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Experiment Station Work,

IX.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., March 15, 1899.

SIR: The ninth number of Experiment Station Work, prepared under my direction, is transmitted herewith with the recommendation that it be published as a Farmers' Bulletin.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

EXPERIMENT STATION WORK—IX.[1]

SUGAR BEETS ON ALKALI SOILS.

It is generally concluded from European experience that alkali lands must be classed among the soils least adapted to the successful culture of the sugar beet. Although the sugar-beet industry is just beginning to be established in this country and we have millions of acres of land whose adaptability to the growth of the sugar beet is unquestioned, it is nevertheless important to ascertain the possibilities of successful sugar-beet culture on alkali soils, inasmuch as the proximity of such soils to beet-sugar factories may make them especially desirable as beet fields. The existence of these conditions in southern California, near the large sugar-beet factory at Chino, and the fact that the beet fields were there rapidly extended with but little regard to the presence of alkali, without seriously injuring the quality of the beet, induced the California Experiment Station to make a study of the effect of different kinds and amounts of alkali in the soil on the growth and quality of sugar beets.

The investigation was made on a 10-acre field located on the border of a tract of alkali land. The tract contained occasional small alkali spots, which, however, did not seem to interfere with its natural growth of wild grasses and sunflowers. This soil was first planted to various grasses and legumes, but as none of these gave promise of a crop the greater part of the tract was again plowed and planted to sugar beets. "These came up quickly, though with a somewhat thin stand, right among the alkali efflorescences, and continued to grow without let or hindrance." The alkali salts did not seem to affect the beets, although they had proved injurious to the grasses and legumes. Different portions of the tract had different amounts and qualities of alkali salts, and to deduce definite conclusions regarding the tolerance of the plants for the several mixtures of salts the tract was divided into plats 50 feet square, which were investigated separately.

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[1] This is the ninth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

The author concludes from the results obtained that without question sugar beets of a good quality can be grown on soil containing as much as 12,000 pounds of alkali salts per acre to the depth of 3 feet, provided the average percentage of common salt is not over 0.04 per cent, or 1,500 pounds per acre.

To find out whether the sugar beet can be profitably grown on alkali lands, it is recommended to those interested in such lands to ascertain the total amount of salts in the upper 3 or 4 feet of soil. This may be accomplished by taking an average sample of the soil to that depth by means of a post-hole auger and having the amount of soluble salts contained in it determined. A considerable portion of the salts present in the first 3 or 4 feet of the soil may come to the surface under cultivation and irrigation and may give the soil the appearance of being too heavily impregnated with alkali to grow beets; but, as these experiments indicate, the feasibility of successfully growing sugar beets depends on the total amount of alkali salts present in this upper stratum, and soils with marked alkali efflorescences at the surface may be perfectly capable of profitable sugar-beet culture.

PLANTING AND REPLANTING CORN.

Owing to abnormal weather conditions, the presence of insect enemies, the failure of the seed, and other influences, it often becomes necessary to postpone the planting of corn or to replant the crop. The question which presents itself under such conditions is how the date of planting affects the yield and maturity. Many of the experiment stations have carried on experiments for several years to determine the influence of the time of planting corn on the yield and maturity of the crop, which have thrown much light on this subject.

In experiments at the Indiana Station it was found that the earliest planting (May 1) yielded the largest crop (41 bushels per acre), while the latest planting yielded about one-fourth less (31.7 bushels per acre). The time required for the crop to mature decreased as the time of planting was delayed. A delay of thirty or forty days in planting shortened the time required for the corn to mature from two to three weeks. At the Kansas Station the average results of experiments in this line carried on for two years showed that corn planted in the beginning of May gave the best results, and at the Illinois Station the average results of similar experiments were in favor of the plantings made from May 4 to 18, with tendencies slightly favoring the later dates.

The experiments indicate, therefore, that under favorable conditions there is an advantage in early planting; but in view of the uncertainties of the weather, which is always a controlling factor in the growing of crops, these results must be applied with caution in practice.

As Tracy[1] has pointed out, planting should not begin too early in the season. "Nothing is gained by putting seed into soil which is too

[1] U. S. Dept. Agr., Farmers' Bul. 81.

cold or too wet to favor germination. It is better to defer the planting a week or ten days than to run the risk of losing it by decay or of having an imperfect stand by planting before the ground is sufficiently dry to work well and warm enough for immediate growth. Every missing plant means a decrease in the yield, and replanting the missing hills is seldom profitable. The replants are surrounded by plants which mature and shed their pollen before the younger silks are formed. The pollination is therefore very imperfect, and the ears on the replants are usually nubbins, which are scarcely worth gathering. When the missing plants amount to from 10 to 20 per cent of the whole, replanting with some earlier maturing variety which will produce its tassels and silks at about the same time as the original planting is often profitable, but will not pay when the misses are less than 10 per cent. When the misses are more than 20 per cent it will pay better to make an entire new planting."

IMPROVEMENT OF SORGHUM BY SELECTION.

Attempts were very widely made some years ago in the United States to utilize sorghum for the manufacture of sugar on a commercial scale. The enterprise proved unsuccessful largely because of the uncertain, but usually low, sugar content of the sorghum cane which was then produced. While the attempts to manufacture sugar have been largely, if not entirely, abandoned, "sorghum sirup is made in every State of the Union and in thousands of small mills,"[1] and for this, if for no other reason, the improvement of sorghum as a sugar producer is still a matter of great importance.

For a number of years several experiment stations have conducted experiments with a view to improving the sorghum plant as a sugar producer. In general the method of improvement consisted of planting seed from plants which were found by analysis to be richest in sugar and highest in purity of juice. Recent bulletins of the Delaware Station report the results of attempts to improve sorghum by selection, comparing crops grown at a number of experiment stations since 1887, and discussing the possibilities of sorghum as a commercial source of sugar.

In 1897 and 1898 experimental crops of sorghum under the supervision of the Delaware Experiment Station were grown at the station and at several other places in Delaware and at Cape Charles, Va. Several thousand stocks have been selected and tested.. The facts ascertained relative to each stock were as follows: (1) The length of stock including seed head; (2) the stripped and topped weight of stock, the seed head having been removed at the arrow joint; (3) the specific gravity of the juice; (4) the direct, or single, polarization of the juice. From these data as a basis the following facts were deduced: (1) The percentage of solids in the juice; (2) the sugar content in a unit volume of juice; (3) the percentage of sugar

[1] U. S. Dept. of Agr. Division of Chemistry Circ. 1.

in the juice; (4) the coefficient of purity; (5) the percentage of juice in the stock; (6) the percentage of sugar in the stock; (7) the weight of sugar in the stock; (8) the coefficient of availability; (9) the weight of pure sugar to be crystallized from a ton of stripped cane, such as the sample; and (10) the number of stocks, such as the sample, required to produce 3,000 pounds of pure crystallized sugar. Each fact is considered important in determining the quality of the sorghum and its adaptation to sugar making. The length and thickness of the stock have a direct bearing on the resistance to wind storms, which is very important, since broken-down cane ferments rapidly, and thus sustains a loss in sugar. The weight of the cane is important partly for the reasons just stated, but mainly because heavy stocks are more readily worked and at a smaller cost and give a higher tonnage per acre than light stocks. The percentage of juice in the stock, the total solids in the juice, and the percentage of sugar directly affect the amount of crystallizable sugar.

The table below gives the analytical results of sorghum crops grown at various experiment stations during a number of years. These results are not considered strictly comparable on account of the variable water content, but they show the wide variations in the composition of sorghum. The analyses reported are taken from the best of the season, so that the small percentages in the sugar content are not due to the decline which takes place toward the end of the season.

Comparison of various sorghum crops.

Station reporting and variety tested.	Year.	Sugar in juice.		
		Maximum.	Minimum.	Average.
		Per cent.	*Per cent.*	*Per cent.*
Iowa	1888	14.72	6.67	12.10
Do	1889	14.87	....	13.18
Kansas	1888	16.56	.96	10.63
Do	1889	15.32	3.41	10.53
Kentucky	1887	15.52	5.26	11.15
Do	1888	12.38	1.59	7.11
Louisiana	1886	16.50	5.40	11.92
Minnesota	1891	15.33	8.34	11.76
Mississippi	1890	14.80	4.19	9.60
New Jersey	1887	....	....	9.00
Do	1888	....	....	8.23
New Mexico	1891	15.02	11.71	12.96
Do	1892	21.9	8.00	11.85
New York	1888	....	....	9.02
Do	1889	....	....	10.87
Do	1891	13.33	2.84	9.13
Do	1892	11.87	6.76	10.33
Delaware, Collier	1894	16.00	7.50	13.10
Delaware, Orange	1898	16.08	5.46	11.61
Delaware, Frame's New	1896	14.40	10.70	12.90
Do	1897	15.96	6.31	11.98
Delaware, Colman	1894	16.60	6.10	12.90
Do	1896	15.20	8.70	12.90
Do	1897	17.84	10.16	14.62
Delaware, McLean (grown in Delaware)	1894	17.40	6.70	13.60
Do	1896	17.10	12.30	15.00
Do	1897	17.35	10.71	15.20
Delaware, McLean (grown in Virginia)	1897	19.05	6.69	15.24
Do	1898	18.78	7.20	14.79
Delaware, Amber (grown in Delaware)	1894	16.00	7.30	12.60
Do	1896	15.00	9.80	13.00
Do	1897	19.19	8.30	15.74
Do	1898	19.50	4.98	15.11
Delaware, Amber (grown in Virginia)	1897	21.50	10.09	18.15
Delaware, Amber (grown in Virginia from heavy seed)	1898	21.24	4.17	16.53
Delaware, Amber (grown in Virginia from light seed)	1898	19.14	7.50	15.81

It will be seen from these results that there are very great variations in the sugar content of the juice. Great differences were also found to exist in the constancy of the sugar content and the length of the season. The analyses show wide fluctuations, even when but a few days elapsed between them. "To what causes these differences may be due, or rather to which cause of many they may be chiefly due, it is not easy to say. * * * There must, of course, be differences of season and of soil more or less favoring or hindering a good crop, yet despite these there has been an unquestionable rise in the quality of the cane, and this must be attributed to judicious selection of seed for propagation."

In discussing the principles of selective propagation the author points out that the consideration of a high sugar content and a high purity only is insufficient and that other qualities, such as size and strength of stock, tonnage per acre, early ripening, and the constancy of the sugar content throughout the season must be taken into account. The object in view is to crystallize the most sugar at the least expense, but the seed which tends toward the attainment of this result is not very easily selected. The ordinary physical tests of seed in fruit propagation are not sufficient here, but an analysis of the juice of the particular plant must be made and the sugar content taken into consideration. The weight of the stocks was found to be influenced largely by environment, and sacrificing a rich sugar content to weight in selection would not be advisable for that reason. "Of the crop all stocks below 12 ounces or, if there be seed enough, all below 16 ounces may well be rejected altogether, and then of the remainder preference should rest on sugar and purity, i. e., available sugar content. A system by which heavy weight of stock should offset low sugar content would hardly lead to profitable results."

It is believed that the task of selecting will become easier as the work is carried on year after year. The selection of cane of good size and weight and promising appearance in general, which is in accordance with nature's survival of the fittest, will produce a plant with sufficient resistance to storms, and when that result has been attained the question remains one of sugar content and purity, or the percentage of available sugar.

IMPROVED CULTURE OF POTATOES.

As a recent bulletin of the New York Cornell Experiment Station shows, the average yield of potatoes in the United States is far below what it should be. This bulletin states that "the average yield of potatoes throughout New York is not more than one-half what it should be and what it would be were better methods practiced." This low yield is not due, as a rule, to poverty of the soil, because "all soils of ordinary fertility contain sufficient potential plant food to produce abundant crops," and a part of this potential plant food can be made available for the use of plants by tillage, and drainage, if necessary.

The experiments of the Cornell Station, which have now covered four seasons, were planned with a view to learning what superior tillage and care would do in the way of unlocking the hoarded fertility of the soil and increasing the yield of the crops.

The soil on which the potatoes were grown has been continuously under crop without fertilizers since the winter of 1893-94, except that cover crops of rye, crimson clover, or wheat, to be turned under in the spring, have as a rule been grown. But the growth of these has necessarily been so small and the cropping so intensive that the soil is beginning to show a deficiency of humus, indicated by its tendency to become hard and compact under beating rains; for "in order to keep a soil permanently in good physical condition, it is absolutely necessary that organic matter be returned in some way, either by green manuring or the use of barn manures."

Notwithstanding this fact, the yields in the Cornell experiments have been much above the average each year. This was as true of 1898 as of previous years, in spite of the additional fact that the latter season was one of severe drought and the soil used in the experiments "is gravelly and porous and especially subject to injurious effects from drought."

It is probable that frequent and deep plowing has done much to bring and keep the land productive. So far as the plowing is concerned all plats have received the same treatment. The land has been turned from two to three times each year, and the pulverizing which has resulted therefrom has liberated sufficient plant food to mature large crops. In addition to the plowing the land has been frequently harrowed and cultivated and the intensive culture which has been given has liberated all the plant food that could be used by the growing crops with the amount of moisture that was present.

A fact clearly brought out by these experiments is that "success with potatoes depends largely upon the preparation given the soil before the potatoes are planted. Plowing should be deep, and at the time of planting the soil should be mellow and loose."

Only first-class marketable potatoes should be used for seed. These should be cut into pieces averaging two strong eyes. "Seed should not be cut for any considerable period before planting. If it becomes necessary to delay planting for some considerable time after potatoes are cut, the cut pieces should be dusted with plaster and spread out in a moderately moist, cool place."

Early planting has usually given best results, but this necessitates careful spraying with Bordeaux mixture and Paris green to protect the plants from diseases and insects. Early and deep planting and frequent and level tillage are especially important in soils like that used in these experiments, which are likely to be seriously affected by drought.

The methods of planting and cultivation used at the Cornell Station in 1898 were as follows:

The pieces were dropped in the furrows directly after the furrows had been opened, one piece being put in a place and at distances 14 inches apart in the row.

A furrow was opened [with a shovel plow] in the middle of the space left when the first furrows were opened. This served to cover the potatoes, the earth being ridged up directly over the potato row. The planting was done on May 10. The soil was then left undisturbed until May 28. The ridges which were left over the seed potatoes covered them to a depth of about 8 inches. By May 28 the weed seeds which were in the surface soil had germinated and the whole surface was covered with tiny weeds. A spike tooth harrow was fitted with a piece of 2 by 4 scantling placed diagonally across underneath the frame and held in place by the harrow teeth. The harrow thus rigged was used upon the potato plats, being first run lengthwise of the rows and then crosswise. The weight of the driver upon the harrow was necessary in order to make it do the leveling as required. The benefit derived from this treatment was very marked. All weeds were destroyed, the surface crust was broken, all clods and stones were removed from above the row and deposited in the center of the space between rows, the surface was leveled and in every way the conditions were made favorable for the rapid growth of the potatoes, and they appeared above ground in three or four days.

In general it may be said that "on soils which are not well drained, either naturally or artificially, and on clay or clay loam soils, potatoes may be planted somewhat shallow and slight hilling may be practiced with benefit."

If planting is done very early in the spring the ridges may be permitted to remain for ten days to two weeks before harrowing down. If planting is done somewhat late the ridges should be harrowed within one week after planting. In the case of the early planting there is usually enough moisture present so that the ridging may temporarily prove a benefit by enabling the soil to become warm. In the case of late planting all the moisture should be conserved, and this is best done by leveling the ridges.

Harrowing the soil before the plants appear above ground, followed by from six to seven cultivations during the season, is recommended.

SECOND-CROP POTATOES FOR SEED.

In the Southern States potatoes planted in the spring mature early in the summer, and during the hot weather of the season it is difficult to keep the tubers from decaying. Consequently this early crop does not furnish potatoes for the table during winter nor seed for the next season's planting. This difficulty has given rise to the growing of late crops, a practice which has been in vogue in various sections of the South for a number of years. When second-crop potatoes are not grown it becomes necessary to obtain seed from northern sources. The general opinion of the Southern potato grower is that planting second-crop potatoes grown at home is more profitable than planting northern-grown seed. Experiments with second-crop potatoes for seed have been made at several experiment stations and some promising results have been reported, but work in this line has not as yet been followed very extensively and open questions still remain.

The Arkansas Station has recently published the results of experiments with northern-grown seed and second-crop seed which have been in progress for three years. Northern-grown and second-crop seed were planted in the spring of 1894 to compare the respective yields.

The second-crop seed had been grown by the station the preceding fall. Bliss Triumph and Early Rose, which are very popular varieties in the State, were grown in this test. The results were in favor of the crop from the northern-grown seed, which matured several days earlier and produced an average of 20 bushels per acre more of merchantable potatoes than the second-crop seed. Of the total yield of tubers from the northern-grown seed 12.6 per cent were culls, while of the total yield from the second-crop seed the culls amounted to 23.5 per cent.

In 1895 four varieties were used in the test, and with but one exception the northern-grown seed produced the larger yield and the larger percentage of merchantable potatoes. The second-crop seed had been grown by the station and only the best tubers from the best vines were used.

In the third year's trials seven varieties were grown. A dry and hot spring hastened the maturity of the crop, and although not so marked as in the two preceding years, the results in general were the same.

The average results for the three years show that potatoes from northern-grown seed produced better yields and matured earlier than potatoes grown from second-crop seed. In general second-crop seed was slow and irregular in sprouting and produced vines inferior in vigor and in appearance. No difference was detected in the keeping and cooking qualities of the tubers of the two crops. The average of the average results of each year for the entire series of experiments is given in the following table:

Second-crop seed compared with northern-grown seed—Average of three years.

	Yield of merchantable potatoes per acre.	Yield of culls per acre.	Total yield per acre.	Time from planting to maturity.
	Bushels.	*Bushels.*	*Bushels.*	*Days.*
Northern-grown seed	94.91	11.19	106.10	108.54
Second-crop seed	81.29	16.04	97.34	111.67
Difference	13.62	4.85	8.76	3.13

A comparison of large and small second-crop seed planted as whole or cut tubers resulted in a better total yield and a larger percentage of merchantable crop from the large seed.

Experiments with second-crop potatoes have been carried on at the North Carolina Station for several years and the methods of culture recommended by this station are here briefly summarized. When the tubers of the second crop are to be used for seed the seed tubers are taken from the crop which was planted in the spring and matured early in the summer. The tubers when dug should be perfectly ripe and should then be exposed to the light until they have become greenish in color and spread out on the ground in a single layer well covered with pine straw or leaves. The covering should be kept moist continually and the tubers remain bedded in this way until they begin to sprout. It was found that cutting small pieces from each tuber when bedding them tends to shorten the time required for sprouting and when treated in this way the tubers are planted without any further cutting. Planting seed pieces as practiced in spring did not prove reliable with summer planting at this station, as the stand obtained was frequently unsatisfactory. By planting only those tubers which show signs of sprouting when taken from the bed a good stand can be secured. Culls from the early crop sometimes used as seed are considered less reliable than the well-ripened tubers. The time of planting necessarily varies with the latitude. The middle of August is considered a good time for planting in North Carolina. The method of planting and cultivating recommended is essentially the same as the practice known as the rural trench system. The seed tubers are placed at the bottom of deep furrows, covered lightly, and the soil compacted around them. From time to time as the plants grow the soil is worked to them until the furrows are filled. The subsequent cultivation should be perfectly level. The plants remain green until they are cut down by the frost, and the tubers which are then dug are an immature crop and keep better than if mature. It is advised to keep them in a heap in the open ground, covered with pine straw or earth, or to keep them in a cool dark cellar. The object is to keep them at a temperature of 35° to 40° F. and to admit no light, conditions most favorable for keeping potatoes.

COLD V. WARM WATER FOR PLANTS.

It is the generally accepted opinion of florists and gardeners that watering plants with very cold water is detrimental to growth, but no one has undertaken to state definitely how cold the water may be without producing this result. It is the common opinion, however, that water applied to greenhouse plants should not be much colder than the air immediately about them. In order to ascertain the facts in the case more definitely the Wisconsin Station instituted a series of tests. The plants were grown under glass, except as otherwise noted.

Twelve cuttings of Coleus, as nearly alike in size and vigor as could be obtained, were divided into four lots and planted in sand. They were watered with water at 35°, 50°, 65°, and 86° F. In twelve days all were rooted equally well. They were potted off and the watering continued. There was no noticeable difference in growth and vigor between the various lots until sixty days after the cuttings were taken, when the 86° lot was slightly the highest. This advantage was only temporary, however, for in a few days the 50° and 65° lots slightly exceeded it in height. Ninety days after the cuttings were taken the 35° lot was plainly checked, but the other three were practically equal. This test was repeated with water at 32°, 40°, 70°, and 100°. In this case it was difficult to discover any influence due to the temperature of the water used.

Transplanted tomato plants were divided into four lots and watered with water at 35°, 50°, 65°, and 86°. The 65° lot made the best growth throughout the test, which lasted for thirty days. The 35° lot made the slowest growth, but was in no other respect inferior to the others. This test was repeated with water at 32°, 60°, and 90°. After sixty days the 32° lot was slightly the best. The plants were the tallest, ripened earliest, and the plants and fruit weighed the most. This trial was repeated with plants from seed saved from the fruits of the first crop. Plants from the 32° lot were watered with water at 32°, those from the 60° lot were watered with water at 70°, and those from the 90° with water at 100°.

"In this case the 100° lot yielded the largest amount of fruit and the 32° lot was next in order, while the 70° lot yielded the least; but the difference is so slight that the results may be considered duplicates."

Seed was again saved from this crop, planted, and different lots watered with water at 32°, 40°, 70°, and 100°. Two months from the date of sowing there was no difference between the lots that could be ascribed to the different temperatures of the waters used. "In this case the 32° lot yielded more than the 70° lot, but less than the 100° lot."

A thousand seeds of forcing radish were sown in each of three plats and were watered with water at 32°, 45°, and 70°, respectively. The 32° lot was considerably slower in germinating than the others. In this test the yield of radishes was smallest in average weight in the 32° and largest in the 70° lot, the difference being, however, only 10 to 13 per cent. In a second test, however, there was a noticeable difference. Water at 32° gave decidedly the best results, while 100° gave the poorest.

Beans watered with water at 32°, 40°, 70°, and 100° were equally vigorous. Water at 32° and 40° gave the best results. Lettuce watered with water at 32° yielded slightly more than other lots.

In addition to the above, two trials were made under outdoor conditions. Eighteen half-barrel tubes were sunk in the ground until the tops were level with the surface and filled with soil. All were suitably drained. Nine were watered with ice water; the other nine with hydrant water, which averaged about 75° in temperature. The warm water produced better results than the cold and the difference was much more pronounced in the summer. In the earlier part of the season both lots were equally healthy and vigorous; but later, when the weather had become cooler and the period of most vigorous growth had passed, the plants watered with ice water appeared unhealthy.

Radishes and beans were planted in three plats in the open ground; one plat was watered with ice water, one with hydrant water, and one not watered at all. Those watered with ice water yielded the most and those not watered at all the least, although the rainfall during the season was regarded as nearly or quite sufficient for the development of crops well cared for. The beans showed no difference in yield that could be attributed to the temperature of the water. The yield from the unirrigated plat was in this case also much smaller than either of the others.

In a number of these tests a record was made of the temperature of the soil before watering and at intervals for several hours afterwards. The application of ice water of course immediately lowered the temperature of the soil several degrees. It was found that with plants in pots the original temperature generally was not regained for several hours. The application of water of 40° or above, etc., was found to have no effect of importance, the original temperature being soon regained after a rise or fall.

From the results of these and numerous other trials not here noted the conclusion appears fully warrantable that the growth of ordinary field and garden crops is not affected by the temperature of any water ordinarily available for irrigation purposes.

The temperature of the soil about the roots of the plants so quickly regains its original temperature that no check to growth is likely to result.

It is concluded from the results of the out-door work that no harm can result from using for irrigation purposes water from the coldest springs or wells, for * * * the temperature of the water from these sources will not be less than 40° in any case when taken from the well or spring, and by the means ordinarily employed in irrigation would be raised many degrees above this point before reaching the roots of the plants.

It is concluded from the results of the greenhouse work that for vegetable and flowering plants commonly grown under glass, well or spring water may be freely used at any time of the year without warming.

SOILS AND FERTILIZERS FOR FORCING HEAD LETTUCE.

Within the last few years the forcing of head lettuce has sprung into considerable prominence as an industry. Growers have been generally agreed that the soil mixture was a considerable element in success, but as to what the exact amount and character of the ingredients in this mixture were there was not a little confusion of ideas. In order to obtain more definite information on this subject, the New York State Station undertook a series of tests to ascertain definitely the influence of the texture of the soil on head lettuce. This was the only variety used, and the results obtained very probably do not apply to loose varieties. In all of the tests each soil contained a superabundance of nitrogen, phosphoric acid, and potash, so that for the purposes of this experiment all of the soils might be considered as equal in fertility, and any difference in yield might be attributed to soil texture.

Mixtures of well-rotted clay loam sod and stable manure with various amounts of sand were tried. There was little difference in the yield, but on the mixtures containing 42 per cent of sand the lettuce was a trifle the earliest. On a mixture of five-sixths sand and one-sixth stable manure by weight, the heads were larger, but loose and of poor texture. When the proportion of stable manure was increased to one-third, the lettuce was small, late, and injured by tip burn. Sandy loam with applications of chemical fertilizers alone gave slightly heavier lettuce than clay loam similarly treated, but when it was mixed with one-half its weight of stable manure the clay loam gave much superior lettuce, earliest in maturity and largest in yield of any soil mixture tried. It seems, then, that the soil mixture best adapted for forcing head lettuce is of rather compact texture and contains a good portion of fine sand, clay, and silt, moderately lightened with fairly well rotted horse manure.

A fertilizer experiment was also made to test the relative merits of stable manure with and without phosphoric acid and sulphate of potash, and to ascertain the effect of increasing amounts of nitrate of soda. It was found that after a soil has received a heavy application of stable manure any further addition of chemical fertilizers is only thrown away. Chemical fertilizers gave best results on sandy soils, fairly well-rotted stable manure on clay soils. Evidently the reason for this difference lies in the texture of the mixtures.

THE DATE PALM IN THE UNITED STATES.

The date palm is a native of the arid regions of northern Africa and southwestern Asia. It was early introduced into America by the Spanish. The history and present status of the date palm in the United States has been made a subject of study by the Arizona Station. The following statements are taken mainly from a bulletin of that station. The palm followed the progress of Catholic missions from St. Augustine to Mexico, New Mexico, Arizona, and California, where it is now grown in the open ground as an ornament as far north as San Francisco. The tree will, however, produce fruit only over a much more limited area. It is not yet grown on a commercial scale anywhere within the United States, though occasional seedlings are found in the desert regions of southern New Mexico, Arizona, and southeastern California, which produce fruit of excellent quality.

The greatest impulse was given to date growing in this country by the importation by the Division of Pomology of this Department of rooted suckers supposed to have been taken from female trees known to produce fruit of excellent quality. These were distributed and planted in Las Cruces, N. Mex.; Phœnix and Yuma, Ariz.; Indio, Pomona, Tulare, and National City, Cal. Of the trees thus planted it appears that 39 are now living, of which 15 have blossomed, 7 of them being pistillate or fruit-bearing plants. It may be two or three years before their true fruit qualities can be ascertained.

The regions in which the date palm thrives are characterized by deficiency of rain and wide variations of temperature. The summer heat is intense, reaching 115° or more, though in winter the thermometer may fall as low as 16° below freezing. These climatic conditions are practically identical with those that obtain in the more southerly portions of the great Colorado desert. So great is the similarity in fact that, so far as climate is concerned, we may reasonably expect the date palm to fruit satisfactorily in the arid regions of our Southwest. Although the date palm requires exceptionally intense heat in summer, it will withstand in winter a temperature that would be fatal to the fig or orange.

Probably the soil best adapted to the date palm is one containing a small percentage of clay, fairly free from humus, and charged with alkali. Irrigation and heat are the all-important considerations. Water is indispensable. The roots should be moist at all times. "The date must have its head in the fire and its roots in the water" is an old Arabian proverb. The water should be applied frequently throughout the year, the most in the spring before blooming and in the fall prior to ripening of the fruit. Care should be taken not to irrigate too much at the time of blooming and just after, as this is liable to interfere with successful fruit setting. The water may advantageously be quite warm, from 75° to 95°, and contain considerable alkali. In midsummer irrigation should be in the late afternoon or evening to avoid scalding.

Palms may be planted along streams or flooded basins. All desert regions are characterized by occasional depressions where the water comes nearly or quite to the surface. During the rainy season these are filled with water and sometimes do not become entirely dry before another rainy season. The date palm thrives in such spots when once established, although its trunk may be partially submerged for some time. Where irrigation is practiced, however, water should not be allowed to rise above the surface of the soil for any considerable length of time, and later to be allowed to dry away, as baking of the soil under these conditions may result in serious injury to the tree. From a study of the soil and climatic conditions in northern Africa, where the date palm flourishes, it seems probable that dates may be grown in the region adjacent to the Salton basin west of Yuma.

The date may be propagated from seeds or suckers. The former method is not much used except in originating new varieties, because, like many other fruits, the date does not come true to seed. The fruit is generally later and poorer, and the excessive number of males that spring up can not be distinguished and destroyed until the tree blossoms, hence propagation by suckers is resorted to, although the date is difficult to transplant with uniform success. Frequently as many as 50 per cent of the transplanted dates die after they have received the best of care, and if neglected hardly any will survive. The Arizona Station gives directions for transplanting as follows:

Suckers may be removed at any time during the spring or early summer, or even in the winter if proper care be given them after removal. If they are to be planted in the open ground, it is advisable to remove them during the spring or early summer, April probably being the best month. In winter, when the plants are at a standstill, the suckers may be removed with comparatively small loss, if the bulbs be not less than 4 inches in diameter and have a few roots. It is necessary, when suckers are removed at this season, to set them in rather small pots, so that the earth, which should be given a daily soaking, may have a chance to get warm quickly. The pots should be kept in a greenhouse, or, better yet, embedded in a hotbed of manure, covered with the customary frame and glass. In all cases the leaves should be cut back to 6 to 12 inches in length. * * *

If proper attention can be given it is best to plant the suckers where they are to remain, as a second chance for loss occurs when they are planted in a nursery and later moved to the position that they are finally to occupy.

A two-inch chisel well sharpened, and an appropriate mallet, are the important tools to use in removing suckers. The leaf stalks should be cut away, exposing the bulb of the sucker, care being taken not to injure the bulb in removing. One should cut in rather deeply at either side, not being afraid of injuring the old plant, cutting out a V-shaped portion extending from the base of the bulb downward for a foot or more and being careful to secure in uninjured condition all the attached roots. If the position of the sucker be not too high above the ground, the V-shaped portion should be continued downward into the soil, that all established roots be obtained. The Pomona substation in California has the best success in removing suckers by banking earth about the stem of the plant so as to cover the bulbs a number of weeks prior to removing them. A good system of roots is established by this method of procedure.

The male and female flowers of the palm are borne on separate plants. In the male plant the flowers are crowded closely together on a large branched panicle and have an odor like musty flour. If the panicle is shaken when the flowers are well opened quantities of pollen will escape, filling the air as if with dust. The flowers in the female panicle are much farther apart; the segments are smaller and less spreading. The center of the flower is well filled by three pistils, two of which soon become abortive.

It is evident, then, that male and female trees should be planted near each other. It is quite common to set one male plant in the center of an irregular circle of six or eight females. If the trees are planted in a row along a roadside the male trees should be planted to the windward. The wind may be depended upon as a rule to effect pollination if the staminate is not more than 6 or 7 rods from the pistillate flowers. At greater distances pollination may be effected, though with doubtful certainty of completeness, by both wind and bees.

The palm is peculiar in that the pollen retains its fertility for a long time. It may be transported to great distances and artificially applied to the female blossom with success. Pollen should not be dusted on the flower too profusely, as overpollination is said to weaken the developing dates and cause them to drop from the tree. When artificial pollination is necessary the male blossom is cut from the tree as soon as the cracking of the spathe shows that it is about to open. The panicle may then be cut into pieces and a piece tied near the opening of each female panicle.

The date palm, whether male or female, varies greatly as to time of blooming. It always blooms late, however, thus escaping injury from late spring frosts. In Arizona the blossoming period begins about April 15 and continues six weeks or more. In planting male trees suckers should be selected from those that blossom earliest and most profusely and continue in bloom from three to five weeks.

The varieties of dates are almost innumerable. They vary greatly in size, color, sweetness, delicacy of flavor, and length of time required to mature. The dates of commerce are usually light colored, these being of firmer texture, and are hence preferable for shipping purposes.

The average yield of a tree is eight bunches, each weighing about 17½ pounds, though they may weigh as much as 44 pounds. In Arizona seedling trees seven years of age have produced upwards of 200 pounds in a single season. Young trees blossoming the first or second time should not be allowed to bear more than four or five bunches.

Among the various enemies of the date, birds and bees do much injury by feeding on the ripe fruit. Cheese cloth sacks loosely inclosing the bunches on the tree afford the best protection. The expense should not exceed 10 cents per tree. Grasshoppers do much damage by feeding on the foliage. The most serious pest that the date has in this country is a scale insect that was imported on palms several years ago. The insect is small, but conspicuous against the dark green leaves, both sides of which are infested. The Arizona Station has not yet discovered any means of eradicating the pest. Applications of whale-oil soap washes and fumigation with hydrocyanic-acid gas have been only partially successful.

RECENT STUDIES ON THE CODLING MOTH.

It is doubtful if there is any more serious pest of fruit culture in the United States than the codling moth. It has been estimated that from one-fourth to one-half of the annual apple crop is destroyed by this pest, or more than by all other insects combined. The codling moth, indeed, is so destructive that the New Mexico Station has discussed the advisability of destroying a year's fruit crop in that State with the idea of exterminating the insect. Its principal food is apples, though it commonly attacks pears, often feeds upon wild haws and quinces, and sometimes works on such stone fruits as plums, peaches, and cherries.

Frequent failure to obtain good results in treating the codling moth according to the long accepted rules has led a few stations to thoroughly investigate its life history. Recent investigations of the Cornell and Nebraska Stations on this subject are of special interest. The results obtained are much at variance with statements commonly found in entomological and horticultural writings.

The Nebraska Station states as a result of its investigations that—

The commonly accepted plan of fighting the codling moth has been to spray the trees with arsenites, either Paris green or London purple, as soon as the blossoms have fallen, and repeat the operation once or twice thereafter at intervals of ten days or two weeks. The efficacy of this treatment, in many cases, has been proved beyond a doubt, yet its inefficacy has been equally well proved in other cases. The assumption has been that the moth begins its work at blossoming time, and that by spraying immediately afterwards we may catch the young larvæ at the time they begin to work. * * * But another factor enters into the problem. When the blossoms fall, the calyx cup is wide open, but soon after begins to close. Since the young larvæ so often begin their work within this cup, it is important that we have a dose of poison there prepared for them. It can only be put there while the cup is still open. Therefore, to do this we must spray soon after the blossoms fall, as directed. But the efficacy of this spraying plainly depends upon getting the poison in this position, having the cup close over it, and hold it there until the larva comes. Therefore, the nearer to the time at which the cup closes that the spraying can be done, and still get the poison inside, the better, for the less danger there is of its being washed away.

In discussing remedies for the codling moth, the Cornell Station bulletin makes the following statement:

No panacea for the codling moth has yet been found, but by thorough work by a Paris green spray we can often save at least 75 per cent of the apples that would otherwise be ruined by the worms. Where more than two broods of the insect occur during the season, as in Kansas, Nebraska, Oregon, New Mexico, and neighboring localities in the West, and in the South, the poison spray is not so effective, for although 75 per cent of the first brood of worms may be killed with the spray, the few worms left will form a sufficient nucleus for a large and very destructive second or third brood. In these localities the best that can be advised at present is to supplement the poison spray with the old banding system.

The Nebraska Station suggests the following treatment for the codling moth under the conditions prevailing in Nebraska:

(1) Spray with Paris green, as generally recommended, about one week after the blossoms fall, or in time to get the calyx cups well filled with the poison, so that they may close over and hold it there.

(2) Spray again with Paris green and Bordeaux mixture combined, or with kerosene emulsion, about June 1, or, better still, observe carefully and apply this when the eggs are being laid in abundance on the leaves, which at Lincoln occurs at about this date. Laboratory experiments indicate that kerosene emulsion will be more effective than Paris green at this time.

(3) Scrape the bark and place paper bands around the tree about the last of June, when the larvæ are beginning to leave the apple to pupate. Examine these two or three times, a week apart, and destroy the insects found beneath them.

(4) If these methods are not wholly effective, owing to the proximity of neglected orchards or from an unusual abundance of moths, later spraying, with either Paris green and Bordeaux mixture or kerosene emulsion, may do some good, but apparently can not be expected to be wholly effective. Late spraying with arsenites is much more likely to injure the foliage than earlier applications, and if the other methods are thoroughly followed it will probably be unnecessary.

(5) If larvæ are still found in the apples in any considerable numbers toward the end of the season, place paper bands about the tree about September 1 or a little earlier. Leave them there until the fruit is gathered from the orchard, then remove and destroy the larvæ hibernating beneath them.

(6) Screens placed over the windows and doors of the cellar or rooms where apples have been stored will prevent those larvæ which are taken in with the apples from escaping as moths in the spring.

JERUSALEM ARTICHOKES FOR PIGS.

Much has been written on the subject of the food value[1] of artichokes, but very few careful experiments have been made to determine just what proportion of rations for farm animals can be profitably made up

[1] U. S. Dept. Agr., Farmers' Bul. 73 (Expt. Sta. Work—IV, p. 10).

of these tubers. To throw light on this point, the Oregon Station fed six thrifty Berkshire pigs—which had been running on wheat stubble and which weighed from 117 to 215 pounds at the beginning of the experiment—from October 22 to December 11 on artichokes, supplemented by a small ration of equal parts of chopped wheat and oats.

An effort was made at the outset to compel the pigs to subsist on a diet of artichokes alone; but in the absence of grain there was very little gain, and the pigs were not contented. They were vigorous in their demands for something more substantial.

The artichokes were grown near the pens, so that the pigs could have access to them whenever they desired. The tubers were left in the ground for the pigs to root out as they were needed.

A portion of the plat was measured and the artichokes dug to determine the yield, which was found to be 740 bushels per acre.

During the experiment the six pigs consumed the artichokes grown on one-eighth acre and made a total gain in live weight of 244 pounds, or an average daily gain per pig of 0.81 pound. The pigs consumed during the period 756 pounds of grain, or at the rate of 3.1 pounds of grain for each pound of gain in live weight. In other experiments it has been found that it requires about 5 pounds mixed grain for each pound of gain in live weight. On this basis the feeding of the artichokes resulted in a saving of nearly 2 pounds of grain for each pound of gain in live weight. The pigs were healthy and vigorous throughout the experiment.

The artichokes used in this experiment "were planted the last of April, on ground plowed deeply and prepared as we would prepare ground for potatoes. The tubers were planted in furrows, which were 3 feet apart. The seed was dropped 18 inches apart in the row and covered with a hoe. The plants were cultivated a few times, but after the tops were 2 feet high no further cultivation was necessary. The tops grew 7 feet high before the end of the season." The pigs left only a few tubers in the ground.

SUPPLEMENTS TO SKIM MILK IN FATTENING CALVES.

The Iowa Station has conducted experiments extending over a number of years to learn what feeding stuffs may be profitably combined with skim milk for calves. In two of the tests linseed meal, ground oats, and a mixture of corn meal and flaxseed were compared as supplements to separator skim milk. In the last test reported corn meal was also included. For this test (which covered 74 days) twelve calves were divided into four lots of three each. During the test each lot consumed about 3,760 pounds of separator skim milk and 1,480 pounds of hay. In addition, lot 1 was fed 429 pounds of linseed meal; lot 2, 605 pounds of oatmeal; lot 3, 59 pounds of flaxseed and 538 pounds of corn meal, and lot 4, 601 pounds of corn meal. The lots were kept in well-ventilated sheds with yards connecting. Salt and water were always accessible. The foods consumed, gains made, and cost per pound of gain in the last experiment are shown in the following table:

Summary of results of calf feeding.

	Nutritive ratio of ration.	Total gain.	Average daily gain per head.	Dry matter eaten per pound of gain.	Cost of feed per pound of gain.
		Pounds.	*Pounds.*	*Pounds.*	*Cents.*
Lot 1. Skim milk, hay, with linseed meal	1:3	483	1.63	4.13	2.5
Lot 2. Skim milk, hay, with oatmeal	1:4.1	498	1.68	4.31	2.2
Lot 3. Skim milk, hay, with flaxseed and corn meal	1:4.8	489	1.65	4.32	2.3
Lot 4. Skim milk, hay, with corn meal	1:4.9	509	1.72	4.16	2.0

From these figures it appears that the best and most economical gains were made on corn meal and skim milk. Comparing the results of all the tests made, it is found that "in each of the three experiments conducted by this station linseed meal has given lower and more expensive gains and has been in every way less satisfactory than either oatmeal or corn meal and flaxseed. * * * The results indicate that pure corn meal is superior to pure linseed meal for feeding calves in combination with skim milk."

While the results of these experiments are contrary to prevailing opinion concerning the relative value of these feeds, it is not unnatural or in any way unreasonable that the carbonaceous grains should be more suitable for feeding with skim milk than a highly nitrogenous product like linseed meal.

The conclusion seems warranted that a nitrogenous feed, such as oil meal, is neither necessary nor most profitable to supplement a separator-milk ration for young calves. All of these rations, even when corn and flaxseed were used, were narrower than whole milk, and it is evident that the element lacking in separator milk is not albuminoids, but fat or its equivalent—carbohydrates—in some form palatable and digestible to calves.

In recent experiments made in Holland the effect of increasing the fat in skim milk for calves or of adding starch was tested. Sufficient whole milk was added to skim milk to make the desired amount of fat.

When starch was fed it was cooked to a paste in the skim milk. About 94 per cent of the starch was digested, the coefficient of digestibility being as high as in the case of the adult animal. The addition of starch to the ration diminished the digestibility of protein somewhat. It was, however, on the whole satisfactory, although the author believes that fat is preferable.

A prominent French investigator has recently published the results of a number of years' experience in feeding starch and skim milk to calves, and regards this combination of foods as very satisfactory. He states that a calf weighing on an average 70 pounds at birth should gain about 2 pounds in weight a day, about 6 quarts of milk being required for this by a calf of the above weight. When the calf is eight days old, starch in the proportion of 1.7 ounces to a quart of milk may be substituted for whole milk. No bad results follow the change in feed and the gains made are satisfactory. The starch should be cooked to a smooth paste with half the milk used, then mixed with the remainder and fed warm. The value of this method of feeding from an economical standpoint is discussed at considerable length.

These experiments all indicate that what might be expected on theoretical grounds is found to be the case in practice. It is known that the body requires protein for its growth and maintenance, and in addition fat and carbohydrates for supplying the necessary energy. Whole milk is the normal food of the calf; it contains a sufficient amount of protein. If the fat is removed, the skim milk supplies the same amount of protein as before, but something must be added as a source of energy. It is known that within limits fat and carbohydrates are interchangeable for this purpose. In the experiments cited above carbohydrates (either in form of starch or cereal grains) were successfully combined with skim milk and in this way the animal was supplied with an abundance of protein and energy and made satisfactory gains. When it is possible to supply protein in a by-product such as skim milk, and the supplementary material in an inexpensive form, the profitable feeding of calves is assured.

PASTEURIZATION OF MILK FOR BUTTER MAKING.

The adoption of pure cultures for starters in ripening cream has led to the quite general use in Denmark of pasteurized milk or cream for butter making. This pasteurization deprives the cream or milk of a large part of the bacteria which it always contains so that the bacteria of the pure culture predominate from the first and largely crowd out those in the cream. In this way the effects of the pure culture are more marked and are not partially masked by the growth of other kinds of bacteria. The use of pure cultures in unpasteurized cream has been likened to the selecting of clover seed with great care so as to avoid all foul seed, and then planting it on soil that has not been previously prepared in any way, in which case it could hardly be expected that the clover would come up clean and remain free from weeds. Similarly, the dairyman, who in using pure cultures is simply carrying on bacterial farming, can hardly expect to reap the full advantage of the pure cultures without first destroying the growing bacteria that exist in the milk and cream.

Although the use of pure cultures has become quite extensive, the practice of pasteurizing, which has practically displaced the old systems in Denmark, has found little if any application in commercial creameries in this country. An extended test of the method, recently reported by the Wisconsin Experiment Station, throws much light upon its practicability and advantages, and the class of creameries which may be expected to benefit by it. Experiments on a commercial scale were made at the creamery of the Wisconsin Dairy School, extending from February to August, thus covering winter, spring, and summer conditions. In these experiments a part of the milk was creamed with a separator in the ordinary way, and another part was pasteurized before creaming by running it through a continuous pasteurizing apparatus which heated it to about 155° F. This pasteurization killed about 94 per cent of the living germs in the milk. The pasteurized and unpasteurized cream was made into butter by a uniform method, using a pure culture starter for ripening the cream, and the product was scored by an expert in Chicago when fresh (from one to two weeks old) and several weeks later, after it had been stored in a butter cellar. The average flavor score (on the basis of 45 as perfect flavor) of 102 churnings of fresh unsterilized butter was 40.69, and of 75 of pasteurized butter was 40.63, practically the same. A slightly larger proportion of the unpasteurized than the pasteurized butter scored 42 points or more. In regard to the flavor the authors of the bulletin say:

> The difference in the fresh scores is so slight that it is impossible from these scores to conclude that one system produces higher flavor than the other. The scorer, however, claimed to be able to detect the pasteurized butter by its "sweet," "curdy," "flat" taste, but did not materially reduce his score on this account. This conclusion is of material consequence, as it is usually claimed that as high a flavor can not be secured in pasteurized butter as in that made in the ordinary way.
>
> Dividing the work into monthly periods (February–August), it can not be said that pasteurizing affects the quality of the butter more at one period than another.

The grain or body of the butter from pasteurized milk was scored considerably lower than that made from unpasteurized milk. In other words, the pasteurizing process appears to injure the grain or body of the butter, according to American standards, although it is suggested that there might not have been this difference if the butter had been scored in markets where pasteurized butter was common.

The pasteurized butter kept better than that from unpasteurized milk. On the average, thirty-nine packages of unpasteurized butter deteriorated 1.2 points in flavor by keeping in a butter cellar for two to four weeks, while thirty samples of the pasteurized butter lost only 0.85 of a point under the same treatment. On this point the butter expert in Chicago says: "Usually I have not been much in favor of pasteurizing cream, but the test that I have just made of these 8-pound pails that were held in storage shows to me that the pasteurizing appears to help hold the sweetness for two or three weeks probably better than unpasteurized butter."

The yield of butter from pasteurized milk was, on the average, a little less than that from unpasteurized milk. The heat applied in pasteurizing was in no way unfavorable to the separation of cream, but in hot weather the buttermilk from the pasteurized cream contained somewhat more butter fat. This was thought to be due to the fact that the pasteurized cream was not as thoroughly cooled, owing to the higher temperature to which it had been heated, for at other seasons there was not much difference in the amount of fat left in the buttermilk.

As to the uniformity of the product, there was only a slight difference in favor of the pasteurized butter, as both kinds of butter were quite uniform in quality. It should be remembered in this connection that the butter was made in the dairy school creamery, under the direction of experts, and under the most favorable conditions for making a uniform product by the ordinary methods. The normal product of this creamery is very uniform, and quite likely greater differences in the uniformity and in the keeping quality of the pasteurized product would have been apparent in the average creamery.

Considering the extra labor and expense involved in the process, and the present demands of the American market, the station does not recommend its introduction into creameries that already make a good product. It is believed, however, that in creameries where difficulty is experienced in making a thoroughly first-class product of uniform quality it would be a material advantage.

"If the demand for export butter should ever reach any considerable proportions, the employment of this system might be of value, since the present standards demanded by the foreign market are as easily obtainable, or even more so, by the pasteurizing system as any other. Then, again, it should be remembered the methods used in this system have by no means reached their highest state of perfection, and that further study may give us better results."

GASSY AND TAINTED CURDS.

The progress of investigation on the relation of bacteria and other micro-organisms to cheese making has shown in a striking way to how great an extent the production of inferior cheese is due to the failure of the cheese maker to prevent or control the action of undesirable bacteria. A common trouble is the presence of disagreeable taints which develop in the milk and curd during cheese making. These are usually, though not always, accompanied by the formation of gas, which results in a gassy curd. Several of our stations have investigated the cause of these troubles, notably the Wisconsin Station, and a recent investigation at the New York Cornell Station was undertaken to determine the source of the infection.

A cheese factory in which the difficulty occurred received milk from a dairy in which there had been considerable trouble from cows retaining the placenta or afterbirth. This was popularly believed to be the source of the taints in the milk and the gassy curd. An investigation of the milk and curd showed that both the taint and the gas were caused by a species of gas-producing bacteria. In proof of this, cheese was made from sterilized milk, to which a culture of this bacillus was added, with the result that the taint and the gassy curd developed. When the milk of the cows which had suffered from retained placenta was rejected the taint and gassy curd continued to develop, and on examining the milk of each of the cows in the dairy it was found that the bacteria producing the gas and taint were present more or less constantly in the milk of all the animals. An examination of the water used in cleaning the utensils and of the dust and filth of the stable failed to establish these as sources of the bacteria. After the stable was thoroughly cleaned and disinfected the trouble continued. This suggested that the germs got into the milk through the teat rather than from the particles of dust which fell into the milking utensils. It is known that bacteria are able to work their way up into the opening of the teat and there continue their growth, being partly washed out during milking, enough being left to continue the growth. In this way the freshly drawn milk continues to be inoculated with the germs, and under these conditions it is impossible to obtain germ-free milk even when every possible precaution is observed. That this theory regarding the source of the bacteria in this case is correct is strengthened by the results of examinations which were made of the teats and udders of a number of cows slaughtered on account of tuberculosis. The cows were milked before they were slaughtered, and immediately after slaughtering the udders were dissected and bacteria cultures made from the milk found in them and from the tissue. The same organisms were found in the milk and in the milk cistern and udders of the cows, showing that the bacteria remained in the udders after milking, ready to infect the next succeeding milking.

When the source of infection is located in the passage of the teats or the udder, the difficulty of removing it is much greater than when it is due to some external infection; but in the case cited the observation of unusual cleanliness in the stable, and the constant cleaning of the udders and teats was rewarded by the gradual disappearance of the taint. The constant cleaning prevented reinfection, so that when the teats happened to be cleared of the organism they were not again infected with it.

One of the chief lessons from work of this sort is the necessity of cleanliness in the stable and in the care of the cows, and prompt attention to any taint which may appear in the milk. A taint is like a contagious disease. It starts from some point, possibly a single cow, and spreads rapidly or is communicated to the milk of the other cows by mixing the milk. Like contagion, it is much more easily controlled and suppressed in the earlier stages, before it has become widespread; later, not only the cows themselves, but the stable, dairy utensils, clothes of the milker, etc., become charged with the germs causing it and are sources of the infection until they are disinfected.

PURE CULTURES OF BACTERIA FOR CHEESE MAKING.

The use of pure cultures of bacteria for ripening the cream in butter making has become very familiar within the past few years, and has been adopted in creameries to some considerable extent. But the use of pure cultures in cheese making has more of the element of novelty in it. Two or three years ago the Wisconsin Experiment Station made some experiments with a pure culture of the bacteria causing the souring of milk, which is believed to be a potent factor in the ripening of cheese. In the opinion of a disinterested party who scored the cheeses, the use of the pure culture improved not only the flavor of the cheese, but its texture as well. In addition to this, the cheeses made with the pure culture were more uniform in quality than cheeses made at the same time without any starter, there being less variation in flavor and texture of different cheeses made on the same day.

Recently, experiments in Scotland have been reported in which pure cultures were used on a commercial scale. The cultures, like those used at the Wisconsin Station, consisted of a form of lactic-acid bacteria, which subsequent investigation showed to be very prevalent in sour milk, whey, and cheese of fine quality, and very similar to the pure cultures used for butter making. The pure cultures were tested quite extensively at one factory during the summer, and were also tried by thirty-two different cheese makers. More than 100 tons of cheese was made with their use. The qualities of the cheese were good, and there was an absence of "the undesirable fodder taste common to spring cheese." A number of the cheese makers who tested the cultures continued to use them all summer and requested that they be supplied with them the following season. In several cases cheese made with the pure cultures took prizes at exhibitions. One noticeable result from their use was greater uniformity in the product.

Trials of pure cultures in two dairies for the purpose of preventing discoloration of the cheese resulted favorably, "and in a third dairy discoloration ceased as soon as the culture was used."

The author considers that the experiments have shown the use of pure cultures in cheese making to be both successful and practical, and believes that there is every probability that the system may be used with great advantage where there is danger of discoloration, difficulty in getting a firm curd, where a starter of some kind is necessary owing to the conditions for keeping milk being imperfect, where there is trouble from tainted milk or tainted curd, for the production of cheese in spring and autumn, and for securing greater uniformity in quality.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FERTILIZERS.

Complete fertilizer is one which contains the three essential fertilizing constituents, i. e., nitrogen, phosphoric acid, and potash.

Nitrogen exists in fertilizers in three distinct forms, viz, as organic matter, as ammonia, and as nitrates. It is the most expensive fertilizing ingredient.

Organic nitrogen is nitrogen in combination with other elements either as vegetable or animal matter. The more valuable sources are dried blood, dried meat, tankage, dried fish, and cotton-seed meal.

Ammonia is a compound of nitrogen more readily available to plants than organic nitrogen. The most common form is sulphate of ammonia, or ammonium sulphate. It is one of the first products that results from the decay of vegetable or animal substances.

Nitrates furnish the most readily available forms of nitrogen. The most common are nitrate of soda and nitrate of potash (saltpeter).

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag. Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble phosphoric acid.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water and are believed to be nearly, if not quite, equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvinit, muriate of potash, sulphate of soda, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all foods and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain to 80 pounds in silage and 90 pounds in some roots.

Dry matter is the portion remaining after removing or excluding the water.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorin, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc., and is one of the most important constituents of feeding stuffs.

Gluten is the name given to one of the most important of the nitrogenous substances classed together under the general term "protein." "Wheat gum," obtained by carefully chewing wheat, is a familiar example. It is the gluten of flour that gives consistency to dough.

Carbohydrates.—The nitrogen-free extract and fiber are often classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, besides real fats, wax, the green coloring matter of plants, etc. The fat of food is either stored up in the body as fat or burned to furnish heat and energy.

MISCELLANEOUS TERMS.

Alkali soils.—Soils found in arid or semiarid regions, which contain an unusual amount of soluble mineral salts (alkali), which effloresce or bloom out in the form of a white powder or crust in dry weather following rains or irrigation. Two distinct classes of alkali are known: White akali, composed largely of sulphate of soda and common salt, which is comparatively harmless; and black alkali, composed largely of carbonate of soda, which is highly corrosive and destructive to vegetation.

Humus is the name applied to the partially decomposed organic (animal and vegetable) matter of the soil. It is the principal source of nitrogen in the soil.

Micro-organism, or **microscopic organism**, is a plant or animal too small to be seen without the aid of a compound microscope.

Bacterium (plural, **Bacteria**) is the name applied in common to a number of different or closely related microscopic organisms, all of which consist of single short cylindrical or elliptical cells or two such cells joined end to end and capable of spontaneous movement. Many kinds of bacteria are harmful and cause diseases and other injurious effects, but many are beneficial. Among the latter are those which give aroma to tobacco and flavor to butter and cheese, and those which enable leguminous plants to use the free nitrogen of the air.

Bacillus (plural, **Bacilli**) is a genus, or kind, of **Bacterium**.

Culture, as here applied to bacteria or other organisms, is the product of their growth under artificial conditions.

Pure culture is a culture containing one kind of organism. Pure cultures of yeast are used in wine making, and pure cultures of bacteria are used in butter and cheese making, and for other purposes, to insure a uniform product.

Sterilized milk or cream, properly speaking, is that in which all the germs have been destroyed (usually by repeated heating to 212° F.—boiling point), but in dairy practice the term is applied to milk or cream which has been heated once to a temperature of about 212° F.

Pasteurized milk or cream is that which has been heated to a temperature (about 155° F.) which does not kill all the bacteria, but only those which are in a vegetating condition and ready to begin their activity at once.

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