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Irrigation in South Dakota

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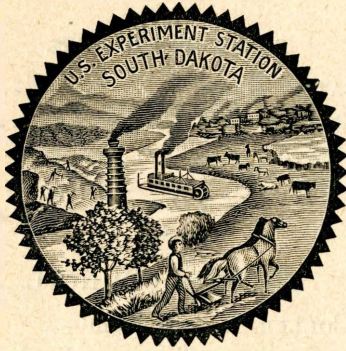
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March, 1897.

Bulletin 52.

U. S.
EXPERIMENT STATION,
SOUTH DAKOTA.



IN CONNECTION WITH THE
SOUTH DAKOTA AGRICULTURAL COLLEGE.

IRRIGATION IN SOUTH DAKOTA.

Departments of Chemistry and Agriculture.

BROOKINGS, SOUTH DAKOTA.

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

Irrigation in South Dakota.

JAMES H. SHEPARD, Chemist. E. C. CHILCOTT, Agriculturist.

The James River Valley in South Dakota is one of the most fertile tracts of prairie land to be found in the Northwest. It comprises the whole central portion of the state lying along the James River, which flows through the state from north to south. This stretch of prairie land is noted for its wealth of native grasses and for its crops of cereals and for its herds of stock. Were it not that at intervals dry seasons occur, this belt would be a veritable Eldorado for the husbandman.

Where so many natural advantages are to be found coupled with such abundant fertility of soil, it is not strange that means should be sought to supply any deficiency of moisture that might occur from time to time and thus to render crop production a matter of inevitable certainty from year to year.

But nature has been lavish in her gifts to this region. This valley is situated in the greatest artesian basin known. Just underneath the thousands of square miles of land comprising this valley lies a sheet of water under such a head of pressure that when pierced by the drill of the engineer, a fountain of water rushes out with such force that it rivals the mechanical possibilities of a huge Corliss engine and with sufficient volume to create and sustain lakes and flowing streams.

Again it is but natural that the consideration of this volume of water in its possibilities for irrigation purposes should become a problem fraught with the deepest interest, not only to the residents of the James River Valley but also to all interested in the development of the resources of a state.

Simple as the problem may appear from the abstract statement of the known factors, nevertheless, the practical application of artesian waters to irrigation purposes in the sub-humid

region in which this valley lies, presents some features which demand a most thorough and scientific investigation.

1st. There is to be considered the expense of artesian well, reservoir, and ditch construction as compared with land values and with the cost of producing farm crops, and herd and dairy products without irrigation.

This consideration is complicated by reason of the fact that year after year no irrigation is required; and it is a question whether the husbandman can not afford better to suffer an occasional loss by drouth than to incur the expense of installing an irrigation plant. Moreover the belief is somewhat general that some phases of farming and of stock husbandry are wholly independent of any artificial water supply, even under the prevalent climatic conditions.

In whatsoever way each individual may solve this problem for himself, certain fundamental propositions must always remain true. As for example, uniformly and continuously remunerative crops, which are always possible under irrigation, must ultimately prove more profitable than a series of crops marked from time to time by partial or total failures. Again, while the one crop system and that system of stock raising which deals only in one line of the industry may succeed in many instances, diversified farming, rendered secure by having stored waters to command in an emergency, is sure in the long run to prove more profitable. It matters not whether the diversification is practiced by individuals or by communities in which each individual pursues a specialty, the sum total being in effect diversification, the final outcome is the same. For example one farmer, availing himself of wide areas of hilly range land bordering the level prairies, may raise large flocks without resorting to irrigation. These flocks he may sell to his neighbor who practicing irrigation on the lower and more level lands has large crops of grain and forage which he has produced by intensive cultivation and which are consumed by the purchased stock. Or again the flock owner may buy the grain and forage from the producer and feed his stock himself. In any case better results must follow. In the case of the individual, he may practice intensive cultivation with irrigation on limited areas, while at the same time larger and outlying tracts may be utilized for the practice of extensive husbandry

without irrigation. In this way all natural advantages are utilized as well as those secured by irrigation. Under this system stock is insured to consume his grain and forage, and grain and forage is insured to finish the stock, thus enabling the farmer to market his entire product in a finished state, rather than as raw material. It would not be difficult to believe that the enhanced gains secured by this system would amply repay the expense of installing an irrigation plant.

2nd. In some portions of the basin wells have failed. In some instances the pipes have clogged, in others they have collapsed and the wells have passed beyond the possibility of further control. It is probable that these failures are fairly attributable to faulty construction; in no case has the water supply been exhausted. In some limited areas of the artesian belt the cap rock which is usually hard and of sufficient strength to withstand the forceful attrition of the rushing water, becomes softer and less coherent. Here the permanency of the well is a mechanical problem. In these areas wells carelessly constructed result in a loss of the capital invested. It is but fair to state, that so far as known, no obstacles have been encountered which may not be overcome by improved methods of construction.

3rd. Some have professed to believe that a continued application of artesian water would result in overloading the soil with soluble salts, detrimental alike to the tilth of the land and to the growth of vegetation. Under the climatic, soil and drainage conditions prevalent, this belief has little foundation, especially if care be used in the application. The natural drainage systems of the valley are promptly acting and efficient. This prevents the rise of the watertable to a height sufficient to enable the soluble salts to reach the surface by upward leaching and to accumulate there in injurious quantities. Moreover, the quantities of irrigation waters needed to supplement the actual rainfall are limited; and during the intervals between applications heavy rains occur, tending to check the surface accumulation of soluble salts. Again the loamy nature of the soil, in which silt performs to a large extent the office of clay, permits the presence of rather large quantities of salines without prejudice to soil or crops. In this connection it might be well to state, that an unnecessarily lavish use of water

would be reprehensible from any point of view. One of the worst features of such a practice would be the leaching out of valuable plant food which has long been accumulating and which would be lost in the increased flow of drainage waters.

Influenced by requests coming from the artesian belt, which includes a large portion of the state, and by a desire to secure some accurate data concerning the problems involved, the Governing Boards of this Station entered into a contract in the spring of 1895 with the Spink County Land and Irrigation Company, who own and operate a large tract of land near Mellette, S. D., and which is known as the "Hunter Farm," to carry on a series of investigations. This farm is equipped with a complete irrigation plant, consisting of a 6-inch well, a 5-acre reservoir, and upwards of five miles of ditches.

By the terms of the contract this Station has no money invested there. It simply paid the salary of a trained irrigator from California during the working season, and supervised the work. The John A. Salzer Seed Company furnished the seed required and gave other material aid in the work. The Irrigation Company furnished the labor and all needed facilities for carrying on the experimentation. But owing to circumstances over which the writers had no control, the work was unfinished and the Station secured no data. Most excellent growths were obtained on the experimental plats installed.

Encouraged thereby, and influenced by the same motives as before, the Boards entered into a similar contract again in the spring of 1896, and placed the writers in charge. Upon completion of the necessary arrangements (in May) work was immediately commenced. The John A. Salzer Seed Company again furnished the seeds and the Jewell Nursery Company furnished fruit and forest trees, shrubs and small fruits.

Thirty-eight $\frac{1}{4}$ -acre plats were installed and sown to various kinds of garden, field and forage crops. The season's work on these plats has been mainly along the line of variety and cultural tests under irrigation.

In addition to these, the larger portion of ten acres was divided into temporary plats of varying size and devoted to a large number of varieties of garden truck. The remaining part of the ten acres continued in the permanent plats established during the preceding year. The tests here were also mainly variety and cultural tests under irrigation.

Detached areas were devoted to orchard, forestry and small fruit plantations.

Of the remaining portions of the farm, about 700 acres were devoted to field crops. In these latter the Station had no interest other than an opportunity which it was expected they would afford for making comparisons between field crops as grown on this farm under irrigation and those grown on land immediately adjoining and to which no water was applied. Two untoward events, however, have precluded the possibility of collecting as exact data as were hoped for. A local hail storm at harvest time seriously injured not only many of the fields of standing grain on the Hunter farm but also those on farms adjoining. Again some of these same fields were rust smitten. Both these destructive agents were very erratic in the damage which they caused, thus making any reliable comparisons very difficult.

The rainfall during the season has been rather above the average. From April to October inclusive, as taken on the plats, 18.05 inches of water fell. This rainfall was distributed as follows: April, 5.30; May, 2.19; June, 3.81; July, 2.85; August, 0.62; September, 0.95; October, 2.33.

In the main the weather was favorable for plant growth. But on the afternoon of July 28th, an erratic and destructive hail and wind-storm occurred which caused much damage both on the Hunter farm and on farms adjoining. On the experimental plats the hail was less destructive, but the wind storm and heavy rain beat down and twisted some of the taller growing forage crops. The field crops adjoining the plats were severely injured, especially the small grains, a part of which was already in the shock.

In the early spring all the plats were in good tilth excepting a low lying portion occupied by plats 21, 22, 23. In these the ground was somewhat lumpy so that although it was possible to obtain a fine catch of clover, in the case of the finer seeds of timothy and hard fescue the soil was not sufficiently fine and moist on the immediate surface to afford a cover suitable for germination.

During May and June and up to about the 10th of July the rainfall afforded all the moisture required. About the latter date the surface soil of the plats became somewhat dry and out

of tith to a depth of about four inches. Below that depth the soil was sufficiently moist and in good condition. The grasses and clovers which had made a very rapid and dense growth up to this time had found an abundance of moisture near the surface and had in consequence developed a shallow root growth. Under the influence of the immense transpiration taking place through the leaves and of the receding water supply these plats began to show the need of surface moisture. The same was true of the onions, which had also made a shallow root development.

Accordingly water was applied to plats 1-20 from July 14th to July 18th, the whole surface being flooded to a depth of from one to two inches. Plats 21-40 were similarly irrigated July 19th to the 25th. Plats 14, 15, 18, 19, 20, 21, 22, 23 were irrigated a second time just previous to the hail storm. After cutting the sand vetch and the sand vetch and oats August 8th, these plats, 34 and 35, were again flooded. In all two inches of water was used. This comprises all the irrigation required by the plats during the season. It is true that during years with less rainfall more water would have been required, but this example will serve to emphasize the fact that the artesian belt requires but a limited quantity of irrigating waters. The plats occupy ground that was used the previous year to raise potatoes under irrigation.

In order to know just what salts the water used in these experiments contains, a sample was taken from the well in the spring of 1895 and analyzed during that season. The water does not flow entirely clear since it carries small quantities of clay amounting to thirty milligrams per litre. The bases and acids are as follows, expressed in grams per litre, or approximately in parts per 1000.

ANALYSIS OF HUNTER WELL.

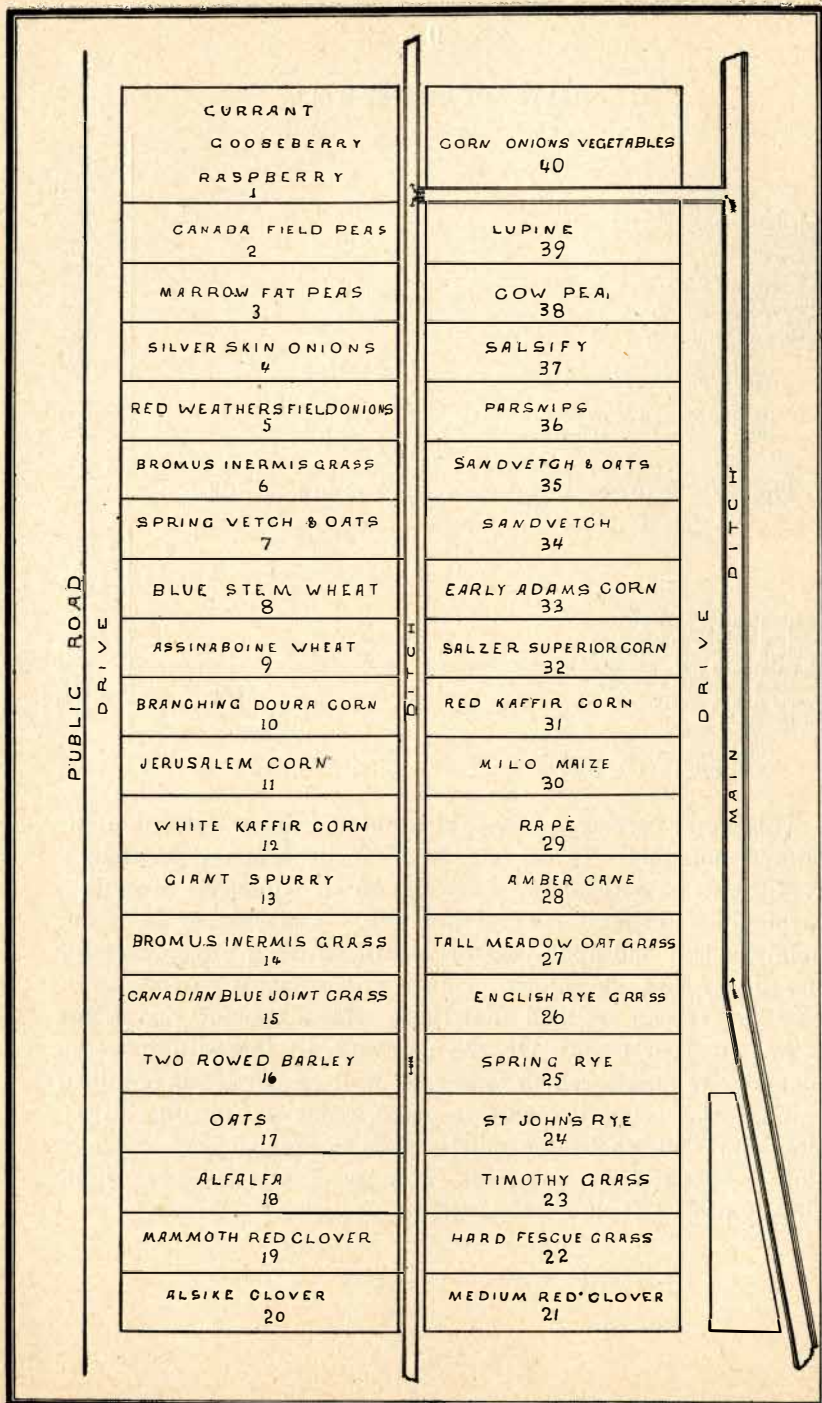
Bases and Acids.	Parts per 1000
Sulphuric anhydride, SO_3.....	.5256
Chlorine, Cl.....	.4653
Lime, CaO}.....	.0110
Magnesia, MgO}.....	.0445
Ferric oxide, Fe_2O_3.....	.0128
Silica, SiO_2.....	.0176
Soda, Na_2O}.....	.9420
Carbon dioxide, CO_2.....	.1475
Total.....	2.1663
Oxygen displaced by chlorine.....	.1050
Total bases and acids.....	2.0613
Total residue by evaporation.....	2.0565

The salts expressed in grams per litre are as follows:

Salts,	Parts per 1000
Sodium chloride, NaCl}.....	.7676
Sodium sulphate, Na_2SO_4.....	.9335
Sodium carbonate, Na_2CO_3.....	.2167
Magnesium carbonate, MgCO_3.....	.0635
Calcium carbonate, CaCO_3.....	.0196
Ferric oxide, Fe_2O_3.....	.0128
Silica, SiO_2.....	.0176
Total.....	2.0613
Total solids by evaporation.....	2.0565

This water carries no free ammonia and but a trace of albuminoid ammonia. It has faint traces of lithium and potassium. It will also be noticed that it carries notable quantities of sodium carbonate and that it is a first flow well. The effect of this water upon the soil and upon vegetation will afford a crucial test for the theory that the saline residues will eventually prove detrimental. It can be said that these effects are not yet visible after four year's use. On the contrary, an inspection of the plates of the plats, which follow, as well as the yields obtained through the use of the water seem to point in the other direction, viz: That the water and its salts are beneficial to vegetation. It is true that on this farm the water has been judiciously used, but there is no excuse for using it otherwise.

PLATE I.



CURRENT GOOSEBERRY RASPBERRY 1
CANADA FIELD PEAS 2
MARROW FAT PEAS 3
SILVER SKIN ONIONS 4
RED WEATHERS FIELD ONIONS 5
BROMUS INERMIS GRASS 6
SPRING VETCH & OATS 7
BLUE STEM WHEAT 8
ASSINABOINE WHEAT 9
BRANCHING DOURA CORN 10
JERUSALEM CORN 11
WHITE KAFFIR CORN 12
GIANT SPURRY 13
BROMUS INERMIS GRASS 14
CANADIAN BLUE JOINT GRASS 15
TWO ROWED BARLEY 16
OATS 17
ALFALFA 18
MAMMOTH RED CLOVER 19
ALSIKE CLOVER 20

CORN ONIONS VEGETABLES 40
LUPINE 39
COW PEAS 38
SALSIFY 37
PARSNIPS 36
SANDVETCH & OATS 35
SANDVETCH 34
EARLY ADAMS CORN 33
SALZER SUPERIOR CORN 32
RED KAFFIR CORN 31
MILCO MAIZE 30
RAPE 29
AMBER CANE 28
TALL MEADOW OAT GRASS 27
ENGLISH RYE GRASS 26
SPRING RYE 25
ST JOHN'S RYE 24
TIMOTHY GRASS 23
HARD FESCUE GRASS 22
MEDIUM RED CLOVER 21

FORAGE PLATS.

PLATWORK, WITH FORAGE CROPS, ETC.*

SMALL FRUITS.—Plat 1, which is a half acre plat, was set to currants, gooseberries and raspberries in the spring of 1896. These fruits all made a vigorous and healthy growth excepting the raspberries. Of these latter, not more than one-third was alive at the end of the season and the survivors were weak and sickly.

PEAS.—Plat 2 (Plate II) was sown in 14-inch drills on May 18th, to Canada field peas. These were cut in the green pea stage, Aug. 4th, yielding 9.6 tons green fodder or 2.16 tons dry hay per acre.

Plat 3 was sown in a similar manner and on the same date to Marrowfat peas. These were picked and sold for green peas at from eighty cents to one dollar per bushel, giving a revenue averaging \$75.00 per acre.

ONIONS.—Plat 4 (Plate II) was planted to Silver Skin onions, May 4th, and Plat 5 to Red Weathersfield onions on the same date. This was a late sowing. The seed was sown in 14-inch drills. Plat 4 yielded at the rate of 200, and Plat 5, 225 bushels per acre.

BROMUS INERMIS.—Plats 6 and 14 were sown to this promising grass. On Plat 6 the seed was sown in 14-inch drills and the ground was cultivated. A heavy stand was obtained which finally completely covered the ground. It set and ripened seeds plentifully. The root leaves formed a heavy growth, the average length being over twelve inches, while the stocks attained a height of twenty-four inches.

On Plat 14 the seed was sown broadcast and a fair stand was secured. Owing to a rapid growth of weeds the plat was mowed with a mowing machine on the 20th of July. This treatment killed the weeds and the grass made a fine aftergrowth, but few seeds were formed. It is undoubtedly true that better results can be had by sowing *Bromus Inermis* with an ordinary grain drill than can be had by broadcasting. The seed is placed in a more advantageous position to germinate, and the underground runners, which the plants send out, soon enable it to cover the ground with a dense growth. This grass lasted until late in the fall and was free from disease. Taking it all

*See Plate I.

PLATE II.



PLAT 4-ONIONS.

PLAT 3-PEAS.

in all, this is one of the most promising of our introduced forage plants. Neither plat was harvested.

SPRING VETCH AND OATS.—Plat 7 was sown to spring vetch and oats on May 7th. The seed was sown in 14-inch drills and the land was cultivated at first. The oats used ripened too early. A later variety would have given better results. The object sought in sowing this combination of seed was to secure a substitute for clover hay suitable for this state. It was hoped that the oats would enable the vetch, which is a low growing plant, to make a more upright growth. This plat was beaten down by the storm so that it harvested but 0.78 tons per acre of dry hay. The spring vetch made no new growth after cutting, but it grows well and is a very promising leguminous forage rich in nitrogen. The principal objection to it is that it is a shy seed bearer in this State, and the seed is expensive. On the Station plats this crop gave 6.125 tons of green forage per acre, or 1.68 tons dry hay.

WHEAT.—Plat 8 was drilled into Blue Stem and Plat 9 into Assinaboine wheat on May 13th. Both made a fine growth at first but were finally destroyed by rust and hail.

BRANCHING DOURA CORN.—Plat 10 was sown May 13th to this variety of the non-saccharine sorghums. The drills were 18 inches apart and a fine stand was obtained. It was cut September 9th, when the grain was partly in the milk and partly glazing. It yielded 15.44 tons green fodder per acre. Mr. Snoxall claimed great difficulty in drying this corn and the other non-saccharine sorghums. Consequently no dry weights were secured. It hardly seems probable, however, that this difficulty should have been experienced with all of them, especially with the Jerusalem corn. At least this difficulty has not been experienced on the Station farm at Brookings.

For several years past much agitation and many discussions through the press have been indulged in, especially by those having seed to sell, concerning the merits of the various sorghums, such as Kaffir corn, Jerusalem corn, etc., as a substitute for Indian corn, both as a grain and forage crop. Extravagant claims have been made for them as drouth resisting plants for this latitude. These claims, however, have received little or no confirmation either on our irrigated or on our home plats without irrigation. Our spring weather is not sufficiently warm to

PLATE III.



PLAT 13—GIANT SPURRY.

PLAT 12—WHITE KAFFIR CORN.

induce the preliminary vigorous growth which is necessary before the hot season sets in. The Indian corns, so far, have shown themselves preferable. It was expected that, under irrigation, these sorghums would show their superiority over Indian corn, if they had any, but the results obtained give no such indications.

JERUSALEM CORN.—Plat 11 was sown May 11th to this corn. The drills were 18 inches and a fair stand was obtained. While the general appearance of this plat would have indicated a heavy yield of forage, owing to the light, spongy nature of the stalk the yield was light, only furnishing 8.22 tons of green fodder per acre. This plat was cut when the grain was in the milk, on September 8th.

WHITE KAFFIR CORN (Plate III) was sown in 18-inch drills, May 12th, on Plat 12. A good stand was obtained and a vigorous growth was made. It was cut September 4th, when the grain was in the milk, and gave 18.12 tons green fodder per acre.

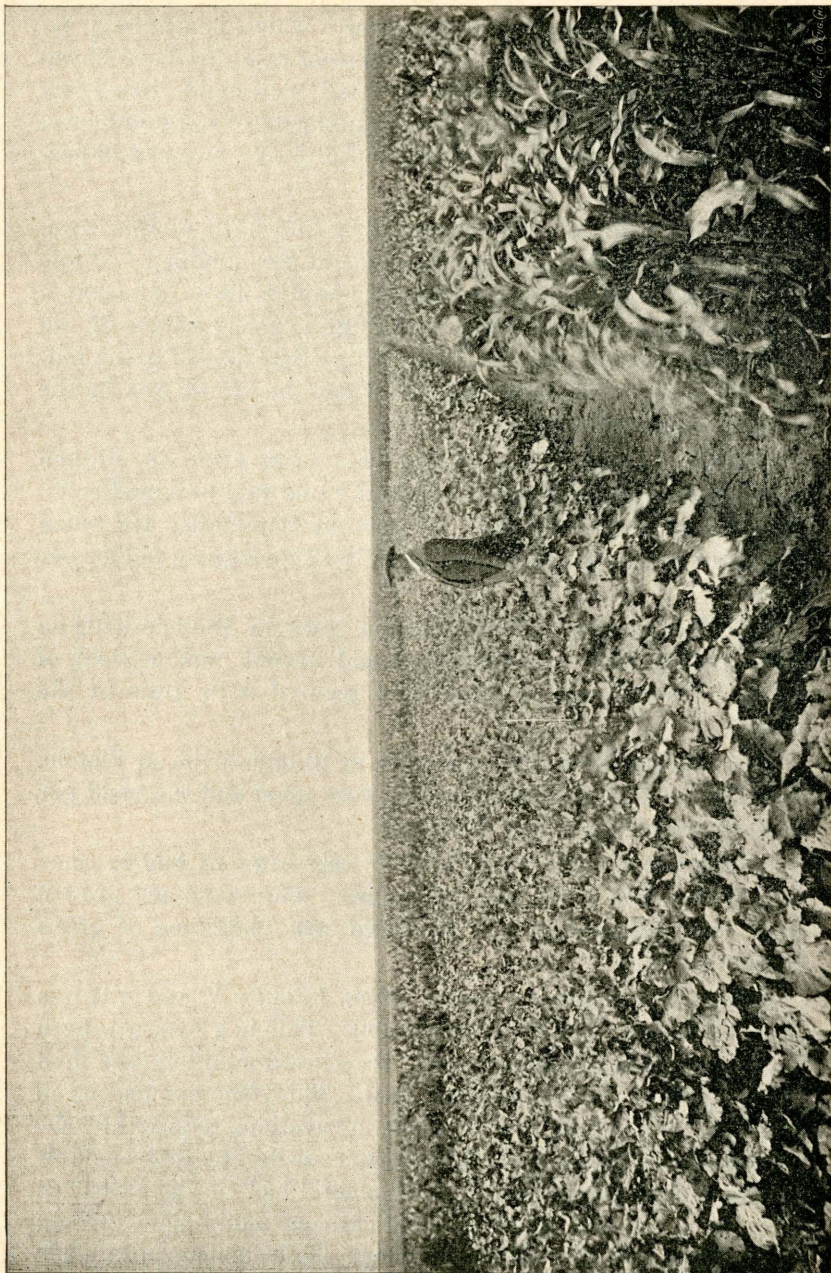
RED KAFFIR CORN (Plate V) was sown in 18-inch drills on Plat 31, May 11th. A good stand and growth, and a yield of 18 tons green forage per acre were secured with grain in the milk.

MILO MAIZE (Plate IV) was sown in 18-inch drills on Plat 30, May 11th. The stand and growth were good and the yield per acre of green forage was 13.44 tons.

AMBER CANE.—Plat 28 (Plate IV) was sown to Amber cane, May 18th. The drills were 24 inches. The stand and growth were both satisfactory and the yield was 14.24 tons of green fodder per acre.

SALZER'S SUPERIOR FODDER CORN (Plates V and VI) was sown broadcast, May 11th, on Plat 32. This is a large southern variety of ensilage Indian corn. It received no other care than the irrigations previously mentioned. This fact stands out in startling contrast to the frequent cultivations required by the sorghums just described. These latter, owing to their narrow leaves and slow growth and their general lack of vigor early in the season, require nearly as much care as onion plats to keep the weeds subdued until midsummer. This ensilage corn made a magnificent growth and yielded 25.6 tons of green or 9.2 tons

PLATE IV.



PLAT 28—AMBER CANE.

PLAT 30—MILO MAIZE.

PLAT 29—VICTORIA RAPE.

dry fodder per acre. Many ears which had reached the milk stage, had set at the time of cutting, August 1st, especially on the outer stalks. This plat was cut early, owing to the fact that the storm had twisted and bent the tender stalks.

EARLY ADAMS FODDER CORN (Plate VI) was sown on Plat 33 in 18-inch drills, May 10th. This is a smaller variety of ensilage corn, somewhat resembling the dent corn raised throughout the state. The stand and yield were very satisfactory, affording 17.28 tons of green, or 9.6 tons dry fodder per acre. Many ears were set and in the milk stage at the time of cutting, August 10th. The yields and general results obtained from the two preceding plats of Indian corn leave little to be desired.

GIANT SPURREY (Plate III) was sown in 16-inch drills May 12th, on Plat 13. This forage made a thick, short growth, yielding 1.2 tons green or .5 tons dry fodder per acre. The storm beat this plat down so that it was impossible to secure nearly all the forage produced. But it made a fine aftergrowth after cutting on August 2nd. Giant Spurrey is not intended for a hay crop but rather for pasturage, since it grows up continually until it freezes. It seeds plentifully and may be worth a trial on dry and sandy land. Stock eats it readily both in a green state and after it has been killed by frost. It is also used as a green manure for plowing under.

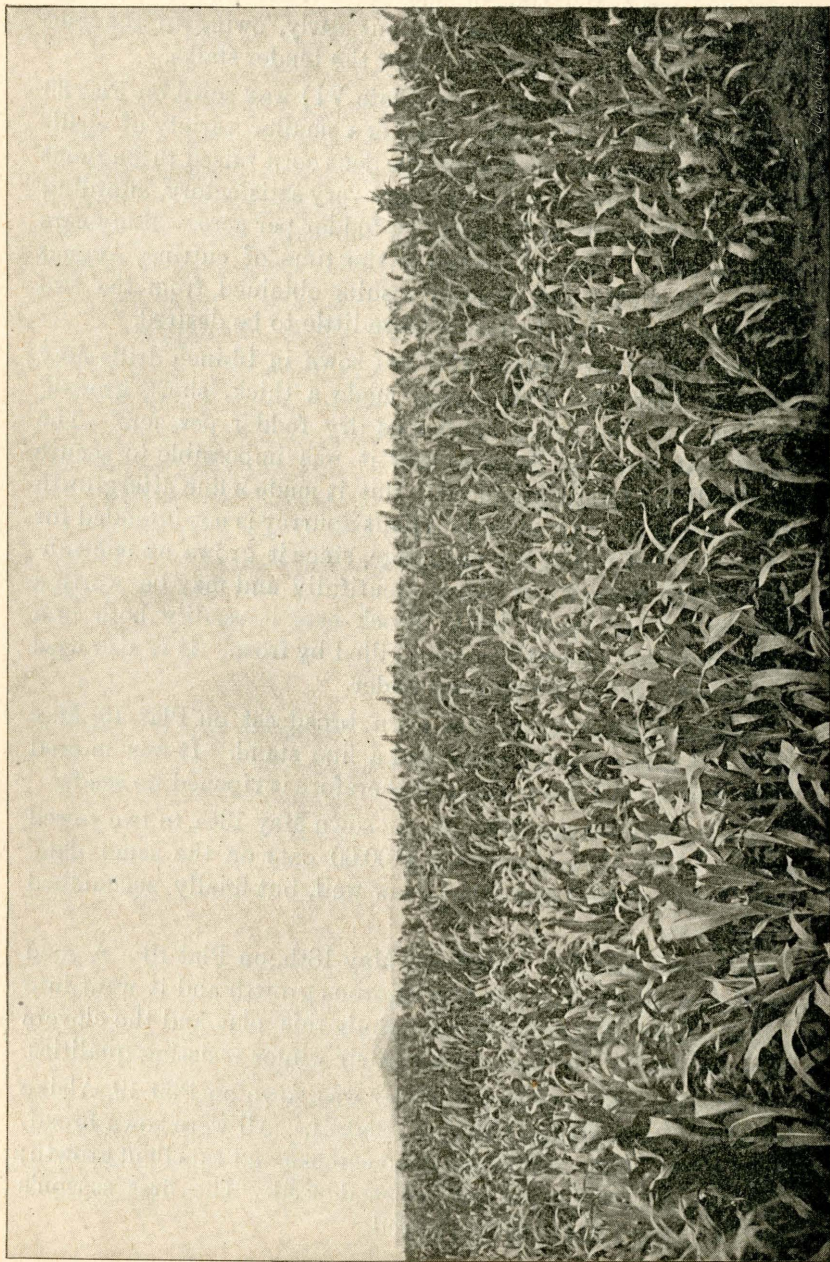
CANADIAN BLUE JOINT was sown broadcast on Plat 15, May 15th. It made a good catch and a fine stand. It was mowed July 20th, to kill the weeds and therefore it ripened no seeds.

BARLEY AND OATS.—Plat 16 was sown May 13th, to two-rowed barley. Plat 17 was sown to \$100.00 oats on the same date. Both made a good stand and grew well, but finally succumbed to the rust.

ALFALFA was sown broadcast, May 18th, on Plat 18. A good catch was obtained, it made a vigorous growth and it went into winter in excellent condition. Both this plat and the clovers will require further time to test their winter resisting qualities.

CLOVERS.—Mammoth red clover was sown on Plat 19, Alsike on Plat 20 and Medium Red on Plat 21. All were sown broadcast on May 18th. All made good catches and excellent growth; and they all blossomed and ripened seed. The first season's results leave nothing to be desired.

PLATE V.



PLAT 32—SALZER'S SUPERIOR FODDER CORN.

PLAT 31—RED KAFFIR CORN.

An interesting experiment in soil inoculation with clover bacteria was made on Plat 19. A quantity of soil was brought from an eastern clover field and sown upon the middle half of this plat. The theory has been advanced by some that the reason of the poor success of the clovers in many parts of the state is due to the absence of the specific bacteria necessary to clovers. No results were visible in this season's growth. But next season will show if any benefit is to be derived.

HARD FESCUE was sown on Plat 22, and TIMOTHY on Plat 23. For reasons stated elsewhere these plats were failures and have been plowed up.

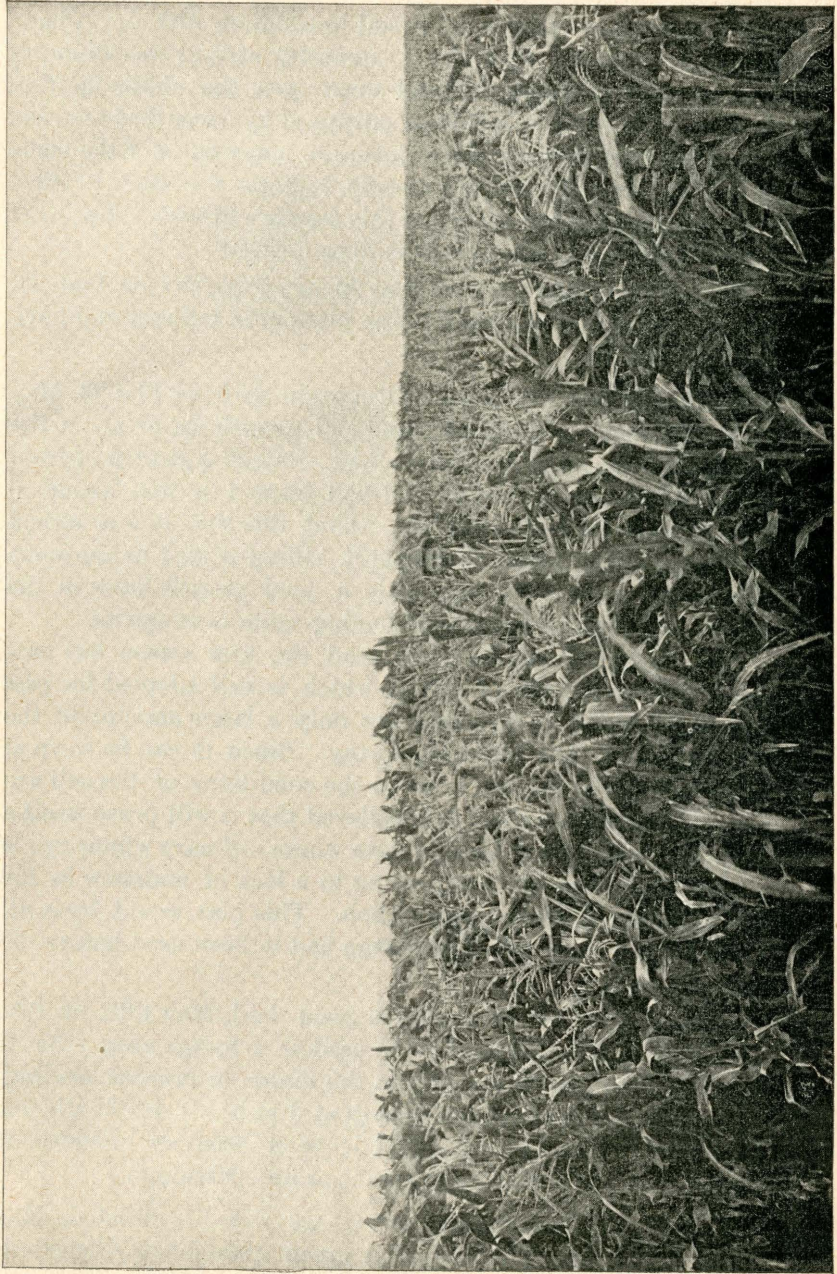
ST. JOHN'S RYE was sown with a grain drill on Plat 24, May 13th. It made a splendid stand and growth up to about the middle of July when the leaves had attained a growth of from 12 to 18 inches in length and had formed a mat about 6 inches deep all over the plat. About this time it was struck with rust which nearly destroyed it, killing it back to the roots. It recovered, however, and made a good growth later in the season and it gives promise of coming again next spring.

This variety of rye does not head the first season but produces a dense growth of foliage which is well adapted for pasturage, of which it furnishes not only a large amount in the fall but also in the following spring. Since it can be sown at any time during the season when the conditions of the soil are favorable to germination, it is believed that it will prove itself a valuable forage plant for this state where ordinary winter rye is a somewhat uncertain crop owing to a lack of moisture in the fall sufficient to insure germination. This plat would have afforded a large amount of pasturage had it been used before the rust struck it.

SPRING RYE was sown with a grain drill, May 13th, on Plat 25. This is also intended to be used as a forage crop. But it requires close pasturage early in the season to prevent heading. This made a fine stand and growth at first but it was finally entirely destroyed by rust. Had it been used as intended it would have yielded a large amount of fine pasturage.

ENGLISH OR PERENNIAL RYE GRASS was broadcasted, May 15th, on Plat 26. This beautiful green grass made a most excellent stand and growth. Where it is hardy it forms most val-

PLATE VI.



PLAT 32—SALZERS' SUPERIOR FODDER CORN.

PLAT 33—EARLY ADAMS CORN.

uable permanent grass lands which are used both for hay and for pasturage. Its leaves are tender and succulent. It was not affected by rust. A more extended trial is necessary in this state to determine its winter resisting qualities. It has winter killed in some sections of the United States, but it is hoped that irrigation will remedy this defect in this state. It seeded sparingly.

TALL MEADOW OAT GRASS was sown broadcast, May 15th, on Plat 27. A fair stand and a good growth were secured. This is a hardy hay and pasturage grass in this state and will serve as a substitute for timothy. It has grown successfully for five consecutive years on the Station grounds.

VICTORIA RAPE (Plate IV) was sown in 16-inch drills, May 14th, on Plat 29. No better results in every respect could have been desired. This crop is intended for soiling or for hurdle feeding.

SAND VETCH (Plate VII) was sown in 16-inch drills, May 7th, on Plat 34. The stand and growth were excellent. This plant alone is a low-growing, twining vine, and when intended for hay must be sown with some late variety of oats to serve as a support. Owing to its low, matted growth and the beating storm, only a small part of the forage could be secured by the mower. On the Station plats it gave 2.5 tons green or 1.26 tons dry fodder per acre.

This is a valuable leguminous forage plant rich in nitrogen. But it is a shy seed bearer in this State and the seed is expensive. It affords pasturage until it freezes.

SAND VETCH AND OATS (Plate VII) were sown in 16-inch drills on Plat 35, May 7th. The growth was satisfactory, but the oats ripened too early and were badly rusted. The crop gave 1.08 tons dry hay per acre.

PARSNIPS AND SALSIFY were sown respectively on plats 36 and 37 in 18-inch drills on May 5th. The stand and growth of both of these were excellent. Both have been reserved for harvesting early in the spring.

COW PEAS were sown in 16-inch drills, May 20th, on Plat 38. A fair stand and a good growth were secured. But few blossoms and no seeds were formed. These peas were cut Sept.

PLATE VII.



PLAT 35-SAND VETCH AND OATS.

PLAT 34 - SAND VETCH.

5th, and furnished 4.88 tons green feed or .92 dry hay per acre.

This forage crop offers little inducement for cultivation in this state. Stock must be educated to eat it and so far as our observations extend it ripens no seed. Much larger crops of more palatable feed, such as Canada Field peas, can be more cheaply produced.

LUPINE was sown on Plat 39 at the same time and in the same manner as in the preceding. A fair stand and a good growth with few blossoms were obtained. It is a coarse, woody forage, but it may have value as a leguminous crop for green manuring. It cut 2.64 tons green or .66 tons dry matter per acre. The storm beat down at least a fourth of the material so it could not be secured.

Plat 40 was planted to sweet corn and onions. Two varieties of onions were sown, Early Prize Taker and Yellow Globe Danvers. The first failed to bottom and consequently gave poor results. The second variety, however, set good bulbs, and although the stand was not so good as could be desired, they furnished 100 bushels to the acre. The seed was sown April 9th.

Two varieties of sweet corn was raised, First of All, and Telephone. Both gave excellent results with the advantage in favor of the latter. The corn was planted May 5th.

GARDEN NOTES.*

Between seven and eight acres were devoted to vegetables. The arrangement of the plats is shown in Plate VIII. The season was mainly favorable but the work was begun too late in the season, and a light hail storm occurring June 15th, injured some of the broad-leaved and tender plants. The garden plats, however, escaped the heavy storm occurring a month later. The striped cucumber beetle did much harm to the squashes and other vines, and plant lice damaged the turnips and some of the cabbages severely. Notwithstanding all these drawbacks, however, the results obtained will be an object lesson as to what may be grown by way of vegetables in the James River Valley.

TOMATOES.—Six varieties of tomatoes were planted, occupying altogether, one acre of ground. The seeds were sown in the

*See Plate VIII.

PLATE VIII.

NORTH ROAD	FLAT DUTCH CABBAGE		11	IDEAL CABBAGE					
	IDEAL DO.			SURE HEAD DO.					
	SELF BLANCHING CELERY		10	BRIDGEPORT MARKET DO.					
	GIANT PASCAL DO.		9	IMPROVED HUBBARD SQUASH					
	DWARF CHAMPION TOMATO			HENDERSON'S SUCCESSION CABBAGE					
	FIRST PRIZE DO.		8	GIANT CHILI SQUASH					
	PONDEROSA DO.								
	50 DAY EARLIEST DO.								
	DITCH		DITCH		DITCH				
	PUBLIC DRIVE	PIE PLANT		ALFALFA		SHEEP'S FESCUE	FALL FESCUE	SWEET POTATOES	
GIANT CHILI SQUASH		ASPARAGUS	FLAT DUTCH CABBAGE	RED CLOVER	FALL MEADOW GRASS	TURNIPS	HENDERSON'S		
			50 DAY EARLIEST TOMATO	WHITE CLOVER	SQUASH	BROMUS INERMIS	AUTUMN KING		
			LA CROSSE SEEDLING DO.	RADISHES	TURNIPS		CABBAGE		
JERSEY WAKEFIELD SALZER'S LIGHTNING EARLIEST OF ALL		EARLY CABBAGE	LETTUCE						
GRAPES		1	SWEET CORN						
CONCORD		MOORE'S EARLY	SAGE & PARSLEY						
AMERICAN BEAUTY									
SHRUBS, EVERGREENS, ETC.									
DITCH		DITCH		DITCH		DITCH			
DRIVE		DRIVE		DRIVE		DRIVE			

WEST

GARDEN PLANTS.

hot beds April 9th, one month too late. The plants were planted in the open ground May 25th. They were irrigated three times receiving in all six inches of water. The tomatoes were all set back at least two weeks by the light hail of June 15th. Owing to this fact and to the unsuitability of some of the varieties planted, only twenty bushels of ripe and one hundred and fifty of green ones were gathered. The varieties experimented with are as follows:

Dwarf Champion. These set fruit freely. The vines are strong, upright growers with such dense foliage that the sunshine could not penetrate to the fruits. Consequently but few fruits ripened.

LaCrosse Seedling. These plants resemble the Dwarf Champion closely and ripened the first fruits with that variety, August 5th. The foliage is too dense.

Ponderosa. These vines set few fruits and only a small per cent ripened. The vines are rank growers and the variety is too late for this State.

Fifty Day Earliest ripened the first fruits July 22nd. The vines are of open growth and they fruited and ripened freely. This is a good variety for this State.

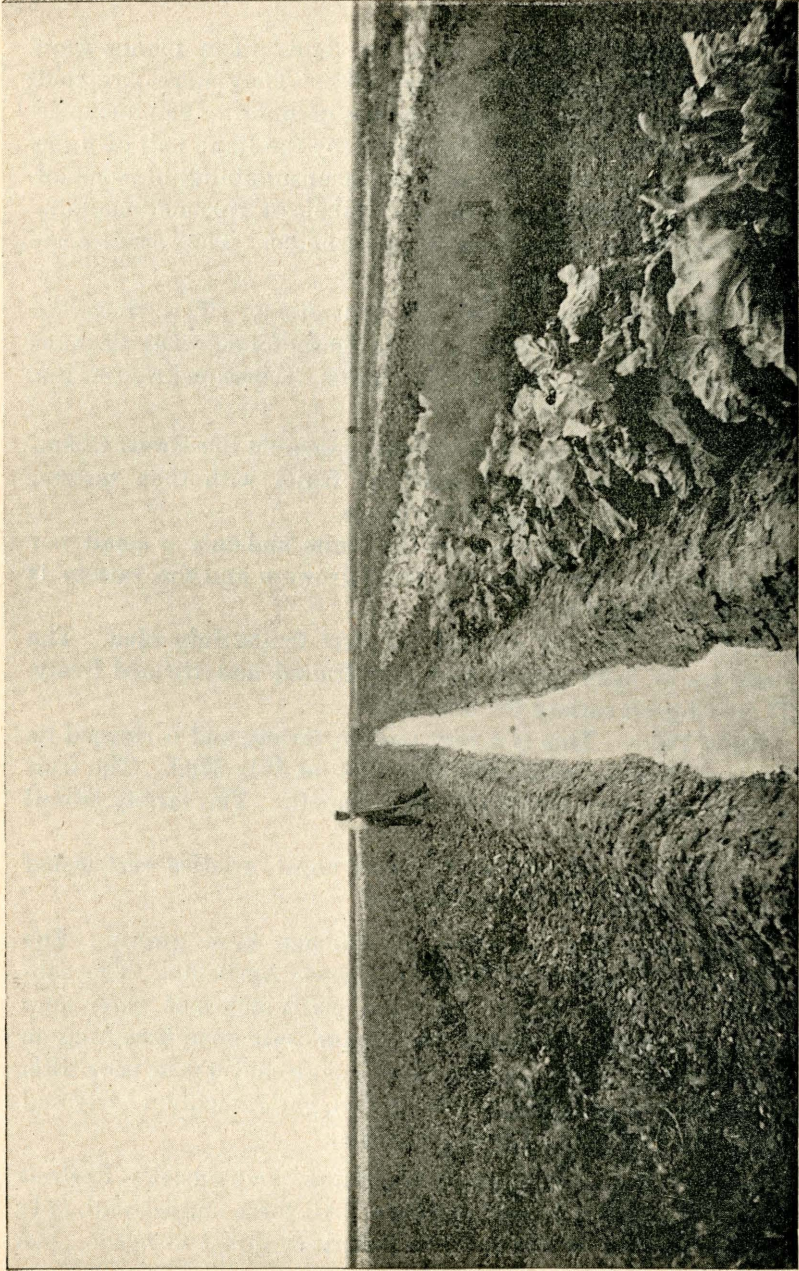
First Prize. This is a very prolific variety and it ripened its fruits uniformly, giving the first ripe on July 22nd. The fruit is large size, dark red and medium smooth. The variety is well adapted to the State.

In addition to the foregoing, seven novel varieties were tested but the results were all indifferent.

CABBAGES.—Nine varieties of cabbage were grown. The seeds of the earlier varieties were sown April 9th. The cabbages were irrigated four times and eight inches of water were used. Generally speaking, the results were good excepting on the south end of the garden where the ground was in poor tilth. Three classes of cabbages were grown, early, medium early and late. The following are the varieties:

Jersey Wakefield, Salzer's Lightning, and Salzer's Earliest of All comprise the early varieties. All these headed well, only twenty plants out of the six hundred set failed to head. The heads were solid and of good size. The second variety averaged four and the other two, three pounds each.

PLATE IX.



PLE PLANT, CABBAGE, ETC.

TOMATOES.

IRRIGATING DITCH.

Henderson's Succession was selected as the second early variety. These plants all headed. The average weight was six pounds per head, all heads being firm and marketable. This variety is to be highly recommended.

Five varieties of late cabbages were tested. The seed was sown May 20th and the plants were set in the plats June 25th.

The Ideal and Flat Dutch varieties did well in every respect. The heads were solid and ranged in weight from four to fifteen pounds each.

Henderson's Autumn King headed fairly well, but the heads were mostly soft and unmarketable.

Sure Head and Bridgeport Market headed poorly. Not over one in ten was marketable and these were small, averaging but from two to three pounds per head. The failure of these varieties is principally due to the poor tilth of the plats on which they were grown.

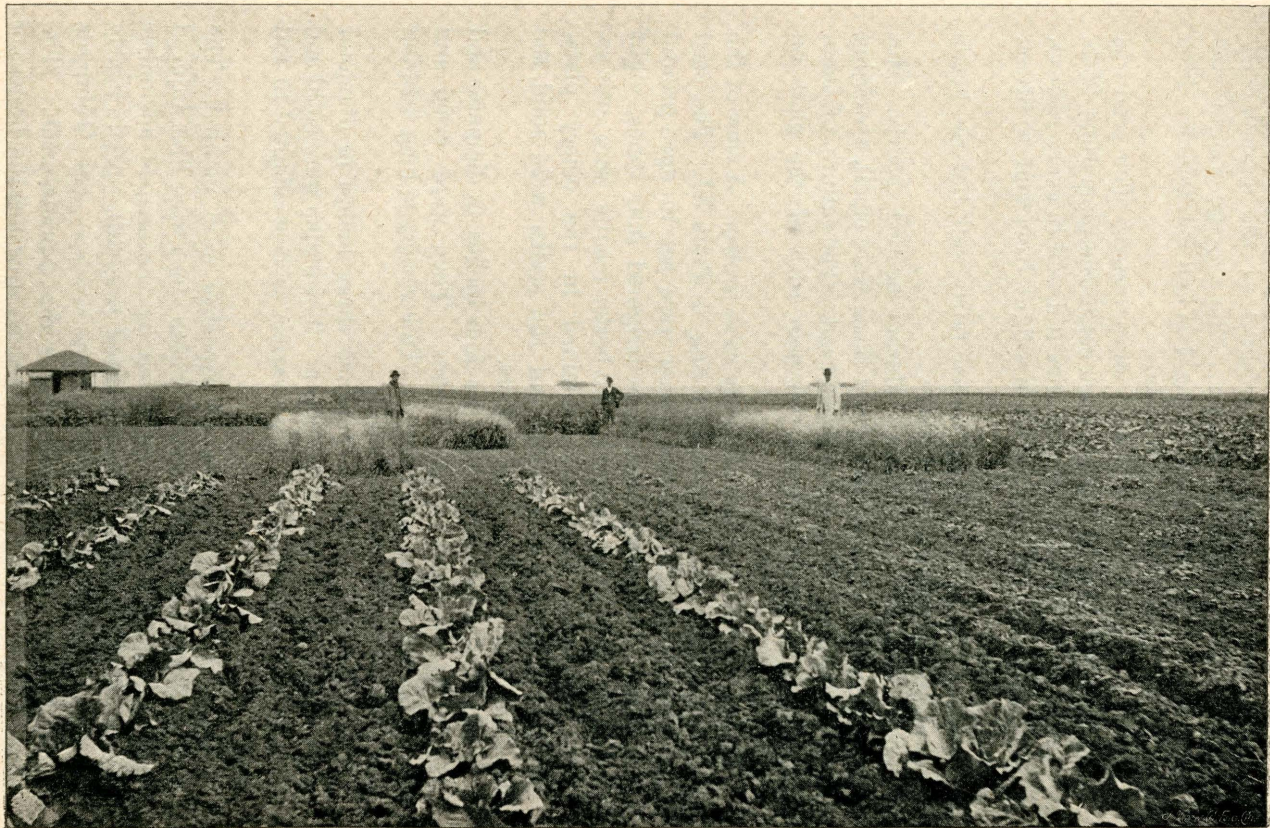
CELERY.—Two varieties of celery were grown. A view of the plat is shown, soon after transplanting, in Plate XI. The seed was sown April 9th, and the plants were set in open ground July 28th. The celery beds were irrigated four times, eight inches of water being applied. No better results were ever secured anywhere than were obtained in the celery plats. Scarcely a plant was missing and the stalks were solid, the bunches large and free from defects.

Giant Pascal furnished bunches four inches in diameter and the stalks averaged thirty inches. They were crisp and tender and of a fine nutty flavor. This variety is long keeping and is to be highly recommended.

Self Blanching furnished bunches three inches in diameter with stalks twenty inches in length. The stalks were solid and tender with a fine flavor. This variety is best adapted to fall use.

SQUASHES.—Two varieties of squashes were planted. The first planting was made in sod. These vines were first injured by hail and then finally destroyed by the striped cucumber beetle. Both varieties were replanted June 3rd. Again nearly all these vines were destroyed by the beetles. The Hubbards ripened fifty squashes averaging eight pounds each. The Giant Chilis ripened fifteen large-sized squashes the largest of which weighed fifty pounds.

PLATE X.



GRASS PLATS, SOWING OF 1895.—CABBAGE IN FOREGROUND.

ASPARAGUS from seed sown the previous year made an excellent growth.

LINEAS RHUBARB from last year's planting gave good results, the stalks being large and borne in great numbers. With good cultivation and mulching, preferably with slow rotting manure, this vegetable can be successfully grown in all parts of the state.

SWEET POTATOES.—Two varieties of sweet potatoes were grown. The vines were nearly all destroyed by hail. The Red Bermudas were completely killed and only eight hills of the Yellow Nonesuch escaped and reached maturity. These matured on the average six marketable potatoes per vine. The largest sweet potato raised measured eight by three inches.

TURNIPS.—Twenty varieties of English turnips were sown, but lice destroyed most of them. The Early White Globe and the Golden Ball were sufficiently early to mature before the lice appeared. These varieties gave a good yield of finely flavored turnips. The seeds of all the different varieties were sown July 22nd. Water was used twice to a depth of three inches.

Salzer's Giant Sage made a vigorous growth and was a success in every way. Moss Curled Parsley grew luxuriantly. Neither the sage nor the parsley was irrigated.

RADISHES. Three varieties were grown, Lady Finger, Chartist and Early Bird. All three varieties gave excellent results, and especially is this true of the Lady Finger. Irrigation was used twice and three inches of water was applied.

LETTUCE.—Three varieties were grown. Salzer's Earliest, Heavy Weight and Early Simpson. The first two varieties headed excellently; the last went to seed. The lettuce was irrigated twice, using three inches of water.

EGG PLANT.—A few vines of the New York Purple egg plant were planted. The results obtained were satisfactory. The ripe fruits averaged three pounds each.

GRAPES. Three varieties of grapes were planted: Concord, Moore's Early and American Beauty. All made a strong, vigorous growth, the first producing shoots eighteen inches and the others fourteen inches in length. Six inches of water was applied.

PLATE XI.



CELERY BEDS.

EVERGREENS.—Nine Arbor Vitæ were set and all but one lived and made a good growth. The Norway Spruces came in poor condition. They made only a fair growth. These were irrigated with the grapes.

The garden work has been under the charge of Mr. J. F. Terry, and the work on the forage plats under the care of Mr. Wm. Snoxall.

In regard to the amount and frequency of cultivation it can be said that good care has been given the plats where cultivation was possible. Not only were weeds kept down as closely as possible, but the ground was stirred as soon as fit after rains and after applications of water.

FIELD WORK.

It was the intention to have a series of comparisons between the crops grown on the irrigated plats and those on surrounding farms where the conditions were as nearly uniform as possible. But the hail storm rendered exact comparisons impossible. One field of wheat of 85 acres which was lying exactly in the path of the storm was estimated to yield, by competent judges, forty bushels per acre. It so happened that one acre of this was cut just before the storm fell and this acre was shocked. Notwithstanding the fact that a considerable quantity of the wheat was shelled from the shocked grain it gave 31 bushels for the acre harvested. Wheat in the immediate vicinity, not reached by the storm, gave from eight to ten bushels per acre.

A field of rye lying in the storm path was shocked when the hail fell. Although badly damaged it gave 31 bushels per acre.

Barley in shock at the same time gave a yield of 30 bushels per acre.

In conclusion it is safe to state that experience thus far is strongly in favor of using artesian water for irrigation. It is true that some have reported indifferent results. But in nearly every instance the poor results obtained may be directly traced to injudicious use of the water. In some instances water has been turned on the land in the winter time to such a depth that it could not be worked early enough in the spring. Again water has been used and the after cultivation neglected, etc., etc. It is absolutely folly to charge evil results obtained in this way to any peculiarity of artesian water. In the use of

any kind of water judgment and good cultivation are necessary.

In regard to the mode of applying water on this particular farm there is but little explanation needed. In the case of crops planted in rows small streams are simply led between the rows. As soon as the ground is in the proper condition this is always followed by thorough cultivation. In the case of crops not to be cultivated single furrows suffice to hold the water until a portion of the ground is flooded. This furrow is then broken and an adjacent portion similarly treated. (The construction of a lateral ditch, partly filled, is shown in Plate IX.)