of hardiness should not cause surprise, because our present cultivated raspberries, blackberries and dewberries are natives of the eastern and southern states. It is evident that a new list of varieties must be secured for the prairie northwest, and this we are endeavoring to do by raising thousands of pure seedlings of the native raspberries from various parts of the Dakotas and the Canadian northwest, and also crossing them with the old eastern varieties. Some exceptionally promising hybrids of this kind have already been secured and are now under propagation.

Currants and gooseberries are easily raised and are perfectly hardy without winter protection. Of currants, Red Dutch, Victoria and White Grape are three of the best varieties. Of gooseberries, Houghton is the best for general planting of all the well tested varieties. The European black currant should receive more attention than has been given it hitherto. The

fruit has considerable medicinal as well as culinary value. However, the plants do not appear as resistant to drought as the red and white currants. Currants and gooseberries should be among the very first plants set in the prairie garden. The plants should be given thorough cultivation and manured with well-rotted manure every year. Wood ashes and soap suds from the family washing will all be beneficial, as these plants appreciate heavy feeding.

Strawberries are easily raised if the garden is so arranged that irrigation can be given in dry seasons. Two rows of Warfield fertilized with an alternate row of Bederwood is still a standard combination for commercial planting. Four hundred Warfield and two hundred Bederwood will give a good start.

A mistake that is still made by beginners is the planting of pistillate or female varieties only. This of course results in failure, as no fruit will result. Another mistake is mulching the plants in autumn with manure strong enough to burn the plants before it is removed in the early spring. Straw as free as possible from weed seed is the best.

## GRAPES

A large number of varieties of the grape has been tested at this Station, including Concord, Worden, Moore Early and other varieties of the *Vitis labrusca*, or wild fox grape of the eastern states. None have proved hardy, even when laid down in autumn and covered with earth and manure over the earth for winter protection. Some grapes are raised in the southern part of the state, and more vines are being planted in spite of the disastrous winter of 1898-99. For the northern part of the state, plant the native wild grape for the present. It appears probable that we must develop varieties from our wild grapes, *Vitis vulpina*, as found in the northwest. None of the cultivated varieties and hybrids of this species, even the Janesville, so far as tested at this Station, have proved hardy, the parent being of the eastern and southern forms. We are now endeavoring to improve the wild grape of the state as

found in the range country west of Pierre, the hope being to improve the fruit in size and quality.

For ornamental purposes the wild grape has decided value. Arbors can be quickly covered with a few vines. If fruit is desired, either bearing vines should be taken, or plants grown from cuttings or layers taken from a bearing vine. This is because bearing vines have perfect flowers, containing both stamens and pistils, while all the other vines bear staminate or male blossoms only. But even if the young vines dug at random prove to be staminate vines they will be desirable, the blossoms being very fragrant.

### **THE BREEDING OF NATIVE NORTHWESTERN FRUITS**

Of fruits native to this state the dwarf Juneberry, sand cherry, buffalo berry, gooseberry and several others have attracted favorable attention and are cultivated to some extent in many parts of the state. It is a fact that in the wild fruits of South Dakota we have the foundation for a great list of hardy and choice fruits. The native cherries, plums, grapes, currants, gooseberries, strawberries, raspberries, Juneberries, etc., can doubtless be bred up to equal in size and quality the cultivated varieties. The wild fruits are already superior in hardiness, as the summers and winters of many centuries have fully acclimated them and weeded out individuals of insufficient vigor.

All who are familiar with the climate and soil of the prairie northwest and with the history of the fruit culture of this vast region, know the practical importance of this line of work. We must create a new pomology. Almost all the varieties familiar to eastern fruit growers are tender and worthless on the open prairie of a large part of the Dakotas, Minnesota, northern Iowa and the Canadian northwest. With a view to meet this demand for hardier fruits, the writer has engaged extensively in the work of originating new sorts better adapted to the conditions. At present considerably over one hundred thousand fruit seedlings are on the grounds of the South

Dakota Experiment Station as the result of this determination. The wild fruits of the prairie northwest form the main material, although some work is being done with the apple. The methods pursued are mainly the carrying out of the well known principle, "Excess of food causes variation." Crossing and hybridizing are used as means of hastening the process of evolution by introducing new elements of variation. The chief reliance is placed on selection from large numbers. Some of the crossing is done under glass to guard against undue loss from unfavorable weather conditions at the time of blossoming. One of the main lines of work is the improvement of the native sand cherry (*Prunus Besseyi*). Over five thousand seedlings formed the material for selection in the first generation, and over fifteen thousand in the second generation, most of which have borne one or two crops. Some of the seedlings bore fruit measuring fully three-fourths of an inch in diameter and of good quality, and this the third season from seed. Several thousand seedlings of the third generation were raised last year. Over seventy-five varieties have been selected as being worthy of propagation. These are being budded on native plum roots, and an effort will be made to breed them true to seed. Some extra large native seedling plums bore heavily last year. Also some raspberry seedlings, of half wild and half tame ancestry, were selected. This spring over 14,000 strawberry plants of some 225 varieties were planted, all crosses of the wild and tame; these were selected from some eight thousand cross-bred plants. The strawberries as brought from the eastern states are not fully hardy in the northern part of South Dakota, and a hardier strawberry is much needed. Some interesting results appear; for instance, the ever-bearing strawberries as imported from France winter-killed, but their hybrids with wild Dakota strawberries proved hardy.

The field is a wide one and the demand for hardy fruits urgent. The practical importance is self evident, since fruit culture is essential to true home-making upon the open prairies.

## METHODS OF IMPROVING WILD FRUITS

In the drier and more sparsely settled regions of the state, new settlers who find it necessary to economize at first may find it better to plant out some of the wild fruits found in the vicinity, rather than invest largely in tender varieties common in nurseries. Wild fruits respond quickly to cultivation and improve in size and quality of fruit. To such planters, a brief account of the methods employed here will be of interest. Planters often ask how we manage to plant so many thousands of trees and shrubs in a short time. After plowing and harrowing, the ground is marked with a horse marker set at four feet. With a good driver, a steady team and the use of tall sticks to sight by, it is easy to mark out the land into rows four feet apart. The plan is to set in regular intervals in the rows, and the same marker is used to cross the rows at right angles. Plums, choke cherries, apples and other trees are set in rows twelve feet apart and about two and one-half feet apart in the rows. Smaller plants, like sand cherries, golden currant, black currant, raspberries and other shrubs are set out four feet apart and about two and one-half feet apart in a row. The planting is very readily done by plowing a furrow in the row as marked by the horse marker, and then plowing back as deeply as possible in the same furrow. This opens a dead-furrow, in which the trees are set very rapidly without the use of a spade. The essential thing is to tramp the earth firmly about each plant and to rake in loose earth on top to prevent baking the surface of the soil. Where the dead-furrows are to be only four feet apart it is better to make them eight feet at first and afterwards plow the furrows for the intervening rows. With over a hundred thousand fruit tree, shrub and plant seedlings raised here in the plant-breeding experiment, and now on the grounds, quick nursery methods are essential. When the selection has been made for the best plants for fruit from which to start the new generation under cultivation, the others are readily removed with a tree digger and a bonfire made. This is truly "a survival of the fittest" as determined by man and not by nature.

## WINDBREAKS

No argument is necessary to show the great need of planting shelter belts to check the wind-sweep.

It is almost useless to attempt to plant trees before the prairie sod is subdued. After the first crop, however, something can be done in planting windbreaks of cheap and easily obtained trees, such as willows, boxelders, cottonwoods.

In planting windbreaks, a "snow-trap" should be provided. This means that two or three thick hedge rows of willows or similar trees are planted four to six rods from the north and west sides of the windbreak. This leaves an open space in which the snow lodges. This open space can be utilized for a garden, if desired.

The new settler upon the open prairie should, first of all, plant a windbreak. It is worth while making a special effort to get the land surrounding the house in shape for tree planting as soon as possible, especially upon the north and west sides. The beginner is not usually able to spend much money upon tree planting, and he should be careful not to waste money buying trees native too far south or east. It takes thousands of years to acclimate a tree much north of the limits of its natural primitive growth, hence strictly native trees have the preference. On the sand bars of the Missouri and other rivers in Dakota, many millions of trees are sown by nature every year, which should be gathered and planted. Of course experience has shown that some native plants are adapted only to moist soils, but the native ash, elm, boxelder and hackberry should not be neglected. Some imported trees coming from similar climates, or climates similar to that of the northwest, should not be overlooked, such as white willow, Russian golden willow, and for large thorny shelter belts, the Russian wild olive. The writer has not recommended the latter tree for timber, but it is certainly adapted to dry soils as a stock-proof windbreak. The beginner, rather than to defer planting until expensive trees are available, should plant the cheaper trees. They will serve a useful purpose the first few years, even on high, dry land,

and if on such dry soils, they can be replaced with more permanent trees as soon as possible.

Many have chosen hardy species of trees, but have lost them because southern or eastern forms of the species were planted. It is now a well established fact that a species of plant extending over a wide geographical range varies greatly in ability to resist cold. Southern boxelders winter-kill in Manitoba; boxelders from Virginia winter-kill in Iowa; boxelders from Kansas kill to the ground at this Station; yet in each case the local native boxelder is perfectly hardy. Red cedars from Tennessee winter-kill in Minnesota and Iowa; the northern red cedar is hardy. This law of varying hardiness is now well understood by careful nurserymen. Dakota planters should make sure that their ash, boxelder, elm and other trees native to the state are not grown from seed picked too far south. Conversely, it is not best for southern planters to get seed from too far north, because the term "hardiness" implies ability to resist heat as well as cold.

Most people make too hard work of their tree planting. Do not plant large trees for windbreaks. Young, either one or two year old, forest trees can be bought cheaply of the nearest reliable nurseryman. If near a sandbar native trees can then be dug very readily. In planting it is best to obtain such trees in the fall and trim the roots and tops back and bury them in the ground over winter. The earth should then be mulched with manure as early in the spring as the ground can be worked. These trees can be planted very quickly in dead-furrows, as already described. The horse marker can be made of runners set four feet apart, connected by a platform upon which the driver can sit. With a steady team and careful driving the ground can be marked very accurately. In returning in the same furrow that has been marked the beam should be pressed down as much as possible. This makes a deep dead-furrow and there will be no need of using a spade in most cases. If the tap root of the young tree is so long that it must be bent in order to get the tree deep enough, it is far better to chop off enough of the root so that



there will be no bending. This permits the new root to grow straight down. Good cultivation should be given and the crust broken after a heavy rain. Young trees should certainly be given as good care as corn, although many successful corn-growers appear to imagine that trees need no care.

### **EVERGREENS FOR WINDBREAKS AND THE LAWN**

An evergreen windbreak is certainly far more desirable than any other, but the expense of securing the plants and the difficulty of making them live has interfered greatly with their extended planting. People forget one thing, that evergreen roots out of soil are like a fish out of water; even one or two minutes' exposure of the roots to a drying wind and hot sun sets the sap, and no amount of soaking afterwards is a help. When received from the nursery the plants, which should not be more than one foot in height, should have the clay and mud washed off the roots and then carefully heeled in, which means the roots are covered with earth in a shady place—a sort of temporary planting until the permanent planting can be done. Only a few trees should be taken up at a time, and these are put in a pail with the roots in water. It is not necessary to use water in planting. In planting many thousands of evergreens in the nursery, we would never get done if we had to use water, but great care is used to pound the earth about the roots, using heavy scantling or "tamper" for that purpose. Of course this means that the earth is in good planting condition. If wet, no pounding must be done. Poke the earth in well with the fingers, protected by heavy gloves. This is to prevent any caves or hollow spaces underneath the roots. The trees should be set so firmly that they cannot be readily pulled up. The ground must be kept stirred up during the summer to prevent baking. If it becomes necessary to water, first remove the surface soil, give a thorough soaking, then replace the dry surface soil and mulch with straw or grass, or similar mulch, to prevent drying out. One such soaking at intervals of two weeks is far better than sprinkling every day, which is another way of killing them. The best

time to plant evergreens is when their buds begin to show signs of swelling. Large evergreen trees may be successfully transplanted in late winter with a frozen ball of earth on the roots. Some enterprising nurserymen in various parts of the country, realizing the general difficulty of getting evergreens to live with ordinary care, are selling evergreens already established in boxes or pots. This method is expensive, but for trees on the lawn the increased expense is better than to have cheaper trees that will not be alive at the end of the summer. Our evergreen windbreaks will be scarce in Dakota until planters are able to secure our strictly native Dakota evergreens, such as the Black Hills or Ponderosa pine, which has been called the "prince of pines for the plains," or the slower growing red cedar of northern origin. Southern red cedar is worthless. The jack pine as received from northwestern Minnesota is a rapid grower and appears perfectly hardy, but it is not as beautiful a tree as the *Pinus ponderosa*, or bull pine of the Black Hills. Scotch pine and Austrian pine are the two best of the old sorts that are usually obtained in the nurseries, but both should be protected on the north and west by windbreaks of cheaper trees. In time it is to be hoped that Dakota nurserymen will be able to supply the demand for the Black Hills pine.

Sometimes several closely planted rows of evergreens are set. This results in the lower limbs dropping off in time, permitting free wind-sweep underneath. A single row, set, say six feet apart in the row, will be better, as the lower limbs will remain, having plenty of sunlight. If several rows are set, at least sixteen to twenty feet should intervene between the rows. The best size to set is usually twice transplanted nursery trees, about twelve to eighteen inches in height.

In regard to mulching evergreens, it may be said that the best mulch is one of loose earth made by constant stirring of the soil all through the growing season. Many people make a mistake by mulching heavily and doing no cultivating. It must be remembered that the roots need air as well as moisture, and where frequent stirring of the earth is imprac-

ticable the mulch must be removed at intervals and the ground stirred thoroughly. If water becomes necessary, do not water every day, as that is the best way to kill them, but water at intervals of a few days and then give the ground a good soaking.

In the fall a heavy soaking of the ground is especially desirable, as the dry winter winds are trying on evergreens and all other plants. A point often made at our horticultural meetings is that the dry winter winds will take the moisture from a fence post. A very common mistake with evergreens is planting large trees. Trees from ten inches to two feet in height are more apt to live than those of larger size. Nursery grown trees, twice or more transplanted, are much better adapted to prairie culture than those direct from the forest, which need careful shading the first year or two.

### THE POPLARS AND WILLOWS

The poplars and aspens comprise some twenty-five species of trees native to the northern hemisphere, and together with the willows, make up the willow family of trees. The many kinds of poplars planted at this Station have been tested mainly from the economic standpoint to determine their value for timber plantations upon the open prairie. The trouble with cottonwood and other poplars is that they are, to use a forestry term, "light-demanding" and not "shade-enduring." They also demand a moist soil with water not too deep beneath the surface. Hence, in closely planted groves on dry upland they prove short lived. As single specimens, or in single rows, where the roots can secure more moisture and the tops light, they do much better than in plantations. Poplars, especially cottonwood and its Siberian relative, *Certinensis* poplar, owing to their rapidity of growth, low cost and ease of propagation from cuttings, are valuable pioneer trees for the prairie planter upon suitable soil. However, trees of more permanent character should replace them when means permit.

The cottonwood is native from Quebec to the Rocky Moun-

tains and south to Florida. A tree widely planted in this state. For lawns of moderate size the cottonwood grows too large and robs the soil of moisture needed by other trees. It is not a good neighbor for other trees, and often wells are clogged by the roots. In the streets of Brookings there are many magnificent specimens about twenty years old, planted when the town was first laid out. Old trees give very little shade, the top being too spreading and open and foliage too thin. The leaves rustle with the slightest breeze and are of light, cheerful aspect. There are no somber tints among cottonwoods; they suggest sunlight; motion, not rest.

In common with all poplars, this tree is dioecious, that is, the male and female flowers are not borne on the same tree. Hence the "cotton," which flies when the seed is ripe, can be avoided by planting trees grown from cuttings taken from staminate or male trees.

The Carolina poplar is a variety of the cottonwood which is at present receiving considerable attention from nurserymen. Our specimens are too young for a definite report. It is a very strong grower of very upright, erect habit of growth, leaves more gradually taper-pointed and less triangular. Most people would call them identical.

Certinensis poplar (*Populus laurifolia* or *Populus certinensis*) is a native of Siberia, especially in river valleys at the base of the Altai mountains. A hardy tree of very rapid growth, somewhat resembling the cottonwood; the young vigorous shoots are strongly angled or grooved; the growth more close and erect; the leaves have wavy or ruffled edges and are on shorter, stiffer stalks. In the closely planted plats on the grounds of this Station Certinensis poplar has not done any better than cottonwood in being quite short lived when crowded for room and water. Upon suitable soil with more space and access to water, both deserve to be planted.

The balsam poplar or Tacmahac is native from Newfoundland west to British Columbia, southward into the northern tier of states; also of northeastern Asia. Probably the most variable of poplars; the many varieties in cultivation have

come from both native and Russian sources. In South Dakota it is native in the Black Hills and the Minnesota valley. A large tree of erect habit, with large resinous fragrant buds, which are used in medicine; leaves heart-shaped, whitish beneath.

The Balm of Gilead is native from New Brunswick to New Jersey, west to Minnesota; is hardy at Brookings, but sprouts more than is desirable. The rich dark foliage and spreading top makes it a better shade and street tree than most of the common poplars.

The white poplar or Abele is native of central and north Europe; in Asia from the Caucasus and the Orient to north-east Asia. Hardy at Brookings. This tree is generally considered hardy in the northwest, but its strong disposition to sucker from the root is objectionable for ornamental purposes. The variety *nivea* is a variety most common in this country. Sometimes, but erroneously, called silver maple, owing to its maple-like leaves. The snow-white under surface of leaf make the tree too conspicuous to be used largely for ornamental planting. On the lawn the innumerable suckers are a nuisance. Not adapted for a street tree because the white down on the under side of the leaves and young shoots catch the soot and dust and gives the tree a dirty appearance.

The American aspen is native of North America, north of Pennsylvania and Kentucky, extending to Mexico and the mountains. A small, handsome tree with whitish gray smooth bark, leaves soft green with whitish veins above and bluish green beneath. Trees from Wisconsin proved hardy and have done better in closely planted groves on dry land than cottonwood. In its native haunts this is comparatively a short lived tree.

The white willow is native throughout Europe, in western and northern Asia and northern Africa. The white willow is one of the best trees for windbreaks on the prairie.

The Russian golden willow is a hardy round-topped tree of very rapid growth, remarkable for its bright yellow bark in winter. The Russian laurel-leaved willow is a small, open-

topped tree valuable for its handsome foliage, the leaves glossy as if varnished. Native of northern and central Europe and Asia. The two foregoing species are the best for ornamental purposes of the various species of willow well tested at this Station.

### DIAMOND WILLOWS FOR FENCE POSTS

It is not generally known that one of our native willows possesses a special value. The farmers along the Missouri River, the southern part of South Dakota and other parts of the northwest are keenly alive to the fact that the heart of the diamond willow is as durable as red cedar for posts. Old trees of diamond willows are easily distinguished by the diamond-shaped patches on the bark which remain attached to the heart of the wood, allowing the softer wood to grow beyond them. Some very curious walking sticks are made by cutting out the softer wood, leaving the hard center and the diamonds to form the cane. It is quite possible that it will be best to raise diamond willows from cuttings of older trees that have made a strong growth, rather than begin upon young seedlings that may be more or less mixed on the sand-bars with other and less valuable specimens of willows. And again, willows in general are noted for the ease with which they hybridize in nature, forming into intermediate varieties.

The object of this paragraph is merely to call attention to the matter. At this Station we are now growing diamond willows to determine whether the posts can be grown profitably. Probably low waste land could be utilized for such a purpose.

### FOUR VALUABLE NATIVE TREES

**White Elm**—Native from Newfoundland to the Rocky Mountains, south to Florida and Texas. In South Dakota it is found along lakes and streams throughout the state. This is probably the best street, park and lawn tree for general planting. At Brookings it has made a good growth both in

the timber plantations and in open exposure. Some white elms from New York have not done as well as native South Dakota trees. As street trees white elms become more beautiful every year, while cottonwoods become open in habit.

**Box Elder**—Native of Canada and eastern United States south to Florida, west to the Rocky Mountains. This is native all over the state and is one of the best trees for the prairie planter for shade and windbreak. The dense foliage appears early. It is a good nurse tree for other more valuable trees, such as ash, which leave out so late that grass gets a start. Only northern native seed should be used. Considerable loss has been experienced in this state from planting southern seed. When planted as a street tree or on the lawn care should be taken to prune carefully in the early years of growth; early neglect causes the scrubby specimens often seen on lawns and in streets.

**Hackberry**—Native from Ontario west to Manitoba and Dakota, south to Georgia and Texas. This is a handsome tree for the lawn and does well even on high, dry land. It is a common native tree along lakes and streams throughout South Dakota. It does well in open exposure at Brookings. This tree has been neglected too long by nurserymen and planters, possibly because of scarcity of seeds, the birds being fond of the small, sweet, dark purple berries which hang on the tree in winter. The tree resembles the white elm, but differs in the thin, taper-pointed leaves divided unequally by the midrib. A beautiful hardy lawn tree of rapid growth.

**Green Ash**—This is native throughout the state. Native trees from this vicinity have done well under cultivation at Brookings. The trees endure severe drought on dry knolls and are very tenacious of life. Of rather slow growth at first, but is one of the most valuable trees for the lawn and groves. The red ash is a native of Canada to Florida, west to Dakota and Missouri. Abundant with the green ash throughout the state, and the two species are much mixed in nature. Both are valuable.

## CARE OF STREET AND LAWN TREES

Many thousands of shade trees have been set out in South Dakota this season. The tall, naked stem of all the nursery trees commonly planted, especially those for street purposes, is the beginning of the end in a large number of cases. Before the sap circulation can be restored the bark dries up and hardens so that later in the season, when the time comes for increase in diameter from the formation of the new layer of wood, the tree is, so to speak, hide-bound, and is injured by sunscald on the south and southwest sides. In parks this is remedied by winding a hay band about the stem. A more convenient way of doing this is by a strip of burlap or gunny sacking wound loosely about the stem from the ground to the main branches. Some overdo this and wind the band too tightly. A better way is to wind very loosely or to hang a strip down on the south side and attach loosely at several places by coarse twine. This permits the free circulation of air and the necessary shading of the stem is effected. If some means could be devised to moisten this at frequent intervals it would help in a dry season to keep the bark from drying out too much. In fact, where a tree is badly dried up at the time of planting, moss may be put inside of the loose burlap and the whole thing kept moist until the trees get good start. This is, of course, impracticable for a large number, but a few trees can be given more care.

Slitting the bark lengthwise is an efficient remedy for the bark-bound condition. This means cutting just through the tough outer bark of the stem, about the middle of June, from the ground to the branches. This gives room for the cambium layer or live layer between the bark and the wood to form the new layer or ring of wood. Do not overdo this and cut into the wood itself. In top-grafting fruit trees, especially the stone fruits, such as the plum, this bark-binding frequently occurs. Slitting the bark is sometimes called "cutting the corset strings" by practical nurserymen, and is an efficient remedy to restore equilibrium in growth between scion and stock, especially in dry seasons.



If too large trees are set in spite of advice to the contrary, it will be necessary to cut back the branches before planting, although most people cut back too much, leaving no immediate outlet for the sap. Small trees six to eight feet in height are much more apt to grow. If kept well cultivated and free from sod they will make rapid extension of new top by the second year; it will then be necessary to prune back the top about half to prevent topheaviness and bending over.

Pruning is best done when the formation of new wood is taking place; this means the latter half of June. All wounds heal readily at that time, if not too large. Care should be taken to prune close to the trunk and not leave a stub. All wounds are healed by new growth proceeding from the cambium layer of live tissue between the inner bark and the wood. It takes more than one season to cover large wounds.

All interfering limbs should be removed and in young trees forks should be removed; that is, one of the limbs should be cut off where the main top divides into two forks. This will prevent a splitting down of the tops later on. Where a wound of any size must be made, it should be covered with common lead paint. This is in keeping with the modern idea of surgery, that germs causing decay and death should be prevented from obtaining entrance to wounds. It is far better than killing the germs after they obtain entrance. One is aseptic and the other antiseptic surgery.

In general, fall planting of trees is not advisable in the prairie northwest. If we were sure of an abundance of snow during the winter, fall planting would be good practice, but the dry winter winds of several of our northwestern states, as was remarked once at an Iowa horticultural meeting, will take the moisture out of a fence post, and the trees will be badly dried out by spring. We often plant out small gooseberry and currant bushes in nursery rows in fall and bank up a little with a furrow of earth; also plant cuttings of many kinds, mainly currant, honeysuckle, spiraea, Van Houttei and similar hardy shrubs, in the fall, but these cuttings are set

into the ground clear up to the top bud and often develop small roots before winter sets in.

The greatest enemy of the trees and shrubs on the lawn is the grass. The grass roots rob the soil of moisture for several feet from the edge of the sod. The best question to ask a man who plants a choice collection of trees and shrubs, each in a little hole in the sod is: How will corn do under such method of culture? The wise planter should certainly give valuable trees and shrubs as good care as he would give to corn. The first ten years of a tree's life it must be protected from grass roots robbing it of moisture; after that it should be able to take care of itself. Clean cultivation is better than any mulch. By this is meant stirring the ground with spading fork and hoe enough to keep the earth mellow throughout the season. Especially must this be done soon after a rain, before the ground begins to bake. A mulch of straw or similar material is good to retain the moisture, especially in July and August, provided it be removed at intervals and the ground stirred. Roots must have air as well as moisture. Continued mulching brings the roots too near the surface. The favorite mulch of the experienced nurseryman and tree planter is the dust mulch, made by frequent shallow stirring of the soil. This is the cheapest mulch where many plants are under cultivation. The drier the season, the more frequent the cultivation. It is next to irrigation, in fact, better than irrigation that is not followed by cultivation to break the crust. The amateur's method of watering choice plants every day is "killing them with kindness." If watering becomes necessary, remove the mulch or top soil, give a very thorough soaking, then replace the first dry surface soil and then the mulch. One good watering like this is better than a dozen ordinary sprinklings. A depression should be left around each plant to catch the water. Do not plant too many trees close to the house. Damp walls increase doctor bills. Sunlight is an excellent germ-killer. If possible, the sun should shine into every room in the house some time during the day. If possible, the road should not be hidden

from the house by trees. The house should be a home, not a hermitage.

### PLANTING ON HARD-PAN

Some planters find it essential, in order to secure rapid growth, to break up the hard-pan which is found a short distance beneath the surface. By picking through the hard-pan at each place where a tree is to stand it permits the free descent of roots and in a dry season the growth of the tree is not affected in the least. This question of penetrating the hard-pan is an important one in many localities of the west. In some regions of the arid southwest and on the Pacific slope and elsewhere orcharding and tree planting have been attempted in dry climates with hard-pan close to the surface, the subsoiling has been done with a stick of dynamite before the planting of the tree. This is now done in a commercial way by experts in the business. The writer has always hesitated to recommend this method to inexperienced amateurs, owing to the danger from premature explosions. However, the principle holds good that hard-pan, which prevents the ascent of moisture from below and the descent of roots into the water-bearing strata, be broken up. If this method of subsoiling be deemed too expensive, much may be done by subsoiling as deeply as possible in the fall before the trees are planted. If the subsoiler follows immediately after the ordinary plow, set to run as deeply as possible, we have found it feasible to subsoil eighteen to twenty inches deep, but where the subsoil is stony it is too hard work and too severe on the implements used.

### VEGETABLES

Over the larger part of the state farmers have been so busy with grain, stock and dairy farming that the culture of vegetables has been much neglected. This is evident from the immense quantities of vegetables shipped into the state, especially the northern portions. And yet the experience of

many men scattered over the state shows that abundant crops of choice vegetables can be easily grown with proper care and management upon our fertile prairies. Many of the failures in raising vegetables in the northern part of the state come from the selection of late instead of early varieties. Inquiries are frequently received by this Station for lists of desirable varieties. While this is to a considerable extent a local matter, it has been deemed advisable to make the following tests to give some indications as to the best list to recommend for trial. In all our prairie gardens we should remember that the directions given in eastern publications about the distances rows should be apart need modification in many cases. In the east, land is scarce and high priced and labor abundant and cheap; in the west these conditions are reversed. Hence the farm garden should not be laid out in the way common near large cities, where land is worth hundreds of dollars per acre, but plenty of room should be given and the garden laid out in long rows to permit of horse cultivation. Our wheat farmers, who deem a quarter section a rather small place for one man to work, almost scorn to touch a hoe. Here American inventive genius has come to the rescue during the past few years, and the latest improved garden seed drills, wheel hoes and weeders, make the labor of weeding comparatively light. A few dollars spent for these improved implements will be money wisely spent. To have abundance of garden vegetables during the entire season and enough to put into the cellar for use all winter and until the next crop comes in, means more than many dollars and cents saved. It means better health throughout the year, a table supplied constantly with the choicest of food, and increased enjoyment of rural life. Another point, the present age is one of extensive adulteration of foods and treatment of canned vegetables and fruit with chemical preservatives, injurious to health. Pure food laws may remedy this state of affairs in time, but until this time comes the era of home canning will return more and more, and the increased use of home grown vegetables will largely conduce to the preservation of the public health.

The people with a small garden or a town lot should study this question also, but from the standpoint of economizing space. The possibilities of a small piece of land in the way of producing food products are wonderful. These possibilities have been demonstrated fully in the densely populated parts of Europe, where farms consisting of two to three acres, and supporting large families, are common.

**Tomatoes**—A large number of varieties of tomatoes have been tested at this Station, and it has been abundantly demonstrated that tomatoes can be successfully raised. Some years the yield of the better varieties has been over 500 sixty-pound bushels per acre. It has also been shown that only early varieties are worth planting for profit.

In the northern part of South Dakota earliness is the first requisite of a tomato. The earlier experiments at this Station show that the large, late smooth varieties are not profitable. Hence the extra early varieties have been most popular, although as a class they bear rougher and more irregular fruit. But improved shipping facilities make it harder each year to sell these rough early varieties in competition with the large smooth varieties shipped in from the south. For market purposes then, we may say that smoothness is the first essential in a tomato. For home use earliness is more appreciated than smoothness except, of course, those intended for canning.

Earliest of All is a standard very early sort, but rather rough. Early Ruby is a standard main crop variety. Early Bird and Early Leader are good early sorts. Of the small preserving varieties, Red Cherry is a standard.

Many busy farmers do not know or care to learn about the construction and management of hotbeds, neither are they near a greenhouse or market gardener.

Tomato seeds can easily be started in shallow boxes in a sunny window in the house and later transplanted to flower pots, old berry boxes or tin cans, but some people dislike to do even this. Where a market gardener is near at hand, plants can be bought cheaply. Sometimes plants started indoors get too tender and slender, and are caught by late

frosts when set out in the open garden, which should not be before the first week in June.

Some planters find it useful for the purpose of economy to melt the solder from tin cans and use them instead of flower pots. The cans are tied together with wire or stout string and filled with earth. Instead of ordinary tin cans it was found better to get cans of uniform size made at the tinner's from strips of scrap sheet iron and tin, with a flange at each end, so the ends will hook into each other, forming a can without a bottom, holding a little less than one quart each. These tins were placed in a board frame on the south side of a house, filled with rich garden soil, and the frame covered with a glass sash. The seed was sown April 22, 1899, and the seedlings thinned to one plant in each tin soon after germination. June 6th the plants were set in open field four by four feet, without disturbing the ball of earth. The vines were killed by frost September 18th.

Three varieties were tested, the plants being taken both from the greenhouse and the cold frame.

It was found that the plants of Earliest of All and Early Ruby taken from cold frame compared favorably with those from the greenhouse. In using the cold frame care must be taken to lift the sash for ventilation when the sun is shining, and to take off the sash entirely on warm days, especially the latter part of May. On cold nights at first it may be necessary to cover the glass with a straw mat or boards. The advantage of the cold frame method is that the plants are not set back by transplanting and are not forced to grow spindling by excessive heat at any time, so that they are well hardened and suffer no backset when set in the open field. However, the method is only suitable for a few plants for the home garden, as on a large scale it is less trouble to transplant them than it is to thin out the plants in the cans.

**Peppers**—Peppers and egg plants were tested in a similar manner with less favorable results, plants from the greenhouse being more productive than those from the cold frame.

## THE COLD FRAME FOR OTHER VEGETABLES

In the foregoing trials, the sash used was ordinary hotbed sash, which can be ordered unglazed from a seedsman or through a lumber dealer, and the glazing done at home to save the extra expense of shipping crated glass sash. But where it is inconvenient to get hotbed sash, the storm windows from the dwelling house will answer the purpose, although not as strongly constructed for rough handling. The cold frame is convenient for starting other vegetables. Upon a succeeding page is given the results with cauliflower, one of the choicest of all vegetables and yet commonly neglected in this vicinity because thought to be much more difficult to grow than its less refined near relative, the cabbage.

With a view to testing the matter entirely from the home garden standpoint, the horticulturist of this Station conducted trials in his private garden in 1899 and 1900 with a cold frame on the south side of the residence. The four storm sash were taken from the house the middle of April and used to cover the cold frame. A cover made of light boards was used on cold nights. Seed was sown in flat boxes of head lettuce, cabbage, kohlrabi, brussels sprouts and cauliflower, and either thinned out in the boxes or transplanted farther apart as soon as big enough to handle to other boxes and later set out with a ball of earth. Excellent cauliflower, cabbage, and early kohlrabi were raised in this way. Brussels sprouts did not head well. Choice head lettuce (Landreth's Forcing and Black Seeded Tennis Ball), equal to that shipped into the local markets, was grown in this way, some being left to reach maturity under the glass and others set out in the open ground where they could be watered. People who are accustomed to the tough-leaved lettuce commonly grown from seed sown out doors in drills in this vicinity, should try this method for the home garden.

A good crop of Earliest of All, Bond's Early Minnesota and Early Ruby tomatoes was grown from seed planted in tins such as those already described and thinned out to one

plant in each tin. Small, though very acceptable Very Early Dwarf Purple egg plants were grown in the same way.

**Egg Plants**—Egg plants are rarely seen in the gardens of the northern part of the state. While this choice vegetable is much more tender in plant than its near relative, the tomato, it should not be left out of the home garden. A few plants can easily be grown from seed started in the house or in a hotbed, the same as tomatoes, but it is not usually safe to set out the plants before the 10th of June. The large varieties of the New York Improved type are the standard for market, but are late and should be restricted to one fruit per plant. The Very Early Dwarf Purple is small, very productive and early, but sets more fruit than it can mature, but should be restricted to two or three fruits per plant. It is worth the extra effort necessary to raise some of the large but late varieties, as but few plants are needed in the home garden. To be certain of the fruits in seasons of early frosts, it would be best for the northern part of the state to raise some of the small but early varieties.

**Peppers**—Many varieties have been tested. The small early sorts, such as Yellow Chili, Cayenne and Red Chili, do better than the very large sorts, which are sometimes too late to ripen well. However, some of the large sorts, such as Large Golden Upright, Large Sweet Spanish, Sweet Mountain, Golden Dawn and Ruby King, should be cultivated, as they are excellent for green peppers. In the southern edge of the state some planters have done well by sowing seed out doors when danger of frost was past.

**Ground Cherry**—This is a near relative of the tomato and is easily grown from seed sown outdoors in May. Fruit five-eighths of an inch in diameter; yellow, round and covered with an inflated husk; sweet and pleasant to eat out of the hand. Very popular for preserves, and if picked before injured by frost can be kept in a dry room until the middle of January or even later. Many people grow this in the home garden, where it will generally volunteer after the first year.

**Staple Vegetables**—Radishes, spinach, bush beans, lettuce,



peas, potatoes, sweet corn, beets, carrots, endive, cress, cucumbers, onions, okra, squashes, parsley, parsnips, turnips, rutabagas, salsify, early muskmelons are all raised with success in Dakota gardens. Early varieties do best. Celery and celeriac must usually be irrigated for the best results on dry upland gardens. Watermelons are usually too late in the northern part of the state. Pole beans are not as popular as bush beans, owing to the trouble of poling or trellising, but yield good crops. Pole lima beans should be planted sparingly usually, as they are very tender against frosts. Bush lima beans are generally safer for the amateur.

Of perennial vegetables, asparagus and pieplant should be included in every garden. Horseradish is also easily grown.

### THE CABBAGE FAMILY

There are many members of this family, some of the choicest of which are but little known in our prairie gardens. Some of these are cauliflower, kale and kohlrabi. Some varieties of each of these have proved desirable at this Station.

**Cabbage**—The varieties are very numerous. One of the standard early sorts is Early Jersey Wakefield, followed by many medium and late varieties. Most planters confine their attention to the smooth leaved cabbages and neglect the wrinkled leaved Savoy, which are of choicer quality, although not as productive. The red varieties should not be neglected for pickling.

**Cauliflower**—This is one of the choicest of vegetables and it has not proved difficult of cultivation at this Station. The young plants are started the same as cabbage, and care should be taken when the head begins to form to tie up the leaves over it, otherwise the sun burns and browns the white head, making it rank in flavor and unfit for market. A good dish of cauliflower is considered a delicacy. Early Snow Ball, Early Dwarf Erfurt and other sorts have proved desirable and are good standard varieties.

**Kohlrabi**—This is very easily raised, and yet is much neglected in Dakota gardens. It is a near relative of the cab-

bage, but the part eaten is the turnip-like swelling just above the surface of the ground. These heads should be used when young, before they get woody. The plants may be started and transplanted the same as cabbage, or sown in drills and thinned. Purple Vienna and White Vienna are good standard sorts.

**Kale**—Does not form a head, but an abundance of leaves, which are cut and used as greens all summer and fall. The plants may be started and transplanted the same as cabbage, but are usually sown in drills and thinned. Extra Curled, Dwarf German, Dwarf Curled Scotch and Brown German were found the most desirable of the ten varieties tested in 1899.

### LESS KNOWN VEGETABLES

Among those that have done well here may be mentioned New Zealand spinach, chives, mustard, nasturtium, sorrel, martynia, cultivated dandelion, turnip-rooted parsley, scoly-mus, skirret and sorrel.

Swiss chard or silver leaf beet makes a strong growth and produces an abundance of leaves. The part eaten is not the root, but the midrib of the leaf, which is prepared much the same as asparagus. The flavor is distinct from that of the ordinary beet root. Swiss chard is a choice vegetable that is very easily grown and should be found in every home garden.

### HERBS

A number of herbs of spicy, aromatic taste and odor are much used for flavoring and seasoning in culinary operations, and they should be more commonly grown in Dakota gardens. The following were sowed in 1899 and made a good growth: Borage, sweet fennel, curled chervil, coriander, summer savory, sage, sweet marjoram, sweet basil, thyme, fennel, anise, dill. Some herbs are used for flavoring only, and others have medicinal value also. Those who have eaten chopped meat seasoned with sage or thyme, cucumber pickles flavored

with dill, German "lebkuchen" or honey cakes flavored with cardamon seeds, cookies flavored with anise seed, lettuce mixed with a few finely cut borage leaves, or rye bread, cottage cheese or pickled beets seasoned with caraway seeds, will usually agree that some herbs at least are useful plants for the kitchen garden aside from their medicinal value.

### ORNAMENTAL SHRUBS FOR THE LAWN

The shrubs should be planted in thick, irregular clusters or groups, with no sod among the plants in the group. The common method of planting shrubs is to scatter them out singly, like "exclamation points," so that each lonesome little bush gets sod-bound and its days are few and full of trouble. These groups should be mainly in the corners and at the sides and back of the lawn, leaving the main center of the lawn free. Avoid cutting up the center of the lawn with a bed of geraniums or other flowers. These belong more in front of clumps of shrubbery or close to the house. "Curved is the line of beauty," hence curved lines are the characteristics of this style. Avoid planting trees in straight lines, except, of course, on division lines. Drives and walks should be laid out in graceful curves. These curves must be laid out for the purpose of passing some obstacle, otherwise the eye is not satisfied and there is constant temptation to "cut across." Hence the skillful landscape gardener plants trees and shrubs in the hollow of the curves; this also increases the apparent extent of the grounds, a fresh view being presented at every turn in the curve. For small grounds, good curved lines may be marked out by throwing a rope fastened to a stake at one end, until the curve satisfies the eye. For the sake of privacy and comfort, a screen or hedge should be planted dividing the front lawn from the back yard. This need not be a straight line, but if preferred may consist of a continuous, irregular border thickly planted with many varieties of shrubs. Next to the shrubs on the lawn side may be planted hardy perennials, annual flowers and some hardy bulbs.

Study the characteristics of trees and shrubs so that due

allowance may be made in the original plan for the changes in size and habit. Do not plant large trees and shrubs in order to get "an immediate effect." "Smaller sizes are cheaper and much more apt to live.

The following are recommended for all the farming regions of the state. For small collections choose the first few on each list:

#### Lawn Trees

Cut-leaved weeping birch, hackberry, box elder, white elm, wild black cherry, burr oak, rock elm, American aspen, Bolle's poplar, pin cherry, mountain ash, choke cherry, wild plum, green ash, red ash, Russian oleaster, European white birch.

#### Lawn Shrubs

Spiraea Van Houttei, spiraea arguta, Tartarian bush honeysuckles, golden currant, Siberian pea tree, Caragana microphylla, Rosa rugosa, snowball, Juneberry, Siberian dogwood, western sand cherry, Siberian almond, mock oranges, hydrangea p. g., Cotoneaster acutifolia, purple-leaved barberry, silver berry, burning bush, Tamarix amurensis, high bush cranberry, snowberry, Prunus tomentosa, buffalo berry, Viburnum lentago, Siberian sand thorn.

#### Shrubs of Trailing Habit

Box thorn, Lonicera Alberti.

#### Varieties With Ornamental Berries

Burning bush, honeysuckles, box thorns, mountain ash, waxwork, Cotoneaster acutifolia, berberis.

#### Varieties With Bright Colored Bark

Red, Siberian dogwood; yellow, Russian golden willow.

#### Varieties With Bright Colored Leaves

Purple barberry, purple birch; yellow, Spiraea opulifolia lutea.

#### Climbing Vines

Virginia creeper, waxwork, trumpet honeysuckle, woodbine, Dakota wild grape, native clematis.

Many of the native shrubs and trees of South Dakota are

worthy of general cultivation, some, in fact, are more honored abroad than at home.

In general, it may be stated that no beginner upon the prairies need wait until his means permit the purchase of cultivated shrubs and trees. In the nearest timber or creek bottom he may find enough wild plants to make a very satisfactory beginning in ornamenting the home grounds.

### THE OUTDOOR FLOWER GARDEN

The space available at this time will not permit a full discussion of prairie flower gardens. Probably no two lovers of flowers will agree as to the best varieties, hence the writer does not expect any one to fully agree as to the following list:

#### Annuals

For several years annual flowers have been cultivated at this Station with the view of determining what varieties will flourish with ordinary field cultivation, no transplanting and no watering; in fact, the same care that would usually be given to beans, beets, carrots and other garden vegetables. The following are the best of those that have done well under this field cultivation: Zinnias, sweet peas, tall nasturtiums, calliopsis, calendula, bachelor's buttons or *Centaurea cyanus*, the French marigolds, California poppies or *eschscholtzia*, poppies, China asters, portulaccas, candytufts, sweet alyssum, single petunias, mignonette, pinks or dianthus, four o'clock, *Bartonia aurea*, *Nicotinia affinis*, snow-on-the-mountain (*Euphorbia marginata*), annual chrysanthemum, *Helianthus cucumerifolius*, balsams, scarlet flax (*Linum grandiflorum*), *Malope grandiflora*, phlox, ice plant, sensitive plant (*Mimosa pudica*).

*Cosmos* grows well, but flowers too late to be of value; the Dawn, a new variety, does better. *Nicotiana affinis* can be taken up in autumn after blooming all summer and potted for the window garden. Four o'clock roots may be taken up, stored in cellar and set out in the spring.

If an abundance of cut flowers are desired, sow seed of

the above varieties along with garden vegetables, so they will get the same cultivation; this is very much better than crowding them in a hole cut out of the sod on the lawn and sprinkling them every day. Of some, especially asters and phlox, the seed is too valuable to sow outdoors, so sow in a box and set out with ball of earth, transplanting once before the final transplanting. Verbenas, pansies and gaillardias do finely, but seed should be started in boxes. Tall nasturtiums need no trellis, but may be allowed to form a dense edging or single row if no trellis is handy; the dwarf nasturtiums are less desirable. In sowing most flower seeds outdoors, make soil fine and mellow, press seeds firmly into the moist soil with the hand, cover very lightly with loose earth; in other words, have a firm seed bed and loose earth on top to prevent baking. Plant large seeds deeper.

### Herbaceous Perennials

By this is meant plants whose roots live over from year to year indefinitely, and the tops die down to the ground every winter. Nearly 3,000 varieties are offered by American nurserymen and collectors of native plants.

The peony (sometimes called the "king of flowers") is undoubtedly the best for general cultivation. Plant as many of the herbaceous varieties as your purse and tastes dictate. (The tree peonies are shrubs and winter-kill in the north-west.)

The experience with perennials is limited in this state, but the following are promising for general cultivation: Golden glow (*Rudbeckia laciniata* fl. pl.), German iris, aquilegia, phlox, baby's breath (*Gypsophila paniculata*), delphinium, Gaillardia aristata, tiger lily, papaver, dicentra, coreopsis. Hollyhocks need heavy winter mulching.

### Native Species

Penstemons or beard-tongues, lilies, sunflowers (especially *Helianthus Maximiliani*), yucca and many others deserve a place in the garden.

### General Notes

Most perennials need dividing and replanting every two or three years, otherwise the clumps become too thick and fewer flowers are produced. Peonies may be left undisturbed much longer. A good place for perennials and annual flowers is in front of a border of shrubbery, along a fence or drive, or next the house, where sod can be kept down and the soil kept mellow. In this border plant anything hardy that pleases you. Even pieplant and asparagus are not out of place; the former is ornamental in leaf and flower, the latter in leaf and fruit. Give a top-dressing every fall of thoroughly well rotted manure, and do not spade up deeply. If next to the sod, the grass roots can be kept from doing much damage by a wide board sunk edgewise into the soil even with the surface.

### Hardy Bulbs

The many varieties of tulips, single and double, early and late, are especially desirable. Plant in autumn and mulch with stable litter over winter. By planting alternate rows of single and late varieties, the season of bloom may be prolonged. When the foliage dies down, plants of asters or other flowers may be set in between, or seed of zinnia or petunia sown earlier between the rows; this gives a second floral display later in the season.