EXPERIMENT STATION

OF THE

KANSAS STATE AGRICULTURAL COLLEGE,

MANHATTAN.

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FORT HAYS BRANCH.

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Experiments at Fort Hays Branch Station, 1902-'04.

HISTORY OF THE FORT HAYS BRANCH STATION†

The Fort Hays military reservation, being no longer needed for military purposes, was turned over to the Department of the Interior October 22, 1889, for disposal under the act of July 5, 1884. In 1889 the honorable secretary of the interior directed the suspension of action on this reservation to await the action of Congress in regard thereto. In February, 1895, Representative Schlyer, of Ellis county, introduced the following resolution in the house of representatives of the Kansas legislature, which was adopted, and concurred in by the senate February 18, 1895:

WHEREAS, The experience of the settlers upon the plains of western Kansas, covering a period of more than twenty years, has demonstrated conclusively that agriculture cannot be pursued with profit under existing natural conditions, and that artificial means and methods must be substituted therefor; and

WHEREAS, the tests and experiments required to determine the fitness of new methods applicable to these higher altitudes and limited rainfall cannot be made at the Agricultural College of the state; and

WHEREAS, The Fort Hays military reservation, at an altitude of 2000 feet above sea-level, contains a valuable body of native timber that should be pre-

*From May 1903.

†J. T. Willard, in Fifteenth Annual Report, 1901-'02.

served to posterity, and the land of said reservation is admirably adapted for such experiments in agriculture as are required in the premises; and

WHEREAS, The buildings upon said military reservation, formerly used as residences for officers and their families, barracks for troops, storehouses, etc., are large and commodious, but cannot be moved without destruction of their value, but in their position are of great value, and could be used, with little additional repairs, for the purposes of a branch of the State Normal School; and

WHEREAS, The location of a branch of the State Normal School at this place would be central and convenient for the whole of the north half of the state; and

WHEREAS, The said military reservation has long since been abandoned by the United States government as a military post: now, therefore, be it

Resolved, by the House of Representatives of the State of Kansas, the Senate concurring therein, That our senators and representatives in Congress are hereby requested to secure the passage of an act of Congress donating the said Fort Hays military reservation to the state of Kansas for the following public purposes: (1) For a western branch of the Kansas Agricultural College; (2) for a western branch of the Kansas State Normal Institute; (3) for a public park.

Resolved further, That the secretary of state be, and he is hereby, instructed to transmit a copy of these resolutions to the president of the United States senate, the speaker of the house of representatives, and to each senator and representative in Congress from the state of Kansas.

On Saturday, February 23, 1895, a copy of said concurrent resolution was laid before the senate by the vice-president and was referred to the committee on public lands, accompanied by senate bill No. 2799, introduced by Senator Martin, and which reads as follows:

Be it enacted, etc: That the abandoned Fort Hays military reservation and all the improvements thereon, situated in the state of Kansas, be and the same is hereby granted to said state, upon the conditions that said state shall establish and maintain perpetually thereon, first, a western branch of the Kansas Agricultural College; second, a western branch of the Kansas State Normal Institute, and that in connection therewith the said reservation shall be used and maintained as a public park; provided, that said state shall, within five years from and after the passage of this act, accept this grant and shall by proper legislative action establish on said reservation western branches of the Kansas Agricultural College and the Kansas State Normal Institute; and whenever the lands shall cease to be used by said state for the purposes herein mentioned the same shall revert to the United States.

This bill passed the senate February 26, and the house March 2, 1895. Congress adjourned March 4 and this bill failed to receive the president's signature.

In view of the passage of senate bill No. 2799 the district land-officers were advised by telegram dated March 22, 1895, that said lands were withdrawn from settlement and entry to give opportunity for further legislation.

A bill similar to No. 2799 was introduced in the fifty-fourth Congress and reported favorably to the house of representatives by Mr.

Curtis, from the committee on public lands. The report of the committee is in part as follows :

"The Fort Hays military reservation is situated in what is known as the arid belt of the state of Kansas.

"The post was established in the early history of Kansas for the purpose of furnishing a convenient basis of, operations against the Indian tribes of the West, and was maintained for many years for that purpose. Excellent buildings were erected thereon for officers' quarters and other army purposes, and are admirably adapted in many respects for the purposes contemplated by this bill. As the Indian tribes were gathered on the reservations in the Indian Territory, this military reservation became useless, and several years ago was abandoned as a military station and turned over to the interior department, and from thence until the present time it has been of no service to the government of the United States; upon the contrary, a continued expense and embarrassment.

"In view of the arid condition of the land it would be difficult to sell it for any reasonable amount. A part of the reservation is covered by an unusual growth of timber for that section of the country, and it is important that this timber be preserved for public-park purposes.

"The state of Kansas has already established a State Agricultural College at Manhattan, in Riley county, about 110 miles west of the eastern border of the state. It has also established a State Normal Institute at Emporia, Lyon county, about 125 miles west of the eastern border of the state.

"The entire length of the state is about 407 miles, and the result is that the people in nearly two-thirds of the state are practically deprived of the benefits and advantages of both of these institutions.

"In view of the arid character of this land and its situation in the western part of the state, about 175 miles west of the present location of the Agricultural College and the State Normal Institute, it would furnish an admirable location for the establishment of branches of these institutions for the benefit of the inhabitants of nearly two-thirds of the state.

"It is and always has been the policy of the government to encourage and develop institutions of learning of this character, and the establishment of a western branch of the State Agricultural College at this point would be particularly beneficial end appropriate for the reasons herein stated, and more fully set forth in the concurrent resolution above named, as it would form a nucleus from which important developments might be expected in determining the agricultural character and value of the arid lands in the western part of Kansas and eastern Colorado; and for all these reasons the committee is of the opinion that the policy contemplated by this bill is a wise and prudent one, and will result beneficially, not only to the state of Kansas, but to the whole country, and we therefore recommend the passage of this bill."

However, the bill did not become a law, although again reported favorably at the second session of this Congress. The same or a similar bill was introduced in the fifty-fifth Congress, and passed the senate, but did not come up for action in the house. It was again introduced in the fifty-sixth Congress — in the senate by Senator Harris, and in the house by Congressman Reeder, and became a law March 25, 1900. As finally passed, it reads as follows:

A BILL granting to the state of Kansas the abandoned Fort Hays military reservation in said state, for the purpose of establishing an experimental station of the Kansas Agricultural College and a western branch of the Kansas State Normal School thereon, and a public park.

Be it enacted, That the abandoned Fort Hays reservation, and all improvements thereon, situated in the state of Kansas, be and the same is hereby granted to said state upon the conditions that said state shall establish and maintain perpetually thereon, (1) an experimental station of the Kansas Agricultural College, and (2) a western branch of the Kansas State Normal School, and that, in connection therewith, the said reservation shall be used and maintained as a public park; provided, that said state shall, within five years from and after the passage of this act, accept this grant, and shall, by proper legislative action, establish on said reservation an experiment station of the Kansas Agricultural College and a western branch of the Kansas State Normal School; and whenever the lands shall cease to be used by said state for the purposes herein mentioned, the same shall revert to the United States; provided further, that the provisions of this act shall not apply to any tract or tracts within the limits of said reservation to which valid claims have attached by settlement or otherwise under any public-land laws of the United States.

Acting under this law, the following joint resolution was passed by the state legislature:

Be it resolved by the Legislature of the State of Kansas:

SECTION 1. That the state of Kansas hereby accepts from the United States the abandoned Fort Hays military reservation, as provided in an act of Congress relating thereto, approved March 27, 1900.

SEC. 2. That the provisions of the act of Congress, "An act granting to the state of Kansas the abandoned Fort Hays military reservation, in said state, for the purpose of establishing an experimental station of the Kansas Agricultural College and a western branch of the Kansas State Normal School thereon and a public park," approved March 27, 1900 are hereby accepted by the state of Kansas.

SEC. 3. That upon the approval of this act by the governor, he is requested to transmit a certified copy of the same to the secretary of the interior of the United States.

Approved February 7, 1901.

Copy transmitted to secretary of interior February 7, 1901.

The following act was passed by the legislature in respect to the division of the reservation and making appropriations for the branch station and the branch normal school:

AN ACT relating to the Fort Hays military reservation, locating thereon an experiment station of the State Agricultural College and a western branch of the State Normal School, providing for the preservation of the native timber land for a public park, and making appropriation therefor.

Be it Enacted by the Legislature of the State of Kansas:

SECTION 1. The boards of regents of the State Agricultural College and of the State Normal School, respectively, are hereby authorized to locate and establish an experimental station of the State Agricultural College and a branch or auxiliary of the State Normal School on the Fort Hays military reservation.

SEC. 2. The following-described tracts of land lying within the limits of the reservation aforesaid, to wit: Section 36, township 13 south, range 19 west; sec-

tion 31, township 13 south, range 18 west: section 1, township 14 south, range 19 west; sections 6 and 8, the east half of section 7, the north half of section 17, and the northeast quarter of section 18, all in township 14 south, range 18 west, are hereby placed under the direction of the regents of the State Normal School, It shall be their duty to lease or rent the said lands to the best advantage, and all moneys derived from rents for such lands shall be collected by the regents aforesaid, who shall deposit the same with the treasurer of the board, to be expended by the said board of regents for the equipment and maintenance of said auxiliary of the State Normal School.

SEC. 3. All the remaining lands of the reservation aforesaid are hereby placed under the direction of the board of regents of the State Agricultural College, except the north half of section 5, township 14 south, range 18 west, which, with the buildings thereon, shall be used jointly as may be determined by the boards of regents of the institutions aforesaid.

SEC. 4. The said board of regents of the State Normal School shall employ a principal and such assistant teachers and janitors as the needs of the school may demand; shall prescribe the course of study, not extending over more than two years, conditions of admission, and such other regulations as may be required for its successful conduct; provided, that such course of study shall embrace only such branches as may prepare pupils for the advanced academic and professional work provided at the State Normal School at Emporia.

SEC. 5. All persons meeting the requirements for admission prescribed by the board of regents shall be admitted to said school; and on declaring their intention to fit themselves to teach in the schools of Kansas shall be exempt from all fees, save a small matriculation fee, which the board of regents may require. Students not intending to teach may be charged a reasonable fee, at the discretion of the board.

SEC. 6. Any person of good moral character over sixteen years of age, having been in actual attendance at least twenty weeks at the above-named school, and having completed the course of study prescribed by the said board of regents, shall be awarded a certificate which shall be a legal certificate to teach in any of the public schools of the state except high schools, and good for one year. Said certificate shall also admit the holder to the third year's work at the State Normal School at Emporia without examination.

SEC. 7. The president of the State Normal School shall be president of said auxiliary normal school, with such duties and responsibilities as the board of regents may determine.

SEC. 8. The sum of $7000 is hereby appropriated for the fiscal year ending June 30, 1902, and the sum of $5000 for the fiscal year ending June 30, 1903, is hereby appropriated, for the current expenses and improvements of said auxiliary normal school, the said amounts to be expended undor the direction of the board of regents of the State Normal School.

SEC. 9. The board of regents of the State Agricultural College is hereby authorized to locate and establish on the reservation aforesaid an experimental station of the Agricultural College, and shall adopt such measures as may be necessary to place the same in successful operation and to preserve the land upon which the native timber is now growing as a public park.

SEC. 10. To carry out the provisions of section 9 of this act, the sum of $3000 is hereby appropriated for the fiscal year ending June 30, 1902, and $3000 for the fiscal year ending June 30, 1903.

SEC 11. All sums of money payable out of the appropriations specified in sec.

tion 8 of this act shall be upon vouchers approved by the board of regents of the State Normal School ; and all sums payable out of the appropriations specified in section 10 shall be upon vouchers approved by the board of regents of the State Agricultural College,

SEC. 12. The auditor of state is hereby authorized to draw his warrants on the treasurer of state for the several sums and purposes specified in this act upon verified vouchers approved by the boards of regents of the State Normal School or the State Agricultural College; provided, that no portion of the money appropriated in this act shall be expended by the board of regents until the attorney-general of the state of Kansas shall first notify the governor and the board of regents that the title to the land in said reservation is unimpaired, and the land is available under the terms of the act of Congress ceding said reservation to the state.

SEC. 13. This act shall take effect and be in force from and after its publication in the official state paper.

Approved February 26, 1901.

Published in official state paper March 1, 1901.

At one time the reservation was supposed to be open for settlement, and much of the land was filed upon and occupied. When the state accepted the reservation these claims constituted a flaw in the title. To remove this, the board executed leases to the claimants running from three to five years, in consideration of which all further claim was relinquished.

The plans for managing the branch station are shown in the following resolutions, adopted by the board December 13, 1901:

Resolved, That the president of the board of regents shall appoint a regent, who shall, under the direction of the board, have special charge of all matters pertaining to the Fort Hays reservation in behalf of the Agricultural College, the Experiment Station Council to direct all experiments, subject to the approval of the board.

Resolved, That the crop experiments and such other experiments as can be provided for be begun in the year 1902 on as liberal a scale as circumstances and the funds at our command permit; and that all seeding, cultivation, harvesting, storing, sale end purchase of commodities, or of live stock and its feeding, pertaining to experimental work, and all records in reference thereto, be under the immediate supervision and direction of a competent man, who shall be stationed at Hays so much of the time as may be necessary for best doing the work contemplated.

Resolved, That such repairs be made upon the buildings on the Fort Hays reservation as shall make them available for use, and that a practical farmer be employed, who shall be known as foreman of the farm, and who shall see that all contracts pertaining thereto are fulfilled and all property belonging to the Experiment Station be properly cared for, and shall perform such other duties as shall be assigned to him.

Resolved, That the regent appointed to have charge of the interests of the Experiment Station at Hays shall be paid his per diem and actual and necessary expenses incurred in the performance of such duties, but shall not be allowed mileage.

J. G. Haney, a graduate of the College, for several years assistant in field and feeding experiments and later agricultural agent of the Chihuahua & Pacific Railway Company, was appointed superintendent of the branch station. He entered upon his duties March 29, 1902, as soon as the title to the reservation was reported clear by the attorney-general, and such experiments as could be made on sod were started."

BEGINNING OF WORK.

The part of the reservation secured by the Agricultural College was that having the greater diversity of location, quality, etc. This was a very important feature, as it admits of experiments under more varied conditions. The land is of good quality, and, with the exception of the immediate bed of the creek, is all tillable.

At the time work was begun there were no improvements nor equipment of any kind on the land. The fort had been abandoned more than fifteen years, and fully half of the buildings were gone entirely, and what remained were in a very dilapidated condition. The appropriation available was used in breaking out nearly a section of land, building seven miles of fence to close the numerous roads that radiated from Hays, on the south side, like a fan. Also some necessary implements and a pony and saddle were bought.

After the 1902–'03 appropriation was available four buildings were moved from the site of the old fort, about a half-mile southeast, to the location chosen for the Station buildings. These were fitted up for a barn, tool-shed, granary, and dwelling. In the fall of 1902 one team was bought for use on the Station. All team work had been hired up to this time, and it was still necessary to hire considerable help in gathering the feed grown on sod and to put in 200 acres of wheat sown that fall.

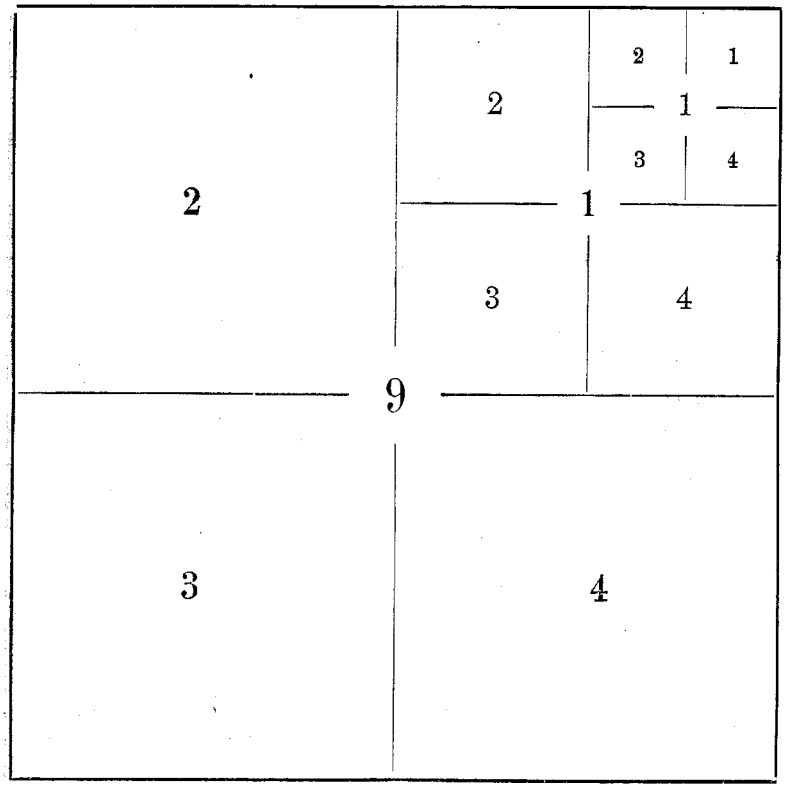
LARGER APPROPRIATION.

The legislature of 1903 was much more liberal in appropriations. A total of $32,550 was appropriated for the succeeding two years. $10,000 was made available on adjournment of the legislature for current expenses, teams and equipment, boarding-house, wells, etc.

July 1, 1903, $14,900 was available for current expenses, horse barn, water plant, fences, live stock, sheds, bridge, and machinery, including a twelve-horse-power thrashing outfit.

July 1, 1904, $7650 was available for current expenses, machinery, sheds, yards, fences, etc. The proceeds from sale of crops, stock, etc, is also available for use at the branch station.

METHOD OF DESIGNATING FIELDS.



The above diagram illustrates the method of designating fields on the Fort Hays Branch Experiment Station. The division into sections and quarter-sections as made by the government land survey is maintained, and the quarter-sections are numbered in the same order as the sections in the township. The forties of the quarters are also numbered in the same manner. Thus, 9–1, would mean the northeast quarter of section 9; 9–1–1, the northeast quarter of the northeast quarter of section 9, etc.

IMPROVEMENTS.

The first improvement made was the breaking, which was done with a view of getting all the land conditions possible. Accordingly, the breaking of 15–2 and the south part of 10–3 gives the highest land available. The breaking continues north, on the west aide of 10-3, into the creek bottom, a portion of which is on 10-2. All of 9–1 is broken, which also comprises upland and bottom.

The fencing done in the summer of 1902 was for protection; beginning at the middle of section 11, on the north boundary, and running east to the northeast corner, south to the southeast corner,

thence west three miles, without a gate, to the southwest corner of 16–2, thence north on section line between sections 16–17, 7–8, 4-5, two miles, to the north boundary. In the fall of 1902, in the eastern portion of the Station, two and one-half miles of fence was built, which joins with the outside fence, and encloses 550 acres of pasture land. In June, 1903, the south half of section 5 was fenced; also the south half of 4–3 is fenced, enclosing the cattle sheds and yards.

The boarding-house is a modern, frame structure, 30 by 49 feet, two and one-half stories, with cellar, and is arranged for furnace heat.

The barn is built with a lean-to on the east, and is 62 by 72 feet on the ground, the main part being 44 by 72 feet. It accommodates twenty head of horses, has two grain bins and a harness-room, space for five vehicles, and will store 150 tons of hay.

Eight sheds, 16 by 16 feet, each having a 4½ feet woven-wire lot in connection 66 by 250 feet, with posts set in cement, are built for feeding experiments. Also a shed for stock cattle, 16 by 64 feet, and an additional implement shed for the thrashing outfit. The sheds are all substantially built, with shingle roofs. The four buildings which were moved from the fort were also remodeled and painted. Considerable old lumber was obtained from the buildings at the fort, which made it possible to do this amount of building with the funds provided.

The implements bought are those which have been needed in the work; and consist of three breakers, two walking-plows, two mold-board gang-plows, one disk-plow, two disk-harrows, two drag-harrows, one subsurface packer, two disk-drills, one lister, one corn-planter, two cultivators, one weeder, two mowing-machines, one binder, one header, one thrashing outfit, four wagons, and two buggies. Also, a variety of small hand implements and tools, including carpenters' and blacksmiths' tools.

The water plant, which is completed, will doubtless be permanent. Water was not found on the immediate building spot, and after eight prospect holes were bored with a six-inch auger a well six feet in diameter was sunk to shale, on the bottom, but more than a quarter of a mile from the creek. It required a steam pump to keep the water out until the shale was reached, at a depth of thirty-two feet, when the flow tested 100 gallons per minute. The last ten feet of the wall was built on a curb and sunk, as at this point sand and sand rock were found. The water is of excellent quality, being nearly soft. It is pumped through 1350 feet of two-inch pipe to a 200-barrel tank, elevated on a stone tower 30 feet high, making a total lift, from the well, of approximately 85 feet. From the tank the water is piped to all the buildings, and fire-hydrants are provided. Water is also carried into all the yards and lots. There is more than a mile of galvan-

ized water-pipe laid, all of which is 3½ to 4 feet under ground. The pumping is done by a windmill. A one-and-one-half-horse-power gasoline-engine is also installed for use when the wind does not furnot furnish power, which seldom occurs.

PRAIRIE-DOGS.

The first work accomplished was the complete extermination of the prairie-dogs in a number of towns along the creek on the best land. The area covered by these towns was estimated at 400 acres. In some places nearly a quarter of a section was so completely infested that it furnished no grass at all.

The work was begun April 6, 1902, and the poison prepared by the special agent of the Station was used as directed. One man did all the work, going over the towns and putting poison at every hole that appeared to be occupied. About a week later the ground was gone over again, and poison put where there appeared to be dogs that were not killed. There still remained a few, scattered here and there. The ground was gone over again, on bright days, with carbon bisulfide and gasoline. When a dog was sighted, a piece of cow-chip, broken so as to be nearly round, was dipped in a mixture of about half and half gasoline and carbon bisulfide and rolled down the hole. The hole was then quickly stopped at the mouth by sod, so that the gases could not escape. Only in a very few cases were these holes ever opened from within. By the 10th of May there were only a very few left, and these may have come from outside. Great care was taken to get every one, however, and the neighbors were encouraged to do the same; so the work was done once for all.

The account of expenses stands as follows:

DR.

To 6 cans of poison, at $1.50	$9 00
To 3 cans of carbon bisulfide	2 70
To 4 bushels of wheat, at 50 cents	2 00
To 2 gallons of gasoline	30
To 156 hours' labor, at 12½ cents	19 50
Total	$33 50

CR.

To 400 acres of dogs exterminated; cost per acre, 8 cents.

Owing to the lateness of the season the dogs were able to get other food, and doubtless did not eat the poison so readily, thus increasing the cost considerably.

ALFALFA.

Alfalfa Seeded on Sod.

Alfalfa being considered of such importance, a trial of seeding on sod was to be made immediately. Accordingly, a bend in the creek, on section 10, was broken April 11 to 17, 1902. This bend was one

of the worst dog towns on the Station. Poison was put out while the breaking was in progress. The breakers were followed immediately by the disk-harrows, and the field double-disked. Then the field was double-disked, crossing the furrows. Following this it was harrowed twice, then gone over with the subsurface packer. This was completed April 21. May 6 it was harrowed again. May 19 a shower fell, the first since breaking, and on the 20th, as soon as dry enough, the float, or clod-masher, was run over the field, and followed with another harrowing. On the 21st and 22d a heavy rain fell—reported at one and one-half inches. The land being in such fine condition, all the water was absorbed. As soon as dry enough it was given another harrowing, and on the 26th the disk-drill, with press wheels, was started. The alfalfa seed was mixed with about an equal part, by measure, of bran. This seeded fifteen pounds to the acre. The seeding of the twenty-two acres that are in the field was finished on the 29th of May. The weather was warm, and favorable for germination, and a most excellent stand resulted. The frequent harrowings had destroyed the weeds, so that the field was very clean. On July 23, fifty-seven days from planting, the alfalfa had begun to bloom, and the mowers were started. The Station having no teams, the cutting was let for two-thirds of the crop, which was at least one-half ton per acre. The growth, in places, measured twenty four inches. After the first cutting it made a good growth, but was not cut. It was thought best to leave a good protection.

Alfalfa Sown in Fall of 1902.

In the same section, and just across the creek, the Station had obtained a small field that was broken in 1901, and grew a crop of wheat in 1902. As soon as the wheat was harvested this land was plowed and packed—during July. August being very dry, the alfalfa was not seeded until September 4. The ground was in fair condition, and the drill did good work. The press wheels were used on a disk-drill. The stand being better than necessary on the spring seeding, less seed was sown, 140 pounds on thirteen acres, or a little over ten pounds per acre. This amount gave a splendid stand, and a fair growth was made in the fall.

Alfalfa, 1903.

The field seeded in the spring of 1902, on sod, was as near perfection as could readily be imagined. The many visitors pronounced it equal to, if not the most perfect and uniform stand ever seen. Contrary to the predictions, of some there has been no appearance of the wild grasses returning.

Three crops of hay were cut—June 12, July 23, and September 25. The first two were of exceptionally fine quality, the thick stand giv-

ing a maximum amount of leaves and a minimum of stem. The three cuttings made a total average of about two and one-half tons per acre for the season.

The fall seeding came on nicely, but it was necessary to cut it twice to get rid of the volunteer wheat. The third cutting was very fine, and there is a splendid stand.

Alfalfa Seeded, 1903.

Extending from the creek bottom to the upland, and joining the first seeding made, a field of ten acres was sown. This will give a comparison between the bottom and upland.

This field was broken at the same time as the other, April, 1902, but was not plowed again until just previous to seeding in 1903. This is not advisable, but, under the circumstances, was unavoidable. It would have been better if plowed the fall previous. The packer and harrow were used liberally, and a good; compact seed-bed secured, The seeding was done May 19, with the disk press-drill, ten pounds of seed sown per acre. The seed started nicely, but heavy rains covered much of it. The rains immediately following seeding were as follows: May 21, 0.48 in.; May 22, 0.12 in.; May 26, 1.93 in.; May 28, 2 in.—making not quite 4½ inches in the first ten days after seeding. However, the stand is much too good to plow up, and the thin places will be reseeded and disked at a favorable time.

A small field of six acres, planted at the same time where it can be irrigated, suffered a similar fate.

SEEDING ALFALFA.

Spring seeding of alfalfa in the West is most apt to be satisfactory. The ground should have been plowed early the previous fall and kept in good condition by frequent harrowings, which should be continued until seeding time—not before May 1. Seeding time should be governed by the moisture in the ground after May 1. The seed is more valuable in the sack than in the ground when the ground does not contain sufficient moisture to produce germination and keep the young plant growing for several weeks. The seed-bed for alfalfa must be *solid* and *moist*. Spring plowing, if necessary, should be shallow. Disking is better than plowing, and the soil should be thoroughly solidified with a subsurface packer or by driving a herd of stock over the field, alternated with harrowings.

Seeding should be done with a disk press-drill at the rate of ten to fifteen pounds per acre, depending upon the quality of the seed. May 1 to the 15 is preferable, or August 20 to September 10. The mower must be run over the field every thirty to fifty days after seeding, depending on the growth of weeds. The alfalfa must not be allowed to bloom and seed the first year, and should not be pastured.

BROMUS INERMIS ON SOD, 1902.

Two small fields of *Bromus inermis* were sown, one adjoining the first alfalfa sown, and a part of the field where the slope from the bottom to the upland begins. This seeding comprised about one acre. The other was on the highest land on the Station. The sod was broken about the same time, and received nearly the same treatment, which was the same as for the alfalfa. An attempt was made to drill the seed, which is very light and chaffy. The seed does not have weight enough to follow down into the feed cups. Accordingly, sand was mixed with the seed in varying quantities, but without success. The writer, while with the Station at Manhattan, succeeded in running the seed through a fertilizer attachment on a drill, but this did not give a uniform stand. So far the only method of seeding seems to be broadcast, by hand, and the air must be very quiet to admit of this.

The field on the bottom was sown May 29, and gone over with a Hallock weeder. The seed was not very good, and a heavy rain just as it was coming up covered much of it, and a very thin stand was secured. The field on the upland was not seeded until June 12, as there was too much wind until that day. The ground was harrowed before and after sowing, and a very fine stand was secured. This upland seeding was two and one-half acres, and adjoining it a similar piece was left for fall seeding. September 6 the land was plowed and packed, the seed sown, and harrowed in. The gound was not in very good condition, and there appeared to be very little seed that started. However, the following spring there appeared to be much more, and, as *Bromus inermis* spreads very rapidly, it was left, and by fall made a very much better appearance.

Bromus inermis spreads by sending out shoots from the older stalks, just at the roots. These shoots grow away from the older plant in a horizontal direction an inch or so, and then come up, making a new plant. For this reason old fields often become sod-bound, and do not produce so well. Disking is recommended for this condition.

BROMUS INERMIS, 1903.

The 1902 seeding grew very nicely. A part of it was harvested for seed and the remainder for hay. Both of the spring seedings of 1902 made a very favorable growth, but, as it was an exceptionally wet season, this would be expected.

A field of ten acres was sown with seed that was grown at the Station at Manhattan. This seed was good, and an excellent stand was secured. The land sown was broken the previous spring — 1902. The latter part of April, 1903, it was plowed and packed. May 20 the seed was sown, and the field disked and harrowed. Conditions

were favorable after seeding, and the field will certainly make a good trial of the grass. The growth practically covered the ground, and would have made considerable late pasture in the fall. The field was mowed once to destroy the weeds. *Bromus inermis* starts very early in the spring, and does not "retire to its subterranean fastness on the approach of winter," near so early as the common grasses. If it proves to be what it now appears to be, it will give a pasturing period from a month to six weeks longer than the native grasses. The greatest difficulty in starting it undoubtedly is in the inferior quality of seed usually obtained. The dealers are not to blame, but the seed should be tested. Ten pounds of good seed, testing ninety-eight per cent., is better than thirty pounds testing fifty per cent,

PEARL MILLET, OR PENCILLARIA.

This crop has been greatly advertised by many seed firms, and is still held up as a great benefactor. It has been grown here both years, and we have bought seed twice, and are still without. It has been grown beside Kafir-corn both seasons, and in no way has it proven superior to Kafir-corn. It does not withstand the hot, dry weather as well as Kafir-corn, and does not yield as heavily. The seed shells easily from the head, which somewhat resembles the head of a cat-tail flag, the seed being embedded in the soft part. While our trials may not be sufficient to condemn it, they have certainly not been favorable.

RAPE.

Rape does not thrive except during the rainy periods. Two weeks of dry, hot, windy weather dries the leaves up until they would burn. During August of 1902 but very little rain fell. The rape made no growth at all, and appeared as if it had gone through a heavy freeze. It did not die, however, and as soon as the rains came in September it recovered wonderfully, and would have furnished considerable late feed.

MELONS.

In April, 1902, several acres were planted to Kansas stock melon, watermelon, and cantaloup. The stock melon seems to be similar to the citron or pie melon, but grows much larger, the average weight being forty pounds. They are very hardy, and made an enormous yield. Cattle, hogs and poultry are very fond of them. They have a tough, dense rind and can be put in a cellar or any place that does not freeze, and be fed at any time during the winter.

Watermelons and cantaloups also yielded well. The melon crop of 1903 was not so good. The seed was planted at the usual time, but the season being so cold and wet, much of the seed did not germinate.

TURNIPS.

Turnips have been grown both years very successfully. In 1902 the seed was sown July 8, and the crop was as fine as could be grown. The turnips were of uniform size and well matured.

The summer of 1903 was rather dry, and the seed was not sown until August 8. This was a little too late for the best results, but they were of good size, and very sweet and tender. The first freeze to injure them was on November 17.

BEETS.

No beets were grown in 1902, but about one acre was planted in 1903. The ground was as well prepared as practicable, it being new, and the beets were planted in rows thirty-five inches apart. A variety of sugar-beets was ordered, but they proved to be Golden Tankard. The seed was planted May 25 and a fairly good stand secured. They required no special attention and made a good crop.

The Golden Tankard yielded.. ..... 9.1 tons per acre
Mangel-wurzels yielded. ..... 15.6 tons per acre.
Irrigated mangel-wurzels yielded.. ..... 21.1 tons per acre.

Cattle, hogs and poultry eat beets with a relish, and during the winter, when feed is dry, a feed of such succulent material is very beneficial. Dairymen especially should grow them, as the milch cow demands such food. It does not require an expensive cellar to keep them.

GARDEN.

In the spring of 1902 a small patch was plowed up that had been previously broken and not plowed for perhaps ten years. After plowing, it was nearly as soddy as new land. It was disked and harrowed until in fair shape. Peas, beans, radishes, lettuce, cabbage, tomatoes and sweet corn were planted. It received no irrigation and was not given any special care. Everything grew nicely, and in abundance. The sweet corn and peas made an especially good showing.

The season of 1903 being unusually wet, the garden of course was all that could be expected of a garden. A much larger variety was planted, and without exception did splendidly. Peas, beans, radishes, lettuce, tomatoes, table beets, parsnips, carrots and sweet corn were as nice in every way as could be wished for.

BARLEY, 1902.

In the spring of 1902 twenty-five acres of barley was sown on fresh sod. The breaking-plow was followed immediately with the disk-harrows, and the sod double-disked, and harrowed with common harrow. The sod not having had a chance to dry, this treatment put the land in good shape.

Seeding was begun April 3 with a disk-drill with drag-chains, it being impossible to get a drill with press wheels. The drag-chains did not settle the soil sufficiently on the seed, and as a result not more than two-thirds of the seed came up; the rest lay in the dry soil until the rains of May 20-26. This was just heading when the crop was harvested, July 21. The straw was very short and not thick on the ground, but the grain was of good quality. This was not a barley year; many fields were not harvested at all, and the yield was low on what was cut. Considering all the conditions, the yield of six bushels to the acre, which this made, was very satisfactory,

SPRING SMALL GRAIN, 1903.

There seems to be no doubt that all spring grains do best on fall plowing. The soil is acted on by the elements during the winter, takes the moisture, and perhaps most important, is ready for early seeding. No fall plowing was done in 1902, owing to a lack of funds and equipment. Hence all spring seeding in 1903 had to be done on spring plowing. The spring of 1903 was very cold and unusually wet. Plowing was begun April 16, and pushed as rapidly as possible. One hundred and sixty acres was to be plowed for the various trials with spring grain. The quarter, 15–2, on which these trials were made, is arranged for a rotation, the purpose being to test the effect of various crops on the wheat crops following. This quarter had all been planted to crops on the sod the season previous, consisting of macaroni wheat, barley, millet, Kafir-corn, and sorghum.

BARLEY VARIETY TESTS, 1903.

TABLE I, showing yields.

Kansas F. H. B. No.	Cooperative, S. P. I. No.*	NAME.	Date planted, 1903.	Date of ripening, 1903.	Yield per acre.	Test, pounds per bush.	Area.
					bus.		*acres.*
1	.....	Six-rowed, Ellis Co., 1902..	Mar. 30	July 10	30.01	45	3.81
2	.....	Two-rowed, Ellis Co., 1902..	" 29	" 15	21.84	46	3.63
3	7970	Black.....	" 29	" 14	19.27	46	1.38
4	7969	White	" 29	" 16	24.27	48	1.38
5	9133	Hanna.....	" 29	" 18	20.11	46	2.90
6	5789	From Austria.....	" 29	" 14	27.33	49	.09
9	7583	Beldi	" 29	" 13	20.61	46	.09
10	6601	From China (hull-less)....	" 29	" 19	13.88	41	.09
11	7584	Telli.....	" 29	" 14	33.24	39.5	.20
12	7796	Tetcherit	April 1	" 14	20.49	41	.09
13	6597	From China (hull less)	" 1	" 14	8.40	55	.09
14	7427	Albacete.....	" 1	" 14	23.63	44	.19
15	5591	Kitzingen.....	Mar. 30	" 14	18.07	47.5	.09
16	8809	Black.....	" 30	" 16	31.67	51.5	.40
17	5792	From Austria.....	" 29	" 16	26.65	48	.09

*Varieties of barley, wheat and other grains designated by numbers under this heading were grown in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture.

The ground plowed very nicely, and as most of it was disked before the crops were planted the spring before, the excessive rain had rotted the sod until it showed very little. The plows were run about an inch deeper than the breakers had gone, and by following with the packer and harrow it was put in good shape.

The field was laid out so that there would be the least chance for the previous crops to affect the yields of the variety and treatment of plats. Force enough was hired so that seeding was finished April 1. All the field, except forty acres, was given the same treatment—plowed, packed, and harrowed. The other forty acres was plowed uniformly and divided into plats, numbered and treated as follows: No. 11, harrowed; No. 12, packed; No. 13, packed and harrowed; No. 14, disked (run nearly straight) and harrowed; No. 15, not treated. All plats were drilled to barley, at the rate of one bushel per acre, with a disk press-drill. On another part of the field a drill without press wheels was used, in comparison with a drill with press wheels. The ground being very moist at seeding time, and heavy rains following, doubtless lessened the effects of the various treatments.

TABLE II. TREATMENT OF LAND TRIALS WITH BARLEY.

The land was all plowed alike, and other conditions, except treatment, were similar.

Plat No.	TREATMENT.	Date planted.	Date cut.	Yield per acre.	Area.
				bus.	*acres.*
11	Harrowed once after plowing.....	Mar. 30	July 15	28.12	7
12	Packed after plowing.....	" 30	" 16	30.01	7
13	Harrowed and packed after plowing..	" 30	" 18	29.35	7
14	Harrowed and disked after plowing...	" 28	" 18	30.35	7
15	Not treated after plowing	" 28	" 19	26.08	7
6	Drilled with press wheels after plowing and packing.....	" 26	" 20	23.58	14.74
7	Drilled without press wheels after plowing and packing.....	" 26	" 20	23.45	8

MACARONI WHEAT AND OATS.

The macaroni wheat sown on sod (same as barley) in 1902 was nearly a failure, The most of it was not sown until April 10, and 1902 was not a wheat year. It was harvested, and made a yield of two bushels per acre, which was perhaps better than the average of the total area of wheat sown in the county, as hundreds of acres were not harvested.

What is said under "Barley," as to preparation of land, etc., in 1903, applies to the macaroni wheat and oats also, as these were planted in the same field, on land plowed, packed and harrowed. It is only fair to say that all of these spring crops were planted two weeks later than they should have been.

SPRING WHEAT, 1903 (MACARONI).

TABLE III, showing yields of varieties.

Kansas F. H. B. No.	Cooperative, S. P. I. No.	NAME.	Date planted, 1903.	Date of ripening, 1903.	Yield per acre.	Test, lbs. per bushel.	Area.
					bus.		*acres.*
201	8212	Kubanka.....	Apr. 2	July 21	7.29	56	10.00
202	8213	Kubanka.....	Mar. 26	" 19	14.45	56.5	6.35
203	8230	Yellow Gharnovoka..	" 26	" 20	13.96	57	2.21
204	8232	Black Don.....	" 26	" 18	10.60	59	1.60
205	9478	Kubanka.....	" 26	" 18	16.13	59	7.06
206	9479	Velvet Don....	" 31	" 18	10.93	57.5	1.71

OATS—VARIETY TEST, 1903.

TABLE IV, showing yield of varieties.

Kansas F. H. B. No.	Cooperative, S. P. I. No.	NAME.	Date planted, 1902.	Date of ripening, 1903.	Yield per acre.	Test, lbs. per bushel.	Area.
					bus.		*acres.*
1	....	Texas Red (A)..	Mar. 25	July 16	36.75	31	7.90
2	....	Texas Red (B)..	" 25	" 12	40.67	31	1.36
3	....	Calgary Gray..	" 25	" 17	24.60	26	1.60
4	....	Neb. Sta. Yel...	" 25	" 16	34.82	30	1.89
5	9422	Swedish Select..	" 25	" 23	24.28	28	1.14
6	8650	N. Finnish Bl'k,	" 25	" 16	6.83	23	0.27
7	....	Bl'k Tartarian..	" 25	" 25	16.66	24	1.32

WINTER WHEAT.

As practically all the land was sod, no extensive culture tests could be made. The field selected for the variety test on 4-3-2, was broken in April, 1902, and, with the exception of a patch of melons, grew no crops. The sod was turned in July, the plow being run about an inch deeper than the breaker. A considerable growth of weeds had come up on the sod, but the plow turned them under well. The packer was run after the plow, to settle the soil. The land was harrowed after showers as follows: August 9, August 14, September 8, and seeding was begun September 16. The variety garden comprised about twenty-five acres, five acres being in another field, on 10-4, but very similar in every respect. Seeding was delayed at times by rains, and was not completed until October 22, there being approximately 200 acres planted.

The variety test comprised the planting of 164 varieties, most of which were furnished by the Bureau of Plant Industry of the Department of Agriculture. The amount of seed available varied from three grains to five bushels per variety. The field drill was used to plant all varieties of which there was a quart or more of seed. The smaller amounts were planted with a hand drill.

There were thirty-one varieties planted with the field drill, the plats carefully surveyed, and the yield of grain and straw computed. All varieties were carefully marked by a good stake, on which was

nailed a zinc tag, with the number and name of the variety written in weather-proof ink. Careful notes were taken on all varieties from the time of seeding until the thrashed grain was weighed and tested. The note-book used was furnished by the Bureau of Plant Industry, and called for the following observations: Date of seeding; date of coming up; germination; autumn condition–color, vigor, and manner and amount of growth; spring condition–survival, vigor, height; summer condition–manner of growth, stooling, character of leaf and stem, average date and uniformity of heading, hardiness; average date of and uniformity in ripening; character of head; average number of heads per plant; character of grain. There are many subheads, requiring a total of forty-nine observations for each variety.

VARIETY TEST OF WINTER WHEAT, 1902–1903.

TABLE V, showing yield of varieties.

Kansas F. H. B. No.	Cooperative, S. P. I. No.*	NAME.	Date of seeding, 1902	Date of ripening, 1903	Yield per acre	Test, pounds per bushel.	Area
					bus.		*acres.*
1	.....	Reservation Turkey.....	Oct. 4	July 14	38.75	57.	0.56
2	.....	Kreuger Turkey	" 4	" 14	36.95	57.	0.47
3	.....	Imported Turkey (1901).	" 4	" 12	39.10	57.5	0.44
4	7786	Kharkov, R. W. W.....	Sept. 16	" 8	40.90	56.5	4.63
5	7787	Beloglina, R. W. W.....	" 16	" 7	38.24	55.	1.89
6	5638	Ulta, R. W. W.....	" 18	" 6	36.25	58.	0.97
7	5636	Crimean, R. W. W.....	" 18	" 7	40.61	57.	0.85
8	5637	Ghirka, R. W. W.....	" 18	" 8	35.68	56.5	0.82
9	7466	Padi, R. W. W.....	" 18	" 15	19.88	53.	0.31
10	2791	Yaroslaf, R. W. W	" 18	" 13	6.44	.....	0.13
11	5635	Crimean, R. W. W.....	" 18	" 15	29.20	58.	0.15
16	1435	Crimean (Stand. Va.)...	" 19	" 9	37.02	57.	0.06
28	1436	Crimean (Kurman-Kene)	" 18	" 8	36.48	56.	0.30
29	1437	Crimean (from Altonau).	" 18	" 6	33.15	54.	0.30
30	1438	Ghirka, winter.....	" 18	" 8	28.44	55.	0.30
31	1439	Ulta.....	" 18	" 8	30.76	56.5	0.30
32	1441	Padi	" 18	" 14	18.06	53.5	0.30
33	1442	Kharkov	" 18	" 9	35.28	56.5	0.30
34	1558	Turkey.....	" 18	" 6	34.84	58.5	0.30
35	1559	Crimean (Miller's Imp.)..	" 18	" 6	36.27	59.	0.25
36	1560	Banat.....	" 18	" 6	36.94	60.	0.24
37	1561	Theiss.....	" 18	" 6	40.97	59.5	0.24
38	1562	Bacska.....	" 18	" 6	36.40	59.	0.24
39	1563	Weissenberg.....	" 18	" 6	39.53	59.5	0.24
40	1564	Pesterboden.....	" 18	" 6	36.59	59.5	0.24
41	1582	Padi	" 18	" 8	24.29	55.	0.24
42	1583	Kharkov	" 18	" 8	39.50	58.5	0.24
97	.....	Turkey (Nebraska).....	Oct. 4	" 13	37.19	54.5	0.41
98	.....	May wheat (Yost).....	" 4	" 12	29.40	57.	1.91
99	.....	Best heads, selection Turkey imp., 1901.....	Sept. 19	" 8	37.09	58.	0.19
100	.....	Best heads, selection Turkey common	" 19	" 8	38.61	58.	0.10

*All varieties having a number in this column were furnished by the Bureau of Plant Industry, United States Department of Agriculture, the "S. P. I." meaning seed and plant introduction."

The season of 1902–'03 proved to be an exceptional one for wheat. The winter was very mild; hence, only a small per cent. of the varieties showed any effects of the winter. While the spring was very moist, there was no marked effect of rust or smut. On the whole, although the season was very favorable for large yields, it was not typical of conditions which a profitable variety must be able to withstand in this section.

PREPARATION OF LAND FOR WINTER WHEAT.

On 16–1, about twenty-three acres, broken in 1901, was seeded to wheat very late. Much of it did not come up until the following spring and was late ripening. There were several days of warm, wet weather in July just as this wheat was filling, and it was very badly rusted. The majority of the fields were ripe at this time and were not so noticeably affected. In July, 1902, plat No. 5 of this field was plowed and packed. September 11, after a heavy rain, it was harrowed. At the same time in July, plat No. 6 was double-disked. Plat No. 7 was left in stubble. October 10, all three plats were seeded, the land being quite wet at the time. There seemed to be very little difference between the disked plat and the stubble, as the heavy rains had packed the ground. The drills did very good work, but the stubble on the disked plat bothered quite badly, as it was torn loose by the disk and left on top and clogged the drill.

The rains brought up the volunteer wheat and it made a big growth. It was also noticeable that the wheat seemed to be very much infected with rust. This doubtless injured the plants and left them infected, as the rust was more noticeable here than elsewhere the following spring, which perhaps accounts for a smaller yield than might have been expected. In the stubble the volunteer did not make as much growth as on the other plats, and hence there was less effect from the rust, which may account for the slight difference in yield between this and the disking. It is probable, owing to the rains which started the volunteer wheat, that if the disking had been done later it would have made a much better showing.

TABLE VI, showing yield of wheat on land plowed and packed, disked, and stubble.

Plat No.	TREATMENT.	Date seeded, 1902.	Date ripe, 1903.	Yield per acre.	Area.
				bus.	*acres.*
1	Plowed, packed, and harrowed..	Oct. 10	July 16	18.68	7.92
2	Double-disked.....	" 10	" 16	12.41	7.96
3	Stubble (no treatment).....	" 10	" 14	11.98	7.42

Disking Sod.

The breaking of the north half of 10–4 was begun May 25 and finished June 7, 1902. The late breaking did not admit of many weeds growing, and as seeding on sod is usually considered good farming, it was decided to try disking the sod. One plat, No. 1, twenty acres, was double-disked and harrowed just before seeding. This put the land in very good condition. Another plat, No. 2, was disked once and not harrowed. The disk was weighted, and cut the sod quite well, and gave the drill a better chance to cover the seed, The disk press-drill was used, and more pressure was put on the disks on the single disking, which made more work for the teams. Plat No. 3 was drilled on the sod without disking previous to seeding. All the pressure possible was put on the drill disks and the land was very rough, making it harder work in every way. The drill did not cover the seed well, but as the soil was very moist and rains followed seeding, there was a very good stand.

TABLE VII, showing yield of wheat on sod, double-disked, single-disked, and not disked.

Plat No.	TREATMENT.	Date seeded, 1902.	Date ripe, 1903.	Yield per acre.	Area.
				bus.	*acres.*
1	Sod double-disked	Oct. 12	July 13	33.85	19.67
2	Sod single-disked	" 15	" 15	25.18	16.26
3	Sod not disked	" 18	" 17	23.01	12.24

Early versus Late Breaking.

A strip of land ten rods wide along the section line on the west side of section 9 is to be planted to timber. The north half of this strip was broken during the first week in April. The south half was broken the last of June and first of July. The strip was double-disked and planted to wheat, seeding being finished October 22. This mile is very level, and there are numerous buffalo-wallows which were too wet to seed, and the wet spring following damaged the wheat in places. But the two halves are very similar in this respect, so the results may be depended on, and they also verify the common opinion that late breaking is the best for wheat.

TABLE VIII, showing yield of wheat on early and late breaking.

Plat No.	TREATMENT.	Date seeded, 1902.	Date ripe, 1903.	Yield per acre.	Area.
				bus.	*acres.*
1	Sod broken in April	Oct. 21	July 18	12.80	10
2	Sod broken in June and July	" 22	" 18	19.11	10

Bean Stubble versus Corn Stubble.

On the south part of 10–3, which was broken in April, 1902, a strip was double-disked and planted to corn, another strip was treated the same and planted to Early Yellow soy beans, and a small strip to cowpeas. The corn was planted with a disk-drill, in rows forty inches apart, and the beans in rows thirty-two inches apart. A good stand of both was secured and a good growth was made. The hot, dry weather in July and August badly damaged the corn, but it made good fodder and quite a few nubbins. The beans were quite badly choked by weeds, mostly ragweeds, which were very bad in places. The cowpeas did not stand the wind and sun as well as the soy beans. The crop was cut with a mowing-machine and made a quantity of feed.

As the ground had been double-disked in the spring, the wheat was drilled in the stubble with the disk-drill. This field is very level and water stood on it during the heavy fall rains; also in the spring of 1903. The straw grew very stiff, the heads were short but well filled, and the wheat was of a good quality.

TABLE IX, showing yield of wheat on bean stubble and corn stubble.

Plat No.	TREATMENT.	Date seeded, 1902.	Date ripe, 1903.	Yield per acre.	Area.
				bus.	*acres.*
1	Bean stubble.....	Oct. 14	July 13	15.78	18.36
2	Corn stubble.....	" 15	" 13	12.33	6.

KAFIR-CORN AND SORGHUM.

Kafir-corn is a very important crop in the drier sections, both for roughage and grain. It withstands the dry, hot, windy periods remarkably, and possesses a rallying quality that is wonderful. The crop may appear to be completely ruined, and if favorable conditions finally prevail, the resurrection which takes place can hardly be credited. Thus far the same may be said of cane or, properly, sorghum.

Sorghum is grown for the roughage alone, as the seed for feeding purposes is not considered valuable. It contains an astringent or bitter element that is distasteful to stock. But it is noticed that this property is more pronounced in certain varieties than others, and stock will readily eat the seed of some varieties.

Kafir-corn is a non-saccharine sorghum, and hence differs from cane or sorghum in that it is not sweet. The Kafir-corn seed, which appears in a head at the top of the stalk the same as sorghum, does not possess the bitter taste and is relished by all kinds of stock. In feeding tests conducted at the Station at Manhattan, Kafir-corn proved to be very nearly as valuable for fattening hogs as corn. The difference is about ten per cent. in favor of corn.

Kafir-corn grown for seed does best when planted with a lister in rows from three to three and one-half feet apart, and cultivated enough to about level the ridges. If seed alone is desired, a special plate should be used in the drill that will put a stalk every four to six inches apart. If the fodder is also sought, the seed should be much thicker. A common practice is to use the regular corn plate set to drop twelve to sixteen inches apart. This will drop a dozen or more grains at a place. When planted in rows the corn-harvester should be used for cutting the crop, and the bundles set up in good-sized shocks. When the heads are dry they may be thrashed with the ordinary thrasher. The most satisfactory method of harvesting the heads is to take a low wagon with a tight rack and a good-sized chunk laid across the back end, with two stakes set in it, about six inches apart at the bottom and one foot at the top, eighteen inches from the chunk. One man with a heavy broadax stands on the wagon and chops the heads off, as two or three others pick up the bundles and lay them on the chunk.

With two wagons and five men this is a very rapid way of obtaining seed. The bundles may easily be reshocked or laid in piles. The thrashing of the entire stalk is not satisfactory, if the stalks are of any size. It is very hard on a machine, and the fodder does not keep so well when cut up. It also dries out, which is undesirable. The practice would be similar to cutting bread for the table a month or so beforehand. It is not palatable.

For roughage alone, the general practice is to plant with the grain-drill at the rate of a half- to a bushel per acre, depending upon the land. This is cut with a mowing-machine, raked, and put in large cocks. A great deal of labor can be saved by using a buck-rake or "go-devil," to bunch the windrows. This is made by taking a 6x6 timber or a pole, or two 2x8, twelve feet long, rigged with five teeth four and one-half feet long. The end ones are placed two feet from each end, and the others two feet apart. A guard two feet high is put up at the back at a right angle with the teeth. On the ends of the timber a collar should be cut, so that a chain hooked around the ends will allow the timber to turn and keep the chain from slipping off. A rope or chain eight or ten feet long passes from the collars to the singletrees. By lengthening the inside checks the team will straddle the windrow. The teeth should be sharpened nearly to a center, and the buck works better if a shoe is put on at the back end of the two outside teeth, so as to raise the back six inches. If this is done, the teeth should be sharpened more from the bottom. By driving lengthwise of the windrows, the teeth gather the hay until the team has a load, when a second man lifts up on the back side of the buck. This

causes the teeth to catch in the ground, the buck turns over, and leaves the load in a pile. When the buck completes the turn, the teeth are held up until a load is left, when they are again allowed to take a load. When the windrow has been gone over once, half of it is bunched. By turning and going the opposite direction, the part of the windrow left is caught and brought up to the piles. Last fall (1903) sixty acres on the Station was handled this way. As labor was scarce nothing more was done to the feed. The buck left the bunches in very good shape, and but very little hand work would have been necessary to have made them as weather-proof as is necessary.

There are those who contend that two crops of sorghum or Kafir corn can be cut in one season, but it certainly is an erroneous idea. For the best feed, the crop should be nearly matured. When the seed is yet soft, so that it can be mashed by thumb and finger, is considered the time to cut for feed. If seed is desired it should be left a little longer; but it should not be allowed to stand too long if the fodder is to be fed at all, as it becomes very harsh and woody, and has very little value.

Kafir-corn for fodder is preferred by some feeders, while others prefer sorghum. Stock usually eat a larger per cent. of sorghum, as it is sweet. Horses will even eat the heavy stalks of sorghum, while this part of the Kafir-corn will usually be rejected. Sorghum that is planted too thinly and grows large stalks does not cure readily, and the freezing and thawing of the juice ferments it and it becomes sour. This objection holds especially if it is fed late in the spring. This is not true of Kafir-corn; hence it is a better late-spring feed.

A very common practice is to mix the sorghum and Kafir-corn about half and half. This gives variety, and doubtless makes the best feed.

The White Black-chaff Kafir-corn seems to be the hardiest as well as the best yielder. The Colman sorghum is an excellent variety for feed. It has a rather soft bark, which makes it more easily eaten by stock. The Black Dwarf is also quite promising on account of its being earlier than most other varieties.

CORN.

It is expected that the work here with corn will be rather unsatisfactory, but it is hoped that it may be possible to develop varieties that are better adapted to this section than are those grown further east. In 1902 about fifteen acres were planted on sod. A part of this was on the highest land on the Station, and, notwithstanding being planted late and on sod, there were many small ears developed. On a partially sheltered field on lower land, also on sod, there was considerably more corn. Parts of the field would have made ten bushels

per acre. While the moisture conditions of 1903 were quite favorable, the early part of the season was so unusually cold that, the corn was very backward. (For yield, see "Irrigated versus Not Irrigated.")

GRASSES.

Perhaps the most frequent inquiry made of the Branch Station is for a variety of grass suitable to the West. Clover, timothy, blue-grass, redtop, and other grasses familiar in the East, do not succeed here. From observations up to the present time, there is little more to be added to what is said of *Bromus* and alfalfa elsewhere in this bulletin. The work with grasses is in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture, and has comprised about forty plantings, mostly different species. The planting has been on too small a scale as yet to be of much significance. The season of 1903 was of course very favorable, and little could be said of the results, as all did well. However, in 1902 the season was not so favorable, and there was more to be observed. Two varieties especially distinguished themselves as being remarkably hardy — *Panicum bulbosum* and *Leptochloa dubia.* The latter proved an annual; so there is no need of saying more of it. *Panicum bulbosum* has no common name in this section, though there are near relatives of it growing wild, and seed has been collected and will be planted. The seed of the *Panicum bulbosum* is quite large, and easily obtained, which is a very important factor. The planting was made on sod ground well worked down, May 24. The seed came up readily and grew rapidly from the first. July and August were very hot, but this grass did not show the least effect of it. All the seed was saved, and the hay cut and weighed. It made a yield of two and one-half tons per acre. *Panicum texanum,* another species, was planted in 1903. This is also very promising.

Colorado bluestem, or wheat-grass *(Agropyron occidentale),* was also planted. This is a native grass, and will be given a thorough trial. The seed of this is easily obtained. In July, 1903, after harvest, the header was used to collect the seed in the pasture, where there were patches of it, and it was thrashed with the common thrasher.

The term "buffalo-grass" is used rather indiscriminately. There appear to be at least three grasses included under this name — the Side oat-grass, sometimes called Tall grama *(Bouteloua racemosa),* Short or Blue grama *(Bouteloua oligostachya),* and the true buffalo-grass, that sends out runners similar to the strawberry *(Buchloe dactyloides).* The seed of the two former can be obtained quite easily, as it is borne on rather tall stalks. But the true buffalo-grass

does not produce its seed in the same manner. The seed forms close to the ground, on the runners, and could only be procured by pulling up the runners. The runners sometimes form a mat so that a mower can be run under it, but this is not often the case. At present, it seems that the only method of obtaining the real buffalo-grass is to plant bits of the sod. An experiment was begun in 1903 to ascertain the distance apart to plant the sod.

For the present it appears that the grasses native to the West are the best, and that they should be carefully protected. Abandoned fields soon return to the native grasses, and will furnish more pasture than sod that has not been broken. The time required for the grasses to reset depends on many conditions. The wind is doubtless the main agent in scattering seed; so the size of the field would be an important factor, as there is a limit to the distance the seed would be carried. A large amount of seed would be produced during a favorable season, and would more readily germinate and retain its start. Animals doubtless carry seed, as well as trample it into the soil. The most effective remedy for the worn-out range is rest. The grasses form a protection for the soil, hold the moisture, and allow vigorous new plants to start. One year's rest will accomplish a great deal more than would be supposed.

HORTICULTURE AND FORESTRY.

It is a great surprise to visitors from the East to find so much native timber along the creek which courses through the Station.

As the reservation was occupied as a military post before the settlers came, the timber has been protected. An agent of the Bureau of Forestry, who has traveled quite extensively, found here the largest White ash that he had ever measured, which is five and one-half feet in circumference. There is also a venerable cottonwood measuring nineteen and one-half feet in circumference. Elm is the predominant species, and many of them are very large. Box-elder grows very large and thrifty. The hackberry is also found, which completes the list of those found in any numbers.

The timber is confined to the immediate banks of the creek, as the prairie fires have doubtless prevented its spreading. The width varies greatly at different points, but it will average, approximately, six rods, and, including the various bends, there is more than seven miles of this timber on the Station, which would comprise 100 acres.

Four thousand seedling cedars and pines of several varieties were planted in a nursery in 1903, to be used along the banks and in places where they will add to the picturesqueness of the belt. A shelter belt, south of the barns and stock-yards, was planted to honey-locust,

Osage orange, and cottonwood; also a large number of seedling honey. locusts are being grown for future planting.

From observation of trees growing on upland in this section, the honey-locust seems to be the most hardy. Old settlers say that they spent twenty-five years finding out what trees to plant, and that if they had known the honey-locust to be as hardy and desirable as it is, they would have had many more groves and shade-trees.

An orchard of apple, peach, plum, cherry, and crab, comprising over 300 trees, has been set. The location seems to be a splendid one, being a northeast slope, and good soil. Nearly every tree planted made a good start, and they were not first-class stock. A small vineyard and berry patch are also well started.

The work along these lines is considered very important and will receive full attention. It is hoped that the Bureau of Forestry of the United States Department of Agriculture will see fit to cooperate in this work, and that it will be given attention commensurate with its importance.

Irrigation Work in Cooperation with the Office of Experiment Stations, United States Department of Agriculture, 1903.

As there are many questions asked regarding irrigation in this section of Kansas, the work was begun with a view of obtaining some reliable information on the subject. The work was to be conducted by using the underground water, as the streams are usually dry when water is most needed. It is known in this section of the state that if the shale-beds are struck without finding water, it is useless to go further unless the shale is gone through, which may be from 200 to 500 feet.

Prospecting. The first prospect was made with a churn-drill with a six-inch bit. The location is about half-way up the rise from the creek bottom to the upland. Shale was found thirty feet from the surface and is overlaid by a thin stratum of sand, in which there is a small flow of water. The hole was sunk thirty feet into the shale which formed a basin, and the well furnishes enough water for a few head of stock.

At the second prospect –500 feet north of the first and eleven feet lower—just at the edge of the bottom, shale was found at the same depth, thirty feet, which shows that there is a dip toward the creek, which is eighty rods distant from the bottom well. Sand and rock were encountered at the second prospect twenty feet down, and contained an abundant flow of water. This was dug out six feet in diameter, and is used to furnish water for general use on the Station.

Four other prospects were made in the vicinity and showed the same dip of shale. Two of these were dry and were also on the bottom, but further from the stream, which has an easterly course at this point. The two others would have made fair wells, are near the creek, and show the shale to have a dip of about 10 feet in 500 towards the creek. One prospect was made on high land nearly one-half mile from the creek. Shale was found at a depth of forty-seven feet, and no water at all.

A prospect was made one-half mile down the creek from the location of these mentioned. The creek at this place runs east for nearly half a mile, then south the same distance. The bottom here is wide and slopes toward the southeast. The best location for a well on this bottom was at the upper northwest end, near the creek. Shale was found at the depth of forty feet, but above this shale was about fourteen feet of sand and gravel, much of which is very coarse. At this place the irrigation well was put down. However, another prospect was made here, fifty rods back from the creek, and nearly the same conditions found as at the first. A mile further down the creek two prospects were made, in a rather small bend near the bank, and very little water was found. The last prospect made was on the highest land on the Station and nearly a half a mile from the creek. Shale was found at sixty-two feet, and above it was found ten feet of sand containing water. The prospector said he saw no reason why it would not be just as strong a flow of water as any found. In all, twelve prospects were made, only five of which showed strong flows of water; and it is doubtful if more than three of these would furnish water enough for irrigation purposes,

THE IRRIGATION WELL. The location is in the northwest corner of the northeast quarter of section 9, and near the creek. Excavation was begun April 11. The well is circular and thirteen feet in diameter. As soon as necessary a hoist was arranged and operated with a traction-engine. Three-quarter kerosene barrels with bails arranged to dump were used to hoist the dirt.

The first water was struck at twenty-four feet, in a layer of very fine sand and clay—nearly quicksand. Below this a hard stratum of dark gumbo was found. The water coming through the fine sand caused trouble immediately, as the soil above caved. The gumbo below the sand was not solid enough, as was found after considerable work, to lay a temporary wall on. A heavy curb was then built of three-inch lumber by cutting the plank in segments and spiking them firmly. Four thicknesses were placed, one on top of the other, and spliced so as to make the curb eighteen inches wide. The inside diameter of the curb was made nine and one-half feet, which made

the outside twelve and one-half feet, so that it easily went into the well. The two lower courses of the curb were set in three inches, so that blocks of plank about one foot long, sharpened from one side, could be spiked against these and form a cutter around the curb; and as the blocks were sharpened from the inside the edge of the cutter was flush with the outside of the curb. This curb was lowered and set and an eighteen-inch wall of rock laid on it. The stone was carefully dressed, wedge-shaped, and chinked with spalls, as there was a great deal of pressure exerted against this wall. After a few courses of rock were laid, sand and mud were taken from the inside of the curb which allowed it to settle, and as it settled more stone was laid on top.

As soon as the flow of water began to bother, a Knowles pump with a four-inch discharge and five-inch suction was set in a frame suspended from the top, and later set on a plank laid on the wall and raised when necessary.

After the fine sand and gumbo were passed, the wall was sunk in clean sand and gravel to shale, which was sixteen feet below where the curb was set. For the last five feet the water gave a great deal of trouble, and it was necessary to get another boiler to supply the stream for the pump,

The superintendent of the Union Pacific railway water service said at the time that the pump was throwing 22,000 gallons per hour. The flow of water brought in a great deal of sand, and it was necessary to take out, perhaps, several times the volume of the well. This also made it necessary to fill in behind the wall after shale was reached. The wall was built of stone to a point above the water and cave, then finished with brick.

The water rises sixteen feet in the well, or within twenty-four feet of the surface. Just under the surface of the water two 8x10 timbers were laid in the wall across the well to support the pump. Timbers were also put in at intervals of seven feet above the water to support the shaft, as the vertical style of pump is used.

The pump, a four-inch vertical centrifugal, is hung in a frame, four feet below the surface of the water. This insures the pump being primed when starting, and it doubtless would be an advantage to have the pump even lower. The frame at the top of the well is built very strong, as the pull of the engine is against the shaft. The pump is operated with the traction-engine, and the regular thrasher belt used.

COST OF WELL. While it may appear that the following statement aggregates quite high, it is believed to be very nearly what a well of this kind, under the same conditions, may be expected to cost. At the beginning it was not known what would be encountered in

putting it down. There is no doubt, however, that another well could be put down at less cost, as the conditions are now understood. The superintendent of the work was a former employee of the Union Pacific railroad water service, and was paid $3 per day; engineers, diggers, and masons, $2, and common helpers, $1.50 per day. Following are the items of expense:

Labor of digging, walling, etc		$398 42
Use of engine, 19½ days, at $3		58 50
Coal for engine, ½ ton per day, at $6		58 50
11.8 cords of stone, at $9.25		109 15
2500 brick, at $13.25 per M		33 12
4 sacks cement, at $1.05		4 20
3x15 plank used in curb	608 ft.	
2, 8x10, 12	160 "	
9, 6x6, 12	324 "	
2, 8x8, 16	170 "	
Boxing for pump	100 "	
	1,362 ft. at $30 M.	40 86
Team, 4 days, grading		10 00
200 ft. 1-inch rope		13 00
2 barrels		2 00
Blacksmith work		15 00
Pump, 4-inch centrifugal, complete		115 37
Freight		7 53
Total		$865.65

THE IRRIGATION FIELD. The field in which the irrigation plats are located was broken in May, 1902. No crop was grown on the sod and it was not plowed again until March, 1903. The plows were then run deeper than the breakers had gone, and the land was packed and harrowed immediately afterward. As the spring was cold and wet, and the work generally delayed, the ground became very weedy, and was plowed, packed and harrowed before planting, in May.

The plats, nine in number, were laid out to secure the most uniform slope from the well. They contain two acres each, and are sixty rods long, with an alley dividing them crosswise at the middle. The well is at the northwest corner, and the plats extends southeast from the well. Only the north half of each plat is irrigated; the south half being given the same treatment in every other respect.

The soil is a dark loam, with enough sand to make it work nicely, but not enough to make any trouble from seepage. As indicated in the digging of the well, the soil has the same color and appearance in every respect from the surface to water. Beginning about five feet from the surface and extending three or four feet further, a dry stratum is found. The soil is harder here than above or below, but not different in other respects.

CROPS. The 1903 planting was much later than it should have been, the potatoes being planted May 18–26, and the corn and beets at the same time. But the ground was in good condition and everything started nicely. The Kaw valley Early Ohio seed potatoes were very poor in quality, largely owing to the lateness of the season. Cabbage was not planted until June 22. All planting was done in the ordinary manner, and ordinary cultivation was given the crops. On July 10 it began to appear that the crops needed water, so the pump was started.

A one-foot weir was used in measuring the water pumped, and as it had been made for some time and was not properly set, it gave considerable trouble and prevented getting an accurate record. The crops were given one irrigation, the water being run down each row, but the soil had been thrown up against the row so that the plants were not submerged. It was found to be a great advantage to have the furrow well cleared for the water to run in, or the upper ends of the rows would become too wet.

The fall in the field is one and one-half feet to thirty rods, which appears to be about right. By having the furrow wall cleared, and running the full flow of the pump into one row, the water will run the full length of the plat in thirty minutes and will wet the soil very nicely between rows. The amount of water taken up by the soil would greatly surprise the beginner. By running the water down every other row (rows three and one-half feet apart), two and one-half inches is required; that is, the amount of water required would cover the whole plat two and one-half inches deep.

COST OF IRRIGATION. There are various changes that will be made in the plant used that will increase its efficiency. The total lift of water when the pump is taking the full capacity of the well is forty-two feet. The average as registered by the weir, and which was low on account of leaks, is 0.52 cubic foot per second. The discharge would equal 4.96 acre-inches in ten hours. (An acre-inch is the amount of water required to cover one acre one inch deep.) The engine, a twelve-horse-power J. I. Case traction, consumed an average of 113 pounds of coal per hour. The coal used is from the Leavenworth mines and is of very poor quality. The plant requires an engineer, and one man to attend the water.

Only one irrigation of the crops was made — from July 11 to 24 — and a total of 99½ hours, pumping was required to cover seven acres, including all the crops mentioned in the tables. This, at the average rate of discharge of the pump, covered the seven acres 7.33 inches deep, or made 51.31 acre-inches, with an average lift of forty-two feet.

With coal at $6 per ton, engineer at $2 per day, and water-

tender at $1.50 per day, it makes the cost of water for these items, delivered on the field, $1.41 per acre-inch; but with the improvements that will be made, this cost can, without doubt, be considerably reduced.

When the water in the well is at its highest point, which submerges the pump four feet, there is a total lift of only twenty-eight feet. The discharge of the pump is practically double what it is at a lift of forty-two feet. This would reduce the cost to one-half, if the water would hold at its highest, which shows the advantage of shallow wells, and the disadvantage of deep ones.

It may be said in justice to the subject that the work done should hardly be considered as fully representing the possibilities. The season was unusually rainy, the land new, the seeding late, and no previous expenditure had been made. The work will be carried on from year to year, and it is expected that the results will be more satisfactory.

RAINFALL AND EVAPORATION. A rain-gage and evaporation tank were kept in the field. The former was the government type, and the latter consisted of a galvanized-iron tank three feet deep and three feet in diameter, set in the ground so that the top of the tank was a few inches above the surface. This was kept filled with water to within six or eight inches from the top, and measurements were made every week. The evaporations for any period would be the difference between the readings at the beginning and close of such period, less the rainfall.

Table XIV gives the rainfall and evaporation by periods from the beginning of the crop-growing to the first killing frost, May 25 to September 13 (1903):

TABLE X, showing yield per acre of irrigated and not irrigated potatoes.

VARIETY.	Width between rows.	Yield per acre.			Gain by irrigation.		
		Large.	Small.	Total.	Large.	Small.	Per ct.
	inches.	*bus.*	*bus.*	*bus.*	*bus.*	*bus.*	
Burbank, irrigated	36	63.92	41.25	105.17	37.26	14.03	95
Burbank, not irrigated	36	26.66	27.22	53.88			
Kaw Valley Ohio, irrigated	36	39.83	37.22	77.05	21.93	6.52	59
Kaw Valley Ohio, not irrigated	36	17.85	30.70	48.55			
Kaw Valley Ohio, irrigated	30	49.51	32.63	82.16	30.86	4.31	75
Kaw Valley Ohio, not irrigated	30	18.65	28.32	46.99			

While the yield was low, the results of irrigation are very marked. The low yield can be attributed to the late planting, as there were not a large number of potatoes in a hill; also, the land being new, did not admit of best results.

TABLE XI, showing yield per acre of irrigated and not irrigated stock beets.

VARIETY.	Yield.		Gain due to irrigation.	
	Irrigated.	Not irrigated.		
	pounds.	*pounds.*	*pounds.*	*per cent.*
Mangel-wurzels	42,100	31,200	10,900	35

Cabbage was irrigated twice, July 10 and 23.

TABLE XII, showing effect of irrigation on cabbage as compared with that not irrigated.

VARIETY.	Total plants.	Number of good heads.	Second-grade heads.	Average weight per head.	Plants not producing heads.	Per cent. of plants did not produce heads.
"Sure Head."						
Irrigated	456	195	141	2.88	120	26.5
Not irrigated	456	94	111	2.27	251	55.

TABLE XIII, showing the yield of varieties of corn, irrigated, not irrigated, and gain resulting from irrigation.

Variety.	Yield per acre.		Gain per acre due to irrigation.	
	Irrigated.	Not irrigated.		
	bushels.	*bushels.*	*bushels.*	
Smith Center Yellow	45.14	37.14	8	22%
Minnesota No. 13, No. 2	34.66	27.14	7.52	28%
Colorado Yellow No. 1	23.52	20.47	3.05	15%
Australian White No. 2	38.17	27.83	10.34	37%
Colorado No. 3	35.94	27.83	8.11	29%

While it is not expected that corn will be a crop that it will pay to irrigate, it is important to know whether irrigation will prevent the damage done by hot winds or not.

TABLE XIV, showing rainfall and evaporation.

Period.	Rainfall.	Evaporation.
	inches.	*inches.*
May 26–30	3.87	.396
May 30 to June 6	.25	.324
June 6–13	.25	1.500
June 13–20	1.64	.636
June 20–27	1.70	.720
June 27 to July 4	.00	1.980
July 4–11	.03	2.160
July 11–18	.23	1.200
July 18–25	.00	1.728
July 25 to August 1	2.27	1.044
August 1–8	.00	1.236
August 8–16	1.74	2.136
August 16–22	1.64	2.952
August 22–30	.32	1.208
August 30 to September 5	.13	1.464
Totals	14.07	20.684

Four boxes, two feet square, twelve inches deep, lined with zinc, were also used in evaporation trials. These were set in the ground, so that the edges were a few inches above the surface. One contained water and the other three earth. All were filled and carefully weighed before setting in the ground. No. 1 was set in a bend of the creek where there was partial protection, and where the wind could not blow over it too strongly. Nos. 2, 3 and 4 were located at the edge of the irrigation field.

The following table gives the weights, water added and evaporation from the respective tanks, covering a period from July 10 to October 20, 1903:

TABLE XV, showing evaporation from tanks.

TREATMENT.	First weight.	Water added.	Final weight.	Evaporation.
	lbs.	*lbs.*	*lbs.*	*lbs.*
No. 1. Soil not cultivated	332.75	83.00	364	51.75
2. Soil cultivatad	329.75	83.00	329	83.75
3. Soil not cultivated	333.75	83.00	327	88.75*
4. Water	249.50	186.75	174	262.25

*It is feared that the low evaporation shown is incorrect, as it appeared that a badger, in digging beside the box, threw some soil into it, which would seem to decrease the evaporation by diminishing the total loss of weight.

The rainfall is not taken into account, as it is supposed that it was the same on all the tanks, and would not show in the relative results.

METEOROLOGICAL OBSERVATIONS, 1903-'04.

It is probable that the three years covered by this bulletin are somewhat above the normal in rainfall. The unusual rainfall of the eastern part of the state doubtless affected the climate by lowering the temperature and keeping the air more humid. The season of 1903 could be called very favorable, as the ground was well filled with moisture by heavy rains during the fall of 1902. The fact that the ground was well filled with moisture during 1903 doubtless accounts for so favorable results with crops in 1904. The rainfall of 1904, while deficient, was very evenly distributed through the growing season.

The following tables give the observations in detail, after instruments were provided.

METEOROLOGICAL RECORD from March 1 to August 31, 1903.

Period.	Temperature.*			Clear days.	Partly cloudy.	Cloudy.	Prevailing winds.	Precipitation.	Soil condition.	Season conditions.
	Max.	Min.	Mean.							
								inches.		
March 1-10	.....	.....	30 8	3	3	4	N.	.00	Cold, wet.	Foggy and misty.
March 11-20	.....	.....	37.5	3	6	1	S.	.275	Wet.	Chilly, misty.
March 21-31	.....	.....	33.2	5	5	1	S.	.137	Good.	Light snows; seeded spring grains.
	.....	.....	34	11	14	6	S.	.412		
April 1-10	.....	.....	45	5	4	1	N. & S.	.175	Good.	Light rain and snow, hard winds.
April 11-20	.....	.....	42.3	5	3	2	N. & NE.	.00	Good.	Two showers, frost three times.
April 21-30	.....	.....	42.4	4	4	2	N. & S.	1.65	Good.	Good rain and snow.
	.....	.....	43	14	11	5	Northerly.	1.825		
May 1-10	77	33	55	4	2	4	S. & SE.	3.15	Wet.	Rainy, foggy.
May 11-20	89	39	64	2	7	1	S. & SE.	.06	Good.	Mist and threatening storms.
May 21-31	87	43	68	3	5	3	N., S., & E.	5.53	Wet.	Rain on all but three days.
	84	38	61	9	14	8	SE.	8.74		
June 1-10	83	44	63.5	0	7	3	N. & NW.	.58	Wet.	Misty, rainy.
June 11-20	93	40	66.5	4	6	0	S. & SE.	1.58	Wet.	Rain and threatening rain.
June 21-30	97	49	73	4	5	1	S. & SE.	1.86	Wet.	Calm days, some rain.
	91	44	67	8	18	4	Southerly.	4.02		
July 1-10	101	49	75	6	4	0	S.	.00	Good.	Fair days and warm.
July 11-20	102	52	77	4	6	0	N.	.21	Good.	Fair, high barometer.
July 21-31	97	53	75	5	4	2	S. & SE.	2.57	Good.	Some mist, cool.
	100	51	76	15	14	2	Southerly.	2.78		
Aug. 1-10	97	51	74	3	7	0	N. & S.	.17	Good.	Threatening storms.
Aug. 11-20	89	58	73.5	0	8	2	NE.	3.68	Wet.	Damp, cool.
Aug. 21-31	96	48	72	2	9	0	S. & SE.	.00	Good.	Traces of rain, hazy.
	94	52	73	5	24	2	Southerly.	3.85		

*Maximum and minimum thermometers not received until May 1; reading, 7 A. M.

Meteorological Record from September 1, 1903, to February 29, 1904.

Period.		Temperature.			Clear days.	Partly cloudy.	Cloudy.	Prevailing winds.	Precipitation.	Soil condition.	Season conditions.
		Max.	Min.	Mean.							
									inches.		
Sept.	1-10	95	38	66.5	6	4	0	NW. & SE.	.00	Fair.	Favorable.
	11-20	93	30	61.5	4	4	2	N.	.02	Fair.	Killing frost, hurt fodder.
	21-30	95	30	62.5	7	3	0	SE. & S.	.48	Fair.	Plowing, seeding wheat.
		94	37	65.8	17	11	2	Southerly.	.50		
Oct.	1-10	90	28	59	7	3	0	NW. & SE.	.00	Good.	Plowing, seeding wheat.
	11-20	91	28	59.5	5	2	3	NW.	1.04	Good.	Season slow.
	21-31	83	26	54.5	7	2	2	NE. & SE.	.13	Fair.	Wheat making little growth.
		88	27	57.6	19	7	5	NW. & SE.	1.17		
Nov.	1-10	70	29	49.5	5	2	3	E., SE.	.28	Good.	
	11-20	57	3	30	8	2	0	S., SW.	.00	Fair.	
	21-30	.....	.....	.....	.....	.....	.....	.....	.....		
		.....	.....	.....	.....	.....	.....	.....	.28		
Dec.	1-10	65	9	37	7	3	0	NW.	Trace.		
	11-20	59	4	31.5	6	4	0	NW., SE.	.00		
	21-31	63	18	40.5	.....	.....	.....	.....	.....		Winter was exceptionally dry; snow came in flurries, and usually not measurable. Frequent high winds, with dry atmosphere. Such conditions prevailed until May, almost.
		62.3	10	36.8	.....	.....	.....	.....	.....		
Jan.	1-10	65	4	34.5	6	2	2	NW., SE.	.00		
	11-20	56	15	35 5	5	4	1	S., NW.	Trace.		
	21-31	50	-6	22	5	6	.....	NW.	Trace.		
		57	4.3	30.4	16	12	3	NW.	.....	Dry all month.	
Feb.	1- 9	69	3	36	5	3	1	NE., S.	.....		
	10-19	57	-1	28	2	5	3	SE., NW.	.....		
	20-29	75	10	42.5	6	2	2	N., S.	.....	Still dry.	
		67	4	35.5	13	10	6	N. & S.	.....		

METEOROLOGICAL RECORD from March 1 to August 31, 1904.

Period.		Temperature. Max.	Min.	Mean.	Clear days.	Partly cloudy.	Cloudy.	Prevailing winds.	Precipitation.	Soil condition.	Season conditions.
									inches.		
March	1–10	86	5	45.5	5	2*	1	NW., SE.	.02	Dry surface.	High winds, dusty atmosphere.
	11–0	80	17	48.5	4	4	2	NW., SE.	.00	"	Poor for plowing.
	21–31	76	16	46	2	7	2	NW., SE.	.08	Subsoil good.	Dry and poor for seeding; winds continue.
		80.6	12.6	46.6	11	15	5	NW., SE.	.10		
April	1–10	67	19	43	4	5	1	NW.	Trace.	No change.	Dry, dusty.
	11–20	74	16	45	6	2	2	NW., NE.	.01	Still dry.	Dry plowing.
	21–30	75	34	54	4	3	3	SE., NW.	.87	Improving.	Grass starting; plowing for crops; a little better for seeding.
		72	23	47	14	10	6	NE., NW.	.88		
May	1–10	84	37	60.5	3	5	2	SE.	2.52	Good.†	First rate; good for garden and spring seeding.
	11–20	78	32	55	4	4	2	SE., SW.	.24	Splendid.	Trees leafing; fine conditions.
	21–31	93	45	69	3	6	2	SE.	.23	Good.	Windy; some warm winds.
		85	38	61.5	10	15	6	SE.	2.99		
June	1–10	88	45	66.5	4	2	4	SW., SE.	.81	Mellow, good.	Good for cultivating; early vegetables ripe.
	11–20	89	52	70.5	3	5	2	SE.	.77	Fine.	Heavy dews and fogs; favorable to rusts.
	21–30	91	40	65.5	2	6	2	S. & E.	2.75	Good.	Good for cultivating crops; moisture bad, acct. rust
		89.4	45.6	67.5	9	13	8	SE.	4.33		
July	1–10	93	60	76.5	2	6	2	E. & S.	1.15	Good.	Fine for cultivating.
	11–20	99.5	58	78.7	8	2	0	S.	1.02	Fine.	Drying up more; crops doing well.
	21–31	94	56	75	7	4	0	SE., E.	.16	Good.	Favorable.
		95.5	58	76.7	17	12	2	S. & E.	2.33		
Aug.	1–10	96	55	75.5	6	4	0	E.	1.25	Good.	Good for plowing; fogs and wet.
	11–20	98	60	79	6	2	2	SE.	1.87	Good.	Very good.
	21–31	100.5	45.5	73	6	4	1	SE.	.04	Fair.	Cooler, and good for plowing.
		98	53.5	75.8	18	10	3	SE.	3.16		

*Also two very dusty days. †Two days too wet.

METEOROLOGICAL RECORD from September 1 to December 31, 1904.

Period.		Temperature.			Clear days.	Partly cloudy.	Cloudy.	Prevailing winds.	Precipitation.	Soil condition.	Season conditions.
		Max.	Min.	Mean.							
									inches.		
Sept.	1-10	99	45	72	7	2	1	W., NW.	.02	Fair.	Drying in places.
	11-20	98	41	69.5	4	3	3	NE., SE.	Trace.	Cloddy, dry.	Somewhat dry for plowing.
	21-30	96	52	74	1	5	4	S. & E.	1.05	Fair.	Improved by rain.
		97.6	46	71.8	12	10	8	SE., NE.	1.07		
Oct.	1-10	89	44	66.5	4	4	2	S., W.	.02	Dry.	Fine for cutting feed, etc.
	11-20	88	27	57.5	4	2	4	S., SE.	.16	Dry.	Showery, colder.
	21-31	80	20	50	10	1	0	W., NW.	.00	Dry.	Beautiful days, but too dry.
		85.7	30	58	18	7	6	S. & W.	.18		
Nov.	1-10	73	22	47.5	5	4	1	W., SW.	.31	Dry.	
	11-20	77	19	48	7	3	0	W., NW.	.00	Poor.	
	21-30	73	10	41.5	7	3	0	NW.	.00	Poor.	November and December were very dry; the few showers and snowfalls made little moisture, and it did not penetrate the soil to any depth.
		74.3	17	45.6	19	10	1	W., NW.	.31		
Dec.	1-10	68	10	39	4	3	3	N., W.	.38	Dry.	
	11-20	50	3	26.5	3	5	2	NW., SW.	.03	Dry.	
	21-31	63	0	31.5	6	3	2	S, NW.	.08	Dry.	
		60	4	32	13	11	7	N., W.	.49		

Total rainfall, March 1 to December 31, 1903, 23.577 inches.
Total rainfall, January 1 to December 31, 1904, 15.84 inches.

Variety Tests of Small Grain

REPORT on the work of the Fort Hays Branch Experiment Station of the Kansas State Agricultural College, in cooperation with the Bureau of Plant Industy of the United States Department of Agriculture, 1904.

The work of 1904 is a continuation of the work begun in 1903, There are no changes of consequence to be noted, and there are few additions of varieties to be mentioned.

The varieties under trial are those furnished by the bureau, and consist of winter wheats, durum or macaroni wheats, barley, oats, rye, and millet. The end sought in the trial of varieties has been to determine the best yielding and most profitable varieties. It is intended that the general term "profitable" shall include all other desirable and necessary qualities.

No hybridizing has been done here, as the number of varieties already in the trial require all the attention that can be given to such work. The plan is to grow the varieties for a series of years under, as nearly as possible, the same conditions, and, by comparing results, determine the most profitable ones. The plan varies with hybrids, as will be noted.

WINTER WHEAT. The fall of 1902, 149 stocks of wheat were received, varying from three grains to four bushels. These were planted and, with few exceptions, produced abundantly. As the amount of seed varied, there was no uniformity in size of plats. The yield was measured on all varieties of which there was seed for one-tenth of an acre or more. (See earlier pages in this bulletin.)

The present year, all varieties of which seed sufficient for an acre was secured in 1903 were planted in one-acre plats. This included varieties Nos. 4 to 11, inclusive, No. 16, and Nos. 28 to 41, inclusive. (Fort Hays Nos.) A few other varieties were planted in small plats to increase seed. All varieties, except the numbers given above, were grown in 100th-acre plats, except some of the selections made from hybrids, of which there was not sufficient seed secured.

The yields given of the 100th-acre plats may be comparative, but in handling so small an amount the chance for error is certainly much greater than in the case of acre plats. However, the work was done with care, and it would appear that by taking the average of the yield secured in three to five consecutive years the results would be sufficiently reliable to determine the relative merits of the varieties. At the end of three to five years the results should justify the elimination of a great many varieties that have proven undesirable. In this way the work in the larger plats in the field would be reduced, as it is very apparent that many of the varieties will not prove at all profitable.

HYBRIDS. The hybrids were planted in the same manner as the

other plats and given the same treatment, except in harvesting. In nearly all hybrids plants were found to resemble each parent, with all gradations between. In 1903 it was possible to select as many as five distinct types from a single hybrid. The hybrids were gone over and selections made of the different types or characteristics. These were planted separate, and the present year it was again possible to make further divisions of the selections made in 1903, showing that variation still continues.

Counting each stock, or selection, a variety, the increase has been approximately as follows: Planted, 1902, 150 varieties; increased by selection, 1903, 46 varieties; increased, 1904, 180 varieties — giving a total of 350 varieties now growing.

WEATHER CONDITIONS. As the fall of the previous year is in a large measure responsible for the winter-wheat crop, the summary must begin then. The spring and summer of 1903 were unusually wet, which put the soil in better condition for fall seeding than it otherwise would have been.

The following is a report of the rainfall by months, which probably influenced the crop being reported:

1903.—April	1.82	inches.	1903.—September	.50	inches.
May	8.75	"	October	1.17	"
June	4.02	"	November	.00	"
July	2.78	"	December	.00	"
August	3.85	"	1904.—January	.00	"
			February	.00	"
			March	.10	"
			April	.88	"
			May	2.99	"
			June	4.33	"
Total	21.22	inches.	Total	9.97	inches.

It will readily be seen that the spring and summer rains of 1903 would leave the subsoil fairly well supplied with moisture. The rains of September and October were small and scattering, and did not wet the soil to any great extent.

All the seeding was done in September and October and a good stand was secured. Although the wheat came up readily, it seemed to make very little growth, and the growth made was very spreading. No measurable moisture fell from November 1 to March 4, when a snow fell, giving 0.02 inch of water. A shower measuring 0.08 inch fell March 31, after which no more fell until April 20, making a period of 170 days with but 0.10 inch of moisture.

Notwithstanding this dry period, the wheat made a good growth with the rains of April and May, and there was a prospect of a much better yield than was secured. While the rainfall of June does not indicate a wet month, there were but nine wholly clear days, thirteen

partly cloudy, and eight wholly cloudy, and a measurable rainfall on ten days; the average maximum temperature being 89°, average minimum, 45°, and average mean, 67°. A number of days were foggy, and there was dew nearly every morning.

About the time the heads began to appear, the bottom leaves were noticed to be badly affected with red rust. The weather during the whole month being very suitable for the development of rust, by the 24th of June it was very bad, especially on the late varieties. Between this time and July 1 the "black" rust spores appeared. The ruptures of the epidermis by the spores were not confined to the leaf and stem, but extended to the chaff and beards. It is thought that at least fifty per cent. of the decrease in yield from 1903 is due to the effects of rust. These observations will apply to rust on the spring grains as well.

During harvest there was no interference from weather conditions, and none during thrashing.

All plats of more than one-tenth acre were harvested and thrashed with the regular machinery. The smaller plats were harvested by hand and thrashed with the "nursery" thrasher, a small thrasher run by a one-and-one-half-horse-power gasoline-engine. The grain from the larger thrasher was weighed as it came from the machine; that of the smaller plats was put through a fanning-mill, there being no cleaning apparatus on the small separator.

The "test," or weight per bushel, was also taken, and is considered a very essential factor in determining the merit of a variety.

The land on which the acre plats grew is situated on the highest land on the Station upland. It was broken in 1902 and grew a crop of sorghums. It was plowed in 1903 in the spring, and grew a crop of macaroni wheat and oats. As the land was well plowed in the spring, it was double-disked and harrowed as a preparation for fall seeding. The plats of wheat were sown crosswise of the plats of the previous crop, to mitigate any difference in soil condition as a result of the previous crop.

The smaller plats were on lower land, but very similar in every other respect. A crop of sweet corn and potatoes had grown previous to planting. It was noticed that the rust affected the lower land crops somewhat worse than the upland. Tables XVI and XIX give the yields of all varieties sown to the extent of one acre or more.

TABLE XVI. Wheat varieties (winter).

Station No.	NAME.	C. I. No.	Date seeded, 1903.	Rust resistance.	Date ripe, 1904.	Yield per acre.	Area.	Test per bushel.
						bus.	*acres.*	*lbs.*
1	Reservation Turkey	.....	Sept. 28	80%	Aug. 2	10.23	1.00	57.5
3	Imported Turkey	.....	" 28	85	" 1	10.13	1.00	56.5
4	Kharkov	2193	" 28	90	" 1	17.75	1.00	60.0
5	Beloglina	1667	" 28	85	" 1	9.16	1.00	58.0
6	Ulta	1439	" 28	85	" 4	10.36	1.00	59.0
7	Crimean	1437	" 28	85	" 5	10.23	1.00	55.0
8	Ghirka	1438	" 28	80	" 6	8.40	1.00	55.0
9	Padui	1582	" 29	80	" 7	3.04	1.00	43.0
10	Yaroslav	1347	" 29	85	" 5	2.48	1.00	46.0
11	Crimean	1436	" 29	85	" 5	4.46	1.00	55.0
16	Crimean	1435	" 30	80	" 5	10.59	1.00	57.0
28	Crimean	1436	Oct. 2	80	" 4	8.53	1.00	56.0
29	Crimean	1437	" 2	85	" 4	10.73	1.00	57.0
30	Ghirka	1438	" 2	80	" 5	9.00	1.00	56.5
31	Ulta	1439	" 2	95	" 2	10.18	1.00	57.0
32	Padui	1441	" 2	75	" 4	3.48	1.00	43.0
33	Kharkov	1442	" 2	85	" 3	10.12	1.00	59.0
34	Turkey	1558	" 2	85	" 4	9.56	1.00	56.5
35	Crimean	1559	" 2	85	" 1	11.13	1.00	57.0
36	Banat	1560	" 3	90	" 5	11.40	1.00	57.0
37	Theiss	1561	" 3	85	" 2	9.16	1.00	56.0
38	Bacska	1562	" 3	80	" 1	10.16	1.00	55.0
39	Weissemberg	1563	" 3	80	" 1	11.20	1.00	56.0
40	Pesterboden	1564	" 3	80	" 3	8.05	1.00	55.5
41	Padui	1582	" 5	75	" 5	2.95	1.00	59.0
42	Kharkov	1583	" 5	85	" 4	12.08	1.00	57.0
97	Nebraska Turkey	.....	" 6	85	" 4	11.51	1.00	57.0
99	Common Turkey	.....	" 8	80	" 4	9.17	3.56	56.0
100	Imported Turkey	.....	" 8	80	" 4	8.53	2.36	56.5
99-2	Best head selection	.....	" 6	90	" 1	11.86	1.00	57.0
100-2	Best head selection, 1902	.....	" 6	90	" 1	11.73	1.00	56.0

MACARONI WHEAT. (For weather conditions, see Winter Wheat.) Seeding was done in good season, but the soil was too dry. The land was plowed in late fall and as there was no rain or snow until after seeding, it did not germinate. Owing to lateness of maturing, the rusts practically ruined all the varieties, and the grains partly formed when the rust became so bad that the growth was entirely stopped. Table XVII gives yields.

TABLE XVII. Macaroni wheat. Variety tests, 1904.

Station No.	NAME.	C. I. No.	Date seeded, 1904.	Rust resistance.	Date ripe, 1904.	Yield per acre.	Area, acres.
						bus.	*acres.*
203	Yellow Ghornavoka	2096	Mar. 10	85 %	Aug. 13	1.76	1
204	Black Don	2100	" 10	85 %	" 14	1.45	1
205	Kubanka	2246	" 10	85 %	" 13	1.70	1
206	Velvet Don	2247	" 10	85 %	" 13	2.35	1

BARLEY. What is said of macaroni wheat also applies to barley, as it was sown on the same kind of land that had received the same treatment. The earlier varieties of barley, owing to their lateness of germination, did not head out nearly so well as the later ones. Table XVIII gives yields.

RYE. This crop was nearly a failure. Seed sufficient to continue several varieties was secured.

TABLE XVIII. Barley. Variety tests, 1904.

Station No.	NAME.	C. I. No.	Date seeded, 1904.	Rust resist-ance.	Date ripe.	Yield per acre.
						bus.
1	Six-rowed, Ellis county	.....	Mar. 14	.....	Aug. 3	8.12
2	Two-rowed, Ellis county	.....	" 14	.....	" 3	8.23
3	Black	191	" 13	75%	" 3	2.66
4	White	195	" 13	75	" 3	1.91
5	Hanna	226	" 13	85	" 1	1.75
6	From Austria	159	" 13	75	" 1	1.19
7-8	From Austria	186-188	" 14	75	" 1	2.02
9	Beldi	190	" 14	70	" 3	5.58
10	From China	192	" 14	50	" 3	8.33
11	Telli	194	" 14	70	" 4	1.66
12	Tetcherit	196	" 14	75	" 2	2.37
13	From China	197	" 14	70	" 4	.84
14	Albacete	199	" 14	85	" 7	7.16
15	Kitzenger	201	" 15	80	" 10	5.91
16	Black	202	" 15	85	" 4	2.96
17	From Austria	248	" 15	85	" 3	3.60

OATS. The land seeded to oats, 9–1–2, was broken in 1902, plowed again in May, 1903, after having been backset in April, 1903, and planted to corn. The corn was given ordinary cultivation and the stalks left on the field until spring, 1904, when they were harrowed down, the field double disked and harrowed just previous to seeding. The soil had retained its moisture well and the oats came up readily, but made very little growth until the rains of May. The varieties were seeded at the rate of one bushel per acre. The plats seeded at different rates per acre and emmer were in the same field. Tables XIX and XIXa give yields.

TABLE XIX. Oats and emmer. Variety tests, 1904.

Station No.	NAME.	C. I. No.	Date seeded, 1903.	Rust resist-ance.	Date ripe, 1904.	Yield per acre.	Area.	Test per bushel.
						bus.	*acres.*	*lbs.*
1	Nebraska Red	.....	Mar. 15	85 %	Aug. 8	25.75	1	31.5
3	Calgary	.....	" 15	70 %	" 10	19.7	1	27
4	Kherson (Nebraska Station Yellow)	.....	" 16	80 %	" 9	45.3	1	30
5	Swedish Select	213	" 16	75 %	" 10	20.3	1	28
6	North Finnish Bl'k,	254	" 16	80 %	" 11	8.12	1	23.5
7	Black Tartarian	.....	" 16	70 %	" 18	4	1	14.5
300	Emmer	.....	" 16	85 %	" 9	18.22	0.5	

TABLE XIX*a*. Rate of seeding test of oats.

VARIETY.	Amount seeded.	Area.	Yield per acre.
Texas Red	1 bu. per acre.	0.5 acre	21.8 bu.
	½ " "	0.5 "	24 "
	2 " "	0.5 "	25.8 "

PROSO (or Broom-corn millet). The seeding was done as per directions and a good stand secured. The growth was rapid and the crop was cut with a binder. A fault seems to be its attraction to birds. It was necessary to stack as soon as possible, or all the seed would

have been eaten. It is probable that twenty-five per cent. or more was eaten. A yield of nine bushels per acre was secured.

PLOWING TESTS. Table XX. Disk plow *vs.* mold-board plow; plowed *vs.* plowed, packed, and harrowed; time of plowing, July 31 to October 30. The field on 10–3 was in wheat, 1902–'03, and comprised the "Bean Stubble *vs.* Corn Stubble" test, this being the first plowing since the sod was broken. The plows were run only an inch or so deeper than the breakers. The packer used was the Campbell subsurface type. The soil was in fair condition as to moisture, and germination was good in all plats except Nos. 31 and 30. These seemed to have been sown too late. However, they came out very well in the spring, but were later and badly, affected by rust. A rain October 11 to 15 brought up the seeding of October 1 on plat 32, which may account for increased yield. The following table gives treatment, yield, etc., of the plats; all plats were sown to Kharhov (No. 4.) wheat:

TABLE XX. Treatment of land for wheat.

Plat No.	Treatment.	Date seeded, 1903.	Date ripening, 1904.	Yield per acre, bushels.	Area acres.
21	Disked August 1, plowed September 28, harrowed August 31	Sept. 28	July 1	6.2	1.8
22	Plowed with disk-plow and harrowed August 1; harrowed August 31	" 28	" 1	14.17	1.8
23	Plowed with mold-board plow and harrowed August 1; harrowed August 31	" 28	" 1	12.33	1.8
24	Plowed with mold-board plow, packed and harrowed September 1	" 28	" 1	18.5	1.8
25	Plowed with mold-board plow and left as plowed,	" 28	" 1	16.57	1.8
26	Plowed with mold-board plow, harrowed and packed July 31; harrowed August 31	" 28	" 1	18.14	1.8
27	Plowed with mold-board plow August 15, packed and harrowed	" 28	" 1	17.86	1.8
28	Plowed with mold-board plow, packed and harrowed August 31	" 28	" 1	9.35	1.8
29	Plowed with mold-board plow, packed and harrowed September 15	" 28	" 1	7.72	1.8
32	Plowed with mold-board plow, packed and harrowed September 30	Oct. 1	" 3	8.57	1.42
31	Plowed with mold-board plow, packed and harrowed October 15	" 16	" 4	5.86	1.68
30	Plowed with mold-board plow, packed and harrowed October 30	Nov. 5	" 4	2.05	1.8

TABLE XXI.—Poor-farming trial.

Plat No.	Treatment, 1903-'04.	Date seeded, 1903.	Date ripe, 1904.	Yield per acre, bushels.	Area, acres.	Treatment, 1902-'03.
33	Single-disked October 6	Oct. 9	July 2	2.8	1.6	Plowed.
34	Plowed August 1	" 9	" 2	8.9	1.6	Plowed.
35	Single-disked October 6	" 9	" 5	2.75	1.6	Disked.
36	Stubble	" 9	" 5	3.63	1.6	Disked.
37	Single-disked October 6	" 9	" 4	2.95	1.6	Stubble.
38	Stubble	" 9	" 2	2.69	.8	Stubble.
39	Double-disked October 6	" 10	" 5	3.63	1.94	Stubble.
40	Disk-plowed September 28	" 10	" 3	5.00	1.94	Stubble.
41	Double-disked September 28	" 10	" 3	4.2	1.94	Disked.
42	Disk-plowed, packed and harrowed September 28	" 10	" 4	9.19	1.94	Disked.
43	Double-disked October 6	" 10	" 5	2.93	1.94	Plowed.
44	Mold-board plowed, packed and harrowed August 1	" 9	" 1	9.66	1.94	Plowed.

POOR-FARMING TRIAL. This field—on 16–1—comprised the "Plowing *vs.* Disking *vs.* Stubble'' in 1902–'03. The plats of 1902–'03 were subdivided, treated and planted as indicated in table XXI. All plats were seeded to Turkey No. 1 wheat.

CULTIVATION OF WHEAT. Increase Plats, 10–4. Table XXII. The seventy-six acres included in the disking-of-sod experiment in 1903 was plowed and packed during the latter part of August. The field was laid out in seven plats of ten and eight acres each, and planted to the seven best-yielding varieties, as increase plats. The prospects were very fine until the rusts appeared; and as the field is on the bottom land, the damage was much worse than on the upland.

THE CULTIVATION PLATS. On a uniform portion of varieties 1 and 3, six plats were laid out, of one-half acre each—three plats on each variety—so that treatment could be given duplicate plats. One plat on each variety was not treated; one was cultivated with a Hallock weeder—weedered; and a third plat on each variety was harrowed. The treatment of the varieties was the same exactly before the plats were laid out. The object sought in cultivating was to maintain the surface mulch, which necessitated treating the plats after rains. The land was somewhat soddy, being the second crop, and did not have the tendency to form a crust so readily as would older soil.

The Hallock weeder used was the ordinary flat spring-tooth, with round point, anti-clog, and carried on a two-wheeled carriage. A common lever iron harrow, with teeth set at an angle of about thirty degrees to the ground, was used on the harrowed plat. The plats were given treatment March 13, 23, 28, and April 28.

TABLE XXII. Cultivation of wheat and increase plats.

Plat No.	Wheat, variety No.	Treatment.	Date seeded.	Date ripe.	Yield per acre.	Area, acres.
1	1	Harrowed	Sept. 21	July 12	12.04	0.5
2	1	Weedered	" 21	" 10	12.24	0.5
3	1	Not treated	" 21	" 6	18.53	0.5
1α	3	Harrowed	" 22	" 12	10.91	0.5
2α	3	Weedered	" 22	" 10	11.6	0.5
3α	3	Not treated	" 22	" 6	15.36	0.5
4	4	Not treated	" 23	" 4	20.41	10
5	5	Not treated	" 24	" 8	19.4	10
6	6	Not treated	" 26	" 8	20.5	8
7	7	Not treated	" 27	" 4	20.08	8
37	37	Not treated	" 28	" 4	14.79	8

Little difference could be seen in the plats until the wheat began heading, but from then on until ripe a difference was noticeable. The not-treated plats ripened several days earlier than the weedered plats and the weedered plats were about as much earlier than the harrowed plats. So the harrowed plat was nearly a week later than the

not-treated plats, The treatment doubtless held the moisture in the soil and caused the wheat to ripen late. This gave the rusts more advantage, with the result that the treatment lowered the yield.

It may be said, however, that rust conditions are very unusual in this section, and this instance should hardly be considered as representative, but as showing what may occur. Table XXII gives yields and plats.

CORN, 1904.

The varieties of corn were planted in small fields along the creek and remote from each other, to prevent crossing. The season was unusually favorable for corn and yields were good.

LISTING *VS.* SURFACE-PLANTING. The land devoted to this trial was broken in 1902, grew a crop of corn on sod; also a crop in 1903, April 26 the stalks were harrowed down the land double-disked and cross-harrowed. May 10–12 half the land was plowed six to seven inches deep, and harrowed, and the other half listed, with a subsoiler on the lister, but not drilled. May 13 the field was planted with a drill. planter set to drop one grain every fourteen inches. The plowed land was surface-planted and the listed land planted in the furrows with the same planter. A very good stand was secured, and the field given ordinary cultivation.

The surface-planted part of the field made a much more rapid growth and tasseled nearly a week earlier than the listed, and was matured nearly the same length of time earlier. The average time of ripening of the field was August 15, or ninety-four days after planting. The variety was Minnesota No. 13. The yield per acre for the listed ground was 32.3 bushels, and for the plowed part 33.8 bushels, or 1.5 bushels in favor of plowing.

DISKING LAND BEFORE PLOWING VS. NOT DISKING. On another field that had also been in corn the previous year, half of the land was disked and harrowed March 31, and the whole field plowed May 10, and harrowed. The field was surface-planted May 11, and a good stand secured. The field was given ordinary cultivation and no difference was noted as resulting from this treatment.

The disking and harrowing removed the protection of the stalks which checked the wind and shaded the land, which may have been as efficient a protection as the soil mulch. The variety was Australian White, a flint corn, and was matured by August 1, or within ninety days. The yield per acre for the disked before plowing was 24.1 bushels; and for the not disked before plowing, 25.9 bushels.

CORN IRRIGATED. The variety grown on the irrigation plat was Kellogg's "Pride of Saline." (See "Yields of Crops under Irrigation," table XXVIII.

KAFIR-CORN, SORGHUM AND PENCILLARIA IN 1904.

The Kafir-corn and sorghum sown for hay at the rate of one bushel per acre gave an exceptionally fine quality of feed, also a large yield. The fine quality permits of stock eating the entire plant, with no waste at all. The pencillaria has been fed in comparison with Kafir-corn and does not compare at all favorably with it. For yields of grain and fodder, see report of "Irrigation Field Yields," table XXVIII.

ALFALFA, 1904.

The field sown on sod in May, 1902, and described earlier in the bulletin, has made a very favorable showing during the past season. There is, apparently, no danger of the wild grasses returning, and the field is exceptionally free from the appearance of any of the grasses that are occasionally found in alfalfa. There is to be seen an occasional very small clump of buffalo-grass, but the alfalfa seems to prevent its spreading.

The rainfall during the season was somewhat light for alfalfa, but what the three crops cut were deficient in quantity they made up in quality, as the hay is very fine. The same may be said of all the alfalfa growing. The fall seeding of 1902 was excellent this year, and the poor stand secured in the spring of 1903 came out splendidly.

TURKESTAN AND DRY-LAND ALFALFA. By the courtesy of Mr. B. A. McAllaster, of the Union Pacific Land Company, twenty pounds of Dry-land alfalfa seed was secured from the Portland Seed Company, of Portland, Ore. This seed takes its name from the region in which it grows, namely, the elevated table-lands in the foot-hills of the Rocky Mountains of Utah and adjacent states. This alfalfa has been grown in these localities without irrigation, until it is said to be very hardy and drought resistant. Also, twenty pounds of Turkestan alfalfa seed was secured from Nungessor & Co., importers, of New York, on the recommendation of Mr. A. S. Hitchcook, agrostologist of the United States Department of Agriculture.

One acre each of these varieties was planted on the upland, on well-prepared land, fifteen pounds per acre being sown. The seed of the Dry-land alfalfa was very large and of a bright golden or greenish-gold color. The Turkestan seed was not over half the size of the former, and of a very dull brownish-green color, However, an excellent stand of each variety was secured, and both made a fine start. It was readily noticed though, that the Dry-land plat made the most vigorous growth, especially the late fall growth. A field of common alfalfa is nearly adjacent to these plats; hence the results may be awaited with interest.

BROMUS INERMIS.

The three sowings made in 1902 did not make a favorable showing the past season. The growth was too small to make a hay crop, and very little seed was produced. The seven and two-tenths acres seeded in 1903 made a good growth and would have made a fair hay crop, but it was left for seed. The seed secured is of very fine quality, but the yield was low.

OTHER GRASSES.

There is as yet very little encouragement in the grasses on trial, The Colorado blue-stem *(Agropyron occidentale)* seed, collected in large quantities in 1903, was sown, but as yet there is no stand. The seeding was somewhat late, and germination may not have taken place. If this is the case, it may come next spring, as the seed tested quite well.

The *Panicum bulbosum* made a very good yield, but collecting seed for further seeding has not been successful.

Elymus canadensis has made a good yield of hay, and would make excellent early pasture. This is known as rye-grass and grows along streams, under partial shade. An occasional bunch is seen on higher land.

Panicum virgitatum is a promising native grass that should be encouraged. It has a bunchy habit of growth and a very large amount of lower leaves. The stems grow three to three and one-half feet high, the head is rather spreading, and the seeds are on the outer ends, similar to oats.

The Tall grama *(Bouteloua racemosa),* or Side oat-grass, can be grown from seed, and is a good late-pasture grass, but it starts very slowly in the spring.

ROTATION EXPERIMENT.

The entire quarter, 15-2, is devoted to a rotation for determining the influence of fallowing, Kafir-corn, oats, legumes and barley on the succeeding wheat crop. A fifteen-acre strip on the north edge of this quarter was broken in 1901 and grew a crop of wheat in 1902. The remainder of the quarter was broken in 1902, and grew crops of barley, millet, macaroni wheat, Kafir-corn and sorghum on sod. In the spring of 1903 the entire quarter was plowed and sown to small grain, with a view to beginning the rotation. The quarter was first divided into forties, and these into five plats of seven acres each. This allowed for an alley of twelve acres extending through the quarter; also, a strip a few rods wide around the outside for protection. The inside alley is to be in wheat continuously, but there is a rotation in the forties, and the forties rotate also.

The forties, beginning with the northeast (No. 1), will rotate west, to No. 2, south to No. 3, thence east to No. 4, and back to No. 1. The plats are numbered from 1 to 5 in No. 1; 5 to 10 in No. 2; 10 to 15 in No. 3; and 16 to 20 in No. 4. For the first time around, the crops will have the same order, viz,: Fallow, Kafir-corn, oats, legumes, barley—this requiring four years. At the beginning of the second round plat 1-1 would have barley instead of fallow; all others moving forward one place also, No. 2 being fallow. These spring crops occupy but one forty, and the other three forties are to be sown in wheat each year. There is thus, each year, wheat one year after fallow, Kafir-corn, oats, legumes, and barley, respectively; also wheat after wheat following the crops named, and wheat after wheat, after wheat following those crops. The object is to learn the best crop to use in rotation with wheat, the latter being the chief product.

THE CROPS OF 1903. No. 1 (northeast forty) was planted as per plan: Plat 1, fallow; plat 2, Kafir-corn; plat 3, oats; plat 4, soy beans; plat 6, millet (instead of barley, by mistake). The No. 2 forty was seeded to barley; No. 3 forty to barley, in treatment plats; and No. 4 to oats, macaroni wheat, and speltz. The center alley was sown to macaroni wheat. As a preparation for seeding, the entire quarter had been plowed, packed, and harrowed—except the plats on No. 3 forty, as previously referred to.

During the spring and summer of 1903, the plats on No. 1 were given the following treatment:

All five plats were plowed, packed and harrowed in March.

No. 1.—Plowed and harrowed in June; seeded to wheat September 20:

No. 2.—Plowed and harrowed in May; seeded to Kafir-corn, in rows thirty-two inches apart; cultivated twice; seeded to wheat in the stubble, September 20.

No. 3.—Seeded to oats in March; land double-disked and harrowed in September, and seeded to wheat.

No. 4.—Plowed in May and planted to soy beans, in rows thirty-two inches apart; cultivated twice; season being wet and cold, beans did not make a crop and were not harvested; seeded to wheat September 19, without treatment.

No. 5.—Plowed in May and seeded to millet (by mistake was not seeded to barley in March); chinch-bugs entered millet from wheat at harvest and before the millet was mature, entirely destroying it; land was double-disked and harrowed before seeding to wheat in September.

There was very little difference in the appearance of the wheat on the five plats, except No. 1, fallow, made a much heavier fall growth,

and also grew more rank in the spring. For this reason, the rusts may have damaged it a little more than the others. Table XXIII shows the record of yields of the plats and quarters of 15–2 for 1903.

TABLE XXIII. Crops of 1903.

Quarter.	Plat.	Area.	Treatment.	Yield per acre.	Notes.
1	1	7 A.	Fallow		
1	2	7 A.	Kafir-corn	1,443 lbs.	Frost killed before matured.
1	3	7 A.	Oats	42.87 bu.	
1	4	7 A.	Soy beans		Not harvested.
1	5	7 A.	Millet		Destroyed by chinch-bugs.
2	.....	35 A.	Barley	28.34 bu.	
3	.....	35 A.	Barley	28.84 bu.	
4	.....	35 A.	Oats, M. wheat, speltz	22.11 bu.	
	Middle part,	10 A.	Macaroni wheat	7.29 bu.	

THE CROPS OF 1904. The quarters Nos. 1, 3 and 4 were sown to wheat during the fall of 1903. The treatment of the plats on quarter No. 2 was as follows :

No. 6.—Fallow; plowed, packed and harrowed April 8-11; replowed and harrowed June 22; double-disked July 26; harrowed September 14; seeded to wheat October 5.

No. 7.—Kafir-corn. Plowed, packed and harrowed April 6-8; seeded to Kafir-corn May 14; rows, twenty-one inches; cultivated twice; harvested October 4; seeded to wheat October 6.

No. 8.—Oats. Plowed, packed and harrowed February 26, 27; seeded March 16; harvested July 14; plowed, packed and harrowed August 24–27; seeded October 5, 6.

No. 9.—Soy beans. Plowed, packed and harrowed April 5, 6; seeded in rows twenty-one inches apart May 17; beans cultivated twice, but did not make a crop; rabbits destroyed a large proportion; seeded in stubble October 7.

No. 10.— Plowed, packed and harrowed February 24, 25; seeded to barley March 17; harvested July 14; plowed, packed and harrowed August 26–30. Table XXIV shows the record of yields of the plats and quarters of 15–2 for 1904.

TABLE XXIV. Crops of 1904.

Quarter.	Plat.	Area.	Treatment.	Yield per acre.	Notes.
1	1	7 A.	Fallow, '03; wheat, '04	22.7 bu.	
1	2	7 A.	Kafir-corn, '03; wheat, '04	18.8 "	
1	3	7 A.	Oats, '04; wheat, '04	11.8 "	
1	4	7 A.	Soy beans, '03; wheat, '04	20.26 "	
1	5	7 A.	Barley, '03; wheat, '04	9.57 "	Millet, 1903.
2	6	7 A.	Fallow, 1904		
2	7	7 A.	Kafir-corn, 1904	2,015 lbs.	Very little seed developed.
2	8	7 A.	Oats, 1904	3.71 bu.	
2	9	7 A.	Soy beans, 1904		Did not make a crop.
2	10	7 A.	Barley, 1904	7.92 bu.	
3	.....	35 A.	Barley, '03; wheat, '04	8.95 "	
4	.....	35 A.	Oats, M. wheat, speltz, '03; wheat varieties, '04	9.04 "	

HORTICULTURE AND FORESTRY 1904.

The orchard of 300 trees set out in 1903 has made a splendid growth. The treatment given is to disk and harrow the land early, plow and harrow later, and keep the weeds down by frequent harrowings until between the first and middle of June. The orchard is then planted to some early variety of corn, This makes a quick growth and protects the trees and ground from hot winds; and also holds any snow that falls during the winter, the stalks being left after corn is snapped. Rabbits have given considerable trouble by gnawing the trees, and it was necessary to put on protectors. The style used is of wood, sawed very thin, which, when wet, will admit of bending around the trunk of the tree, and is then secured by wire.

Of the 4000 evergreens planted, thirty-two per cent. lived and have made a good growth. The rather high per cent. that did not start is attributed to the severe weather at the time of planting. The shipment had just been received, unpacked and puddled for planting when four inches of snow fell, April 28, 1903. The trees had been packed and perhaps kept too warm, as many of them had started to grow. The freezing they received doubtless injured many of them. The Austrian pine has proven most hardy. Individuals made a growth of fifteen inches during the past season, 1904.

The locust, Osage, etc., in the shelter belt south of the buildings, made a very large growth.

In November, 1904, a strip two and one-half rods wide, along the west side of 9-2, was planted to acorns. The rows were put one rod apart, so that a row of rapid-growing soft wood—willow or cottonwood—can be planted to partially shade or protect the oak while starting. The acorns were dropped about eighteen inches apart in the row, as they did not appear to be very good. The horticultural department of the Manhattan Station collected them near Cawker City, Kan.

A bend on the north side of the creek, on 4-3, was planted in the same manner. The planting here included several rows of walnuts, alternating with oak.

The ground for these two plantings had been fall-plowed and put in good shape. A lister, with subsoiler attached, was used to open the furrow, and the seed covered with a cultivator with two small shovels.

In a bend on the west side of the creek, east of 9–1, the sod was opened and an acre or so planted in the sod. The soil in all the plantings was very dry, but as the furrows were not completely filled, the snow will lodge and doubtless moisten the seed. In all about nine acres were planted to oak and walnut seed.

IMPROVEMENTS, 1904.

Very few improvements were provided for during the present year, the only appropriation being for sheds, yards, and fencing. Four more sheds have been built in the feed-lots, making twelve in all, Nearly two miles of hog-and-cattle-yard fence of woven wire has been built, and there is more in process of construction.

The work of putting in the wheat crop of the present fall was greatly facilitated by the purchase of a steam plow. With the twelve-horse-power traction-engine owned by the Station, an eight-disk plow, cutting seven feet, and a three-section harrow, are worked satisfactorily. The harrow was so attached that it covered the ground twice. With the equipment, an engineer and guideman, ten acres a day (of ten hours) were covered. The water-tank was built up to carry sufficient water to serve the engine half a day; so teams going to the field at regular times hauled the coal and water, thus saving the expense of a team for that purpose. The engineer received $2 per day and the guideman $1.50. Fifteen hundred pounds of coal were burned, which, at six dollars per ton, would make the cost of plowing, for these items, eighty cents per acre.

The engine used was the regular twelve-horse-power J. I. Case traction, and the plow a Hapgood-Hancock disk. The wear on the engine was hardly noticeable after plowing 200 acres. It is the belief of the writer that the steam plow has become a necessity, and that they will come into much more general use. However, the problem of hitching and handling the plows by the engineer is far from being solved. The manufacturers are making every effort to better their models, and the farmers, of the wheat-growing districts especially, are anxious to furnish every assistance possible.

FEEDING TRIALS.

BABY BEEF. A considerable amount of feed having been grown at the Fort Hays Branch Station during the season of 1903, a feeding experiment was authorized. The feeds were those which can be grown on nearly every farm in this section of the state. At the time the experiment was planned, eighteen months had not yet elapsed since the first sod was turned at the Branch Station. Owing to the scarcity of labor, the feed-lots were not completed until December, 1903. The calves were grade Hereford and Shorthorn, the former predominating, and were eight to ten months old when put in the lot. The lots are on well-drained, ground, 66x300 feet each, enclosed by woven-wire fence. Each lot has a shingle-roofed shed open to the south, and good, clean water in a tank near it.

The fifty six head of calves were carefully sorted and weighed, so

that the lots were made as nearly alike in quality and weight as possible. On December 21, after having been weighed on three consecutive days, they were put on feed. The feeding was begun at one pound of grain and ten pounds of roughage per day for each animal. This was increased gradually for more than two months before the lots were getting all the grain they would eat. The roughage was reduced as the quantity of grain increased. After they were feeding up to the limit, they were given just what they would clean up twice daily. The grain and hay were carefully weighed to each lot at every feed. The grain was all medium-finely ground and the lots getting corn were fed corn-and cob meal until the last three weeks, when they received straight cornmeal. All the feed was of good, ordinary quality and grown on the Station farm.

The experiment continued 182 days, ending June 21,1904. Table XXV shows feed and results of the seven lots.

TABLE XXV. Feeding experiment.

	Lot and Feed.	Average weight at beginning.	Gain per head.	Daily gain per head.	Feed to make 100 pounds gain.		No. in good marketable condition.
					Grain.	Hay.	
1	Corn and alfalfa	399	338	1.85 lbs.	545	388	8
2	Barley and alfalfa	401	297	1.62 "	519	421	6
3	Wheat and alfalfa	413	284	1.56 "	404	432	6
4	Corn and sorghum	397	224	1.23 "	715	592	4
5	Corn and prairie hay	406	262	1.43 "	641	381	5
6	Corn and oats straw	405	251	1.37 "	717	354	4
7	Mixed feeds*	403	328	1.80 "	473	414	7

* One-third each of grains and one-fourth each of different hays.

There was a more marked difference in the appearance of the lots than the results show, though the rank would be in the same order as the daily gains. The alfalfa lots fed much more evenly than the sorghum-, straw- or prairie-hay-fed lots; hence would have brought a better price on the market. It had been expected that all the lots would be sold on their merits, but as a few head in several of the lots were not in first-class condition, only part of these were sold. Thirty-six head were shipped to the Kansas City market. They averaged 694 pounds, and brought five cents on a steady market, netting $33 per head. When bought for the experiment, the fifty-six head cost $13 each, $3.22 per hundredweight.

In table XXVI, the feeds have been given approximate local prices –*i. e.,* corn, 40 cents, wheat, 65 cents, and barley, 40 cents per bushel; alfalfa, $4, prairie hay, $3.50, sorghum, $3.50, and oats straw, $1 per ton.

TABLE XXVI. Feeding experiment.

Lot No.	Weight when bought.	Cost of lot.	Value of feed.	Lot weighed at close.	Selling value.*	Value of lot.	Gain per lot.
1	3,193	$102 91	$97 10	5,900	$5 25	$309 75	$109 74
2	3,206	103 33	118 66	5,583	5 00	279 15	57 16
3	3,305	106 52	119 07	5,410	5 00	270 50	44 91
4	3,173	102 26	94 16	4,967	4 50	223 51	27 09
5	3,251	104 78	92 24	5,347	4 75	253 98	56 96
6	3,236	104 30	88 35	5,243	4 50	235 93	43 28
7	3,220	103 78	118 69	5,707	5 00	285 35	62 88

*From a study of the market at the time the thirty-six head were sold, it is thought that the lots would have sold for the price indicated.

A detailed record of the labor for the 183 days' feeding was kept, from which the following extract is taken:

One man, 3¾ hours daily, for 183 days, @ 12½ cents per hour	$55.75
One man with team, 2⅓ hours daily, for 183 days, @ 25 cents per hour	106.75
Grinding 1426 bushels grain, @ 1 cent	14.26
Total	$206.76

An additional item of expense would be 243 pounds of salt consumed by the calves, its value not considered in the above table.

ROUGHAGE TEST.

A COMPARISON OF PENCILLARIA STOVER WITH KAFIR-CORN STOVER AS A ROUCHAGE FOR CATTLE. The cattle were fed with the intention to keep them in good condition only. The animals used in the experiment were cows — eight head of grade Short-horn and eight head of grade Hereford, from the Station herd. All except two had nursed calves the preceding summer, and were in fair condition only. All were hornless and quite even in quality. They were purchased two years ago from farmers and ranchmen in Ellsworth county; consequently, were of various temperaments — some old milch cows, others quite wild and not accustomed to being handled.

The cows were divided into two lots, with four Herefords and four Short-horns in each lot. Every precaution was taken to have the lots identical with reference to individual qualities — weight, size, and disposition. To obtain a more accurate beginning weight, the cows were weighed on two successive days, and the average of these weights taken as the beginning weight of the experiment.

The Kafir-corn stover was of fair quality, although as it was not out until the seed was ripe some of the leaves had dropped off, but it was of good color, and the cows ate it readily. None of the Kafir-corn fodder fed was irrigated.

The pencillaria was somewhat overripe for fodder when out and some of the leaves had fallen; consequently a greater percentage of stems was harvested than would have been if it had been harvested

earlier. Part of it had been irrigated, so the stems were larger, which accounts for the larger per cent. of waste from the irrigated than from the unirrigated.

During the experiment it was easily observed that the cows getting pencillaria were not doing so well, were getting thinner and in poorer condition; but their appetites seemed to be good. However, it is believed that had the experiment been carried longer — even three to four months — they would have shown a lack of appetite for the feed, both Kafir-corn and pencillaria. It was further observed that the lot being fed pencillaria had a poorer appetite for salt than did the lot receiving Kafir-corn.

The experiment was begun December 16, 1904, and lasted twenty-two days.

TABLE XXVII. Feeding experiment.

Lot No.	Feed.	Animals in lot.	Total weight of lot, beginning.	Total weight of lot, close.	Average weight, beginning.	Average weight, close.	Average gain or loss per head.	Lbs. rough-age fed.	Lbs. rough. wasted	Lbs. eaten.
			lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*			
9	Kafir-corn stover,	8	8,475	8,530	1,059.3	1,066.2	+6.9	5,660	670	4,990
10	Pencillaria stover	8	8,552.5	8,312	1,069	1,039	−30	6,210	3,685	2,520

Comparison of the irrigated and not-irrigated pencillaria fed:

	Irrigated.	*Not irrigated.*
Fed	3,530 lbs.	2,680 lbs.
Waste	2,330 "	1,355 "
Eaten	1,200 "	1,325 "

Irrigation Work In Cooperation with the Office of Experiment Stations, United States Department of Agriculture, 1904

Irrigation of growing crops in this section necessarily comes at a time when labor is high-priced, owing to the great demand for harvest hands. Hence, the work this year included the winter irrigation. During the winter and early spring it would be much more economical to apply water. Also, in case of streams being used, if practicable, the water could be used when it is usually allowed to go to waste.

The planting of the plats was planned so that each crop would be included in the test of winter and summer irrigation. Winter irrigation was to consist of giving the land one good wetting before plowing in the spring, and no subsequent irrigation. Summer irrigation was to consist of irrigating the crops when it appeared that they needed moisture.

The preparation of the land was such as would be given any field by a thorough, practical farmer. The plats are laid out so that the irrigated and not-irrigated parts receive identically the same treatment, except the application of water to the irrigated part. The land being new, it was plowed only an inch or so deeper than previously, or six to seven inches. The plats planted to sugar-beets were subsoiled six to eight inches deeper than the plowing, the subsoiler being run in each furrow behind the plow.

There is no doubt that previous treatment would affect the crops; hence the following table is given to show what was previously grown on the various plats. The land was broken in 1902, and no crops grown previous to 1903:

TABLE XXVIII.

Plat.	1903 crop.	Treatment, 1903.	1904 crop.
1	Potatoes	Half irrigated,* ground plowed after potatoes were dug	Sugar-beets, winter irrigated.
2	Potatoes, west half; cabbage, east half	Half irrigated, potato ground plowed afterward, cabbage ground not	Sugar-beets, sum'er irrigated.
3	Corn	One-half irrigated	Potatoes, winter irrigated.
4	Corn	One-half irrigated	Potatoes, summer irrigated.
5	Kafir-corn, west half; sorghum, east half	Not irrigated	Kafir-corn, west half winter and east half summer irrigated.†
6	Soy beans and cowpeas,	One-half irrigated	Sorghum, west half winter and east half summer irrigated.
7	Mangels and sugar-beets	Very poor stand secured; ground plowed and harrowed in July	Corn, west half winter and east half summer irrigated.
8	Corn	One-half irrigated	Potatoes, no irrigation.
9	Corn	One-half irrigated	West half potatoes, not irrigated; east half pencillaria, half irrigated.

*Irrigated half is always *north* half of plat.
†Refers to east or west half of north half of plat.

CHANGES IN THE PUMPING PLANT. Several changes were made in the pumping plant which increased its efficiency. First, it was possible to lower the discharge pipe two feet by resetting the weir. Second, the well being on the bank of a creek having running water in it nearly the whole year, tubing was put from near the level of the water in the creek through the bank into the well. A dam was then built across the creek, raising the water about three and one-half feet above the regular level of the water in the well. The 6-inch tubing put through the bank was 30 feet long and had a fall of about 2 feet in that distance. The head of 3½ feet through the 30 feet of 6-inch tubing practically ran the capacity of the pump at a lift of 28 to 30 feet. At starting, the water would be 3½ feet above the ground-water level, and the pump would lower this 4 to 6 feet. The weir reading showed about one cubic foot per second at this lift.

Between the pumping for the winter irrigation in April and the summer irrigation the dam went out, and another was built which did not raise the water so high by a foot. This decrease in head allowed the pump to lower the water several feet below the level the former head maintained, and showed a decrease in discharge of approximately 0.10 cubic foot—or gave the pump a discharge of 0.90 cubic foot per second.

The cost of winter irrigation, with the three-and-one-half-foot head of water to supply the pump was approximately seventy-five cents per acre inch, delivered on the field. This irrigation required 33.9 acre-inches, pumped in thirty-two hours. Fuel and labor figured at the same price as in 1903--*i. e.,* coal, $6 per ton; engineer, $2 per day; water-tender, $1.50 per day. When the cost was $1.41 per acre-inch, the lift in 1903 was 42 feet, as against 30 feet the present season. It might be said that for the first twelve hours of pumping the pump did not discharge full capacity, as it was windy, the belt slipped, etc. One period of thirteen hours pumping during the winter irrigation cost but 68 cents per acre-inch delivered on the field.

But one irrigation was given the plats for summer irrigation, which required 28 hours' pumping, during which period 28.14 acre-inches were pumped, at a cost of 81 cents per acre-inch delivered on the field. The increase in price over the winter irrigating is due to having one foot less head of water, which allowed the pump to lower the level in the well four to six feet below the level held during winter irrigation.

Table XXIV compares the three periods of pumping. The "lift" is only an approximation, as the level would vary from time to time.

TABLE XXIV.

Period.	Hours pumped.	Coal burned.	Lift.	Approx. rate dis-chg. pr. sec.	Acre-in. pumped.	Cost per A.-in. del'd.*	Coal per acre-inch.
		lbs.	*feet.*	*cu. ft.*			
1903.....	99.5	12,600	40–42	.52	51.31	$1.41	245 lbs.
1904—							
Winter irrigation..	32	4,900	28–30	1.07	33.9	.75	144 "
Summer irrigation,	28	4,400	34–36	1.01	28.14	.81	156 "

*Coal, $6 per ton; engineer, $2 per day; water-tender, $1.50 per day.

MANNER OF IRRIGATION.

WINTER IRRIGATION. Checks were made with a "ridger," four feet apart and the long way of the plats, and water turned into several of these at a time. As soon as the water had reached the opposite end of the plat it was turned back and the flow shut off.

The ridger was made of two 4x6's, four feet long, bolted in a V shape, with an opening about four feet at one end and eight inches

at the other. A plate of heavy strap iron was bolted on the inner lower edges of the 4x6's, to protect them from wear. The hitch was made at the wide end, so that the dirt scraped up by the two sides made an even ridge as it passed out at the back or narrow opening.

The plats to be irrigated were all treated alike, and as soon as dry enough they were plowed, the land packed, and harrowed. If it was not possible to plow the plat as soon as in condition, a harrow was put on to restore a soil mulch.

The variation in the amount of water which the plats seem to have taken was perhaps due to stopping the pump for noon or night on one plat before it was finished and not on all. If the stop was made when the water was but part way over, it would be necessary to run over the wet portion again after the first water had been taken up. Whether the ground had been fall-plowed also made a difference in the amount of water taken, as is seen by comparing plats 1 and 3. Plat 1, having been in potatoes, was fall-plowed, while No. 3, being in corn, was not fall-plowed.

The alfalfa that was irrigated was sown the year previous and is not a very good stand. The cuttings of weeds, etc., of the previous year were left on the field, which made it difficult to run the water over it. This doubtless accounts for the large amount put on. However, there is no doubt that the effect of this one irrigation will show for a number of years.

SUMMER IRRIGATION. The crops were given good cultivation and made a good, vigorous growth from the beginning. It will be noticed that while the rainfall during May and June was not abundant, it was very evenly distributed and kept all crops growing nicely. While the potatoes and beets did not seem to suffer, it was noticed that they did not appear quite so thrifty as the winter-irrigated plats; and it is probable that an irrigation about June 15 would have been a great help.

Irrigation was begun June 28, and after one hour's pumping work was stopped by one of the hardest and heaviest rains of the season. Harvest began immediately after this attempted irrigation, and it was July 26 before the work could be resumed. In the meantime the potato crop was practically matured and subsequent watering would doubtless have been detrimental.

At this time it could be distinctly noticed that the winter-irrigated plats were in the best condition. The corn, Kafir-corn and sorghum on the winter-watered plats had made a growth of eight inches to one foot more than on other plats.

The period of cultivation was practically over, but the soil had not been ridged up along the rows. To clear the rows for irrigation, a

flat, broad shovel (duck-foot) was put on a cultivator and run between the rows. The made a good opening for the water and kept it away from the plants. The crops all shaded the ground; so no further cultivation was given.

All the plats responded very readily to the watering, soon showing an improvement over the winter-irrigated ones.

CULTIVATION AND WEATHER. These features have been mentioned at other places, but not specifically. The cultivation began as soon as the land was plowed. The plows were followed every few hours with the Campbell subsurface packer, and this with a harrow. The crops were planted immediately after the plowing, and soil mulch maintained by use of the harrow and Hallock weeder, until the crops were too large for these tools. The plats of sugar-beets did not receive this treatment after they were up, as the plants are too tender. But as soon as possible the spring-tooth cultivator was used.

After the other crops were too large for the harrow or weeder, the small-shoveled, four-gang cultivator was used as often as necessary to keep the weeds down and the soil in good condition. This required a cultivation after every rain that formed a crust to any extent.

The sugar-beets were given one cultivation before thinning. The seed was planted very thick, and when they had about four leaves they were thinned to one plant to every six inches, and at the same time all weeds were removed. It was necessary to hoe the beets once after thinning, as they grow very spreading, and the weeds cannot be taken out of the row.

The weather has also been spoken of as being generally favorable, but there is no doubt that there was a slight deficit in the rainfall throughout the season. By reference to the accompanying table (No. XXV), it will be seen that the rainfall for April, May, June, and July — the four growing months — was but 10.53 inches for the entire period; and previous to this period there had been very little rain for months. However, the very even distribution of the rains and the absence of any long dry periods gave the crops a chance to make full use of all the moisture that fell.

RAINFALL AND EVAPORATION. Observations of rainfall and evaporations were conducted on the irrigation field, similar to those of 1903. The rain-gage and large evaporation tank were set at the northwest corner of the field. Measurements were taken once each week throughout a period from April 28 to October 29. These are given in table XXV, as are also notes on the general weather of the period.

CROPS AND RESULTS. The crops irrigated were sugar-beets, Burbank and Early Ohio potatoes, Black-hulled White Kafir-corn, Colman

TABLE XXV.

PERIOD.	Evap. tank reading. 1st.	Evap. tank reading. 2d.	Rain.	Water added.	Evap'n	Wind.	Weather.
	feet.	*feet.*	*feet.*	*feet.*	*feet.*		
Apr. 28 to May 8	1.175	1.240	.247	.....	.182	SE	Cloudy; moderate.
May 8 to May 14	1.240	1.022	.....	.....	.218	N	Mild; bright.
May 14 to May 21	1.022	.924	.018	.....	.116	S-SE	Part cloudy; mild.
May 21 to May 28	.924	.847	.011	.171	.088	E-SE	Part cloudy; warmer.
May 28 to June 4	1.018	1.013	.064	.....	.069	NW	Showery; mild.
June 4 to June 11	1.013	.939	.015	.....	.089	S	Less cloudy; fogs and mist.
June 11 to June 18	.939	.901	.05	.132	.088	SE	Warmer; part cloudy.
June 18 to June 25	1.033	.982	.066	.....	.117	S & E	Showers; warm.
June 25 to July 2	.982	1.109	.163	.....	.036	E & S	Stormy; warm.
July 2 to July 9	1.109	1.096	.068	.....	.081	E & S	Showers; cooler.
July 9 to July 16	1.096	.948	.003	.....	.151	S	Clear; warmer.
July 16 to July 23	.948	.897	.053	.273	.104	S & E	Clear; hot days.
July 23 to July 30	1.170	1.048	.010	.....	.132	SE	Windy; cooler.
July 30 to Aug. 6	1.048	1.092	.108	.....	.064	E-SE	Clearer; mild.
Aug. 6 to Aug. 13	1.092	1.008	.0216	.246	.105	E-SE	Clear; warmer.
Aug. 13 to Aug. 20	1.254	1.345	.147	.....	.056	E	Cloudy; wet; warm.
Aug. 20 to Aug. 27	1.345	1.198	.0025	.....	.149	SE	Clearer; warm.
Aug. 27 to Sept. 3	1.198	1.103	.....	.....	.095	NW	Clear; cooler.
Sept. 3 to Sept 10	1.103	.992	.....	.160	.111	W	Clear; moderate.
Sept. 10 to Sept 17	1.152	1.041	.....	.....	.111	E-SE	Part cloudy; warm.
Sept. 17 to Sept 24	1.041	.964	.005	.275	.082	E & S	Part cloudy.
Sept. 24 to Oct. 1	1.239	1.253	.084	.....	.070	S-SE	Showery; cooler.
Oct. 1 to Oct. 8	1.253	1.181	.....	.....	.072	S & E	Part cloudy; moderate.
Oct. 8 to Oct. 16	1.181	1.085	.0066	.156	.102	S	Threatening; moderate.
Oct. 16 to Oct. 22	1.241	1.180	.004	.....	.065	NW	Part cloudy; cooler.
Oct. 22 to Oct. 29	1.180	1.114	.....	.....	.066	W-NW	Clear; moderate.
Totals.....	.....	.....	1.147	1.413	2.619		

NOTE.—From January 1, 1904, to April 28, the rainfall total was 0.049 foot.

sorghum, Kellogg's "Pride of Saline" corn, Pearl millet (or pencillaria) and alfalfa. It may be said that all the crops responded favorably to the irrigation.

The beets, Kafir-corn, sorghum and pencillaria were planted in drills twenty-one inches apart. The potato seed was cut but little and dropped one piece in a hill, eighteen inches apart, the rows being thirty inches apart. The corn was planted on the surface, one stalk in a hill, the hills sixteen inches apart, width of rows being thirty-six inches. The sorghum, Kafir-corn, corn and pencillaria were cut with a corn-harvester. The corn was husked from the shock, sorted into good, marketable ears and nubbins, and weighed. The fodder was likewise weighed. The heads were cut from the Kafir-corn, sorghum and pencillaria, thrashed, and weighed. The heads were weighed before thrashing also, so as to obtain full weight of fodder and grain. The potatoes were dug in the usual manner and sorted into an extra-good market class and second grade. The beets were pulled, topped, and weighed, then put in a root-house. Samples of the beets were sent to the Chemical Department of the Agricultural College and the Greeley Sugar Company, of Greeley, Colo., for analysis. Tables XXVI and XXVII show the result of these analyses.

TABLE XXVI. By the Chemical Department of the Agricultural College, Manhattan, Kan.

TREATMENT.	Aver. weight.	Sugar in juice.	Coefficient of purity.
	pounds.		
Winter irrigated	2.79	13.91%	78.1
Summer irrigated	2.25	12.71	79.4
No irrigation	1.86	14.15	79.8

TABLE XXVII. By the Greeley Sugar Company, Greeley, Colo.

TREATMENT.	No. beets.	Average weight.	Sugar in juice.	Sugar in beets.	Purity.
		ounces.			
Winter irrigated...(large)	5	67.59	14.0%	12.6%	78.5%
" " ...(small)	5	23.60	15.0	13.5	77.7
Summer irrigated..(large)	5	70.40	13.4	12.06	75.2
" " (small)	5	28.16	14.8	13.30	79.5
No irrigation.....(large)	5	42.94	13.8	12.4	77.0
" .....(small)	5	19.71	15.5	13.95	82.0

Accompanying the Greeley Sugar Company's report on the analysis was a letter from the manager of the plant, from which the following extract is taken:

"The results show that none of the beets were ripe. We divided each lot into two samples, large and small, so that you might see how much more preferable an averaged-sized beet is for sugar than a very large one. We claim that the maximum size for a good sugar-beet is 3 lbs., while the average ones come nearer 1½ lbs. The small beets of the not-irrigated sample were the only ones of the whole lot that could be termed of commercial value, and even they were not good enough to be very encouraging from a manufacturer's point of view.

"We would judge from the general appearance of the beets, they being somewhat stubby and a large proportion having grown above ground, that the soil had not been prepared to as great a depth (10 to 12 inches) as we find necessary to give the best results. Very truly yours,

C. A. GRANGER, General Manager."

Thus it would seem that the beets were oversized and green at taking the sample. But they usually would have time to fully mature before heavy frost. Owing to long distance from factory, the freight rates prohibit shipping the beets.

The potatoes are of very fine quality and command a price over the shipped-in stock from irrigated districts. The yield might have been increased by planting thicker on the irrigated plat, but this would have interfered with finding the "duty of water" alone. It has been the intention throughout these experiments that only the addition of water should be responsible for any variation in yield.

Table XXVIII gives the result of the 1904 work in irrigation experiments.

TABLE XXVIII.—Results of irrigation experiment, 1904.

Crop.	Irrigated.								Not irrigated.				
	Acreage.	Winter or summer.	Date watered.	Water applied, inches.*	Yield, per acre. First grade.	Yield, per acre. Second grade.	Yield, per acre. Total.	Sugar test.	Acreage.	Yield, per acre. First grade.	Yield, per acre. Second grade.	Yield, per acre. Total.	Sugar test.
							Tons.					Tons.	
Sugar-beets	1.0	Winter.	April 12	5.7	.....	.....	16.52	13.91%	1.0	.....	.....	14.14	14.15%
	1.0	Summer.	July 26	5.31	.....	.....	19.57	12.71	1.0	.....	.....	14.36	
					Bus.	Bus.	Bus.			Bus.	Bus.	Bus.	
Potatoes (*a*), Burbank	.5	Winter.	Apr. 12–13	3.83	71.08	25.76	96.84	.....	.5	49.24	24.52	73.76	.....
	.5	Summer.	June 28	1.01	53.94	25.50	79.44	.....	.5	34.54	23.52	58.06	.....
Potatoes (*a*), Kaw Valley Ohio	.5	Winter.	Apr. 12–13	3.83	57.34	49.12	106.46	.....	.5	30.84	34.74	65.58	.....
	.5	Summer.	June 28	1.01	50.04	24.24	74.28	.....	.5	31.56	31.16	62.72	.....
							Bus. seed.	Tons fod.				Bus. seed.	Tons fod.
Kafir-corn (*b*), Black-hulled White	.5	Winter.	Apr. 13–15	6.53	.....	.....	42.86	3.02	.5	.....	.....	44.64	1.72
	.5	Summer.	July 27	4.02	.....	.....	35.36	4.50	.5	.....	.....	19.64	1.72
Sorghum, Colman	.5	Winter.	April 15	3.04	.....	.....	35.36	7.18	.5	.....	.....	32.86	2.69
	.5	Summer.	July 27	5.54	.....	.....	40.00	7.53	.5	.....	.....	35.70	2.69
												Bus.	Tons.
Corn (*c*), Kellogg's Pride of Saline	.5	Winter.	Apr. 15–16	5.38	46.28	5.14	51.42	1.71	.5	41.58	5.70	47.28	.80
	.5	Summer.	July 26	4.54	53.42	5.72	59.14	1.77	.5	37.42	5.70	43.12	.80
Pencillaria	.5	Summer.	July 29	2.34	.....	.....	14.08	4.78	.5	.....	.....	7.78	3.38
							Tons.					Tons.	
Alfalfa	1.0	Winter.	Apr. 16–18	16.9	.....	.....	3.4	.....	1.0	.....	.....	2.06	
	1.0	Summer.	July 27–29	13.6	.....	.....	3.04	.....	1.0	.....	.....	2.76	

TABLE XXVIII.—Results of irrigation experiment, 1904—*concluded.*

Crop.	Gain by irrigation.						Winter *vs.* summer irrigation.			
	First grade.	Second grade.	Total.		Per cent.		Yield for winter.	Yield for summer.	Gain.	Per cent. in favor of W. or S.
Sugar-beets				Tons. 2.38		16.83	Tons. 16.52	Tons. 19.57	Tons. 3.05	18.46, S.
				5.21		36.28				
Potatoes (*a*), Burbank	Bus. 21.84	Bus. 1.24		Bus. 23.08		31.29	Bus. 96.84	Bus. 79.44	Bus. 17.4	21.9, W.
	19.40	1.98		21.38		36.82				
Potatoes (*a*), Kaw Valley Ohio	26.50	14.38		40.88		62.33	Bus. 106.46	Bus. 74.28	Bus. 32.18	43.32, W.
	18.48	−6.92		11.56		18.43				
Kafir-corn (*b*), Black-hulled White			Bus. seed. −1.78	Tons fod. 1.3	Seed. −3.98	Fodder. 75.5	Seed, bus. 42.86	Bus. 35.36	Bus. 7.5	21.21, W.
			15.72	2.78	80.04	161.6	Fod., tons. 3.02	Tons. 4.50	Tons. 1.48	49.00, S.
Sorghum, Colman			2.50	4.49	7.6	166.9	Seed, bus. 35.36	Bus. 40.0	Bus. 4.64	13.12, S.
			4.30	4.84	12.04	179.9	Fod., tons. 7.18	Tons. 7.53	Tons. .35	4.87, S.
Corn (*c*), Kellogg's Pride of Saline	4.7	−.56	4.14	.91	8.75	113.7	Corn, bus. 51.42	Bus. 59.14	Bus. 7.72	15.01, S.
	16.0	.02	16.02	.97	37.15	121.2	Fod., tons. 1.71	Tons. 1.77	Tons. .06	3.50, S.
Penicillaria			7.3	1.4	93.8	41.42				
Alfalfa				.80		30.74	Tons. 3.40	Tons. 3.04	Tons. .36	11.84, W.
				.28		10.14				

*Indicates depth of water over plat.

(*a*) Summer irrigation was interrupted June 28 by heavy rain; no further irrigating was accomplished.

(*b*) Results were undoubtedly influenced by the volunteer Kafir-corn from previous year's crop grown on this ground; also by flocks of birds that fed on grain before harvested. The growth of volunteer sorghum tended to choke the Kafir-corn and decreased yield.

(*c*) First grade signifies good ears; second grade signifies nubbins.

Summary of the Work of 1902–'03.

1. The Fort Hays Branch of the Kansas State Agricultural College Experiment Station is established on the abandoned Fort Hays military reservation, in Ellis county. The reservation comprised 7500 acres of good land, and was ceded to the state for the purpose of establishing western branches of the Agricultural College Experiment Station and the State Normal School. The land was divided about equally between these two institutions.

2. The first work was the breaking of the virgin prairie, which was begun in March, 1902. Nearly a section is now under cultivation.

3. No government funds are available for use in connection with the Branch Station. The state legislature appropriated but $3000 per annum for the first two years; while the legislature of 1903 appropriated $32,500 for the current biennium.

4. The buildings of the abandoned fort were in a very dilapidated condition when the state acquired the property; the place having been abandoned for fifteen years. A few of the structures were moved intact and remodeled for various purposes. Others were dismantled and the material worked in with new in the construction of needed buildings at the Station. These now consist of a superintendent's residence, 30 x 40 feet; a two-and-one-half-story boarding-house, 30 x 50 feet; a barn, 64 x 72 feet; eight cattle-sheds with lots attached; granary and tool or implement sheds. Also a 30-foot stone tower supporting a 225-barrel water-tank, which is supplied from an excellent well by wind or gasoline-engine. From this water-tower, more than a mile of pipe, laid under ground, furnishes water to the buildings and stock tanks. There is also an irrigating well with a capacity of 20,000 gallons per hour; a complete thrashing outfit and such other machinery as is required for the work of the Station; and more than twelve miles of barb-wire fencing enclosing the land, including about a thousand acres of pasture.

5. Four hundred acres of land along Big creek, which runs through the Station, was badly infested with prairie-dogs. These were completely exterminated by poison, at a cost of eight cents per acre.

6. Alfalfa was sown on fresh sod carefully prepared, and gave excellent results. Fall seeding on backsetting gave as good results as other seedings.

7. *Bromus inermis* was seeded on sod both spring and fall, the former sowing giving the better stand.

8. Pencillaria has not compared favorably with Kafir-corn or sorghum. Rape was not a success. Melons, turnips, beets and all varieties of garden vegetables gave very satisfactory returns.

9. Barley is a successful crop. Seventeen varieties were planted

in field trials and five varieties in nursery. Telli gave the best yield. By using a subsurface packer after the plow the yield was increased four bushels per acre, and harrowing and disking after plowing gave the same results. The use of a drill, with or without press wheels, made very little difference. The season was wet after seeding.

10. Macaroni wheat has given fair returns, though the seasons have been unusually wet. Kubanka produced the best yield. Six varieties were in the field trial and twelve in the nursery.

11. Oats have made a good showing. Among seven varieties in the field trials and twelve in the nursery, Texas Red made the heaviest yield.

12. Winter wheat has received most attention. One hundred and sixty-five varieties were planted, only twenty of which failed to make a yield. Thirty-one were in field trials. A number of new varieties made better yields than the common wheats. In the tests of preparation of land, the best prepared, earliest broken and earliest seeded produced the best yields of wheat. Wheat on bean stubble showed an increased yield over wheat on corn stubble.

13. Owing to the unusual amount of moisture, all forage crops did well. Corn on sod, Kafir-corn and sorghum all produced splendid crops.

14. More than forty varieties of grasses, mostly native of the higher and drier sections, are under trial. *Bromus inermis, Panicum bulbosum, Elymus canadensis, Agropyron occidentale,* with several others, are very promising.

15. Irrigation experiments were interfered with by the heavy rains. The crops under experiment were potatoes, cabbage, corn, Kafir-corn, and sorghum. Potatoes irrigated yielded 100 per cent. more than those not irrigated.

16. An orchard of 300 fruit-trees and a nursery of 4000 cedars and 500 forest-trees have made a very nice growth.

Summary of the Work of 1904.

1. The weather conditions were perhaps more favorable than usual for cultivated crops, but very unfavorable for spring small grain. Owing to a wet June, all small grain rusted very badly.

2. The test of varieties of small grain was unfavorable. Winter wheat yielded but one-half as much as in 1903, but the best yielding varieties were the same both years. Kharkov being the highest. Spring small grains were practically a failure, with the exception of oats, and of these Kherson gave the best yield and Texas Red the next.

3. In testing treatment of land for wheat, the medium early plow-

ing gave the best results, and the yield was better after the disk-plow than after the mold-board plow,

4. A comparison of plowing, double disking, single disking, and stubble for wheat shows that good farming pays.

5. The cultivation of the wheat with the weeder and harrow decreased the yield.

6. With corn, a comparison of disking land before plowing, listing, and surface planting showed very little advantage in one method over another.

7. All forage crops made splendid yields.

8. Alfalfa sown on sod in 1902 shows no bad symptoms, and is in excellent condition.

9. *Bromus inermis* and other grasses have not made as favorable a showing as was hoped for.

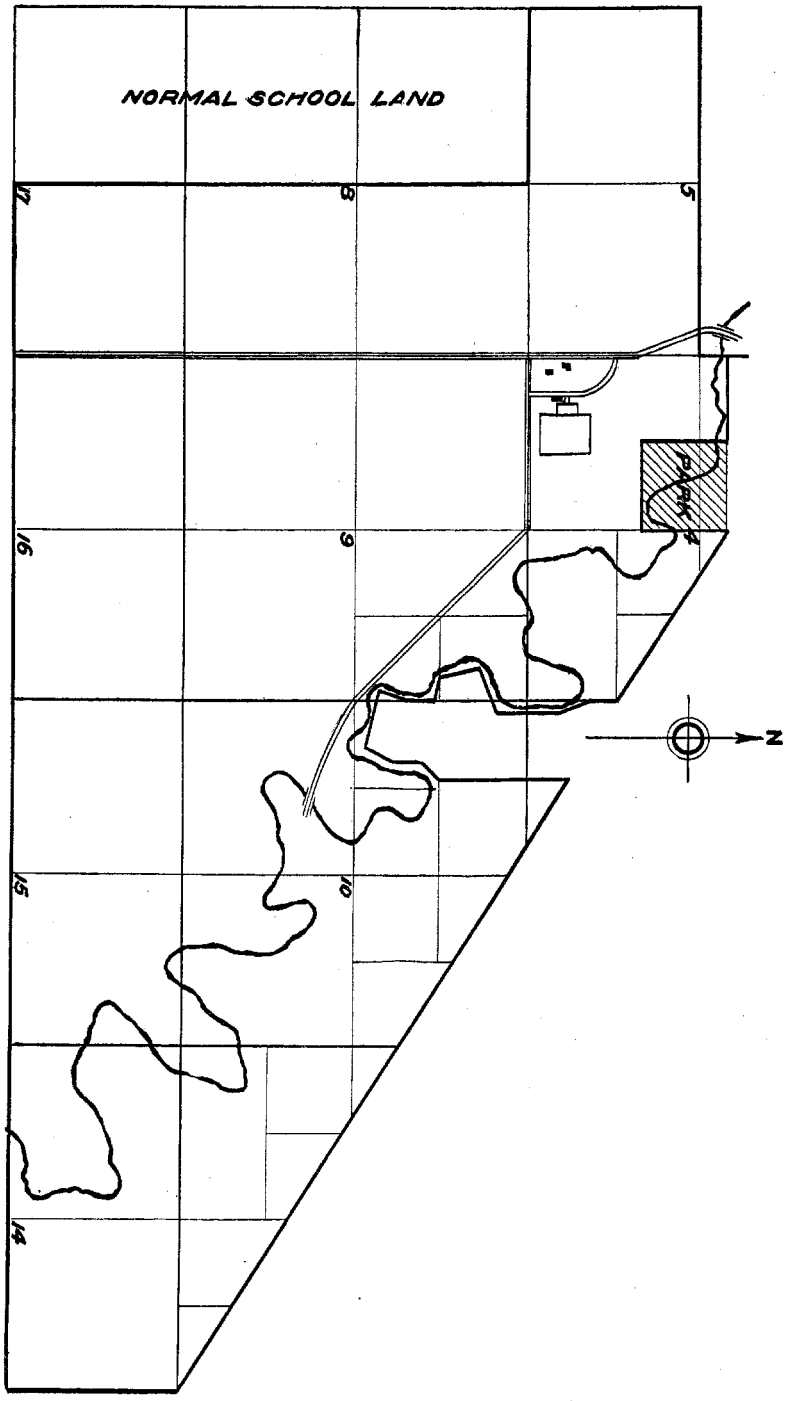
10. A rotation experiment on 160 acres, to determine the effect of various crops, thus far shows very favorable results for fallow and legumes.

11. The fruit orchard made a very satisfactory growth. Of the 4000 evergreens planted, thirty-two per cent. are growing nicely. The shelter belts made a good growth and more planting has been done.

12. A steam plow was purchased and gave very good satisfaction. Other improvements in the way of fences, yards, etc., were also made.

13. A baby-beef feeding trial with feeds grown at the Station proved very successful, and shows alfalfa to be of great value. A roughage-feeding trial shows that pencillaria stover does not compare favorably with Kafir-corn stoves.

14. The irrigation work was considerably extended and good results were obtained. However, it appears that our method of pumping water is too expensive to warrant irrigating the common crops. Potatoes and other vegetables, and perhaps alfalfa, will give profitable returns for irrigation.



—6 **Plate 1.** Outline map of part of reservation.

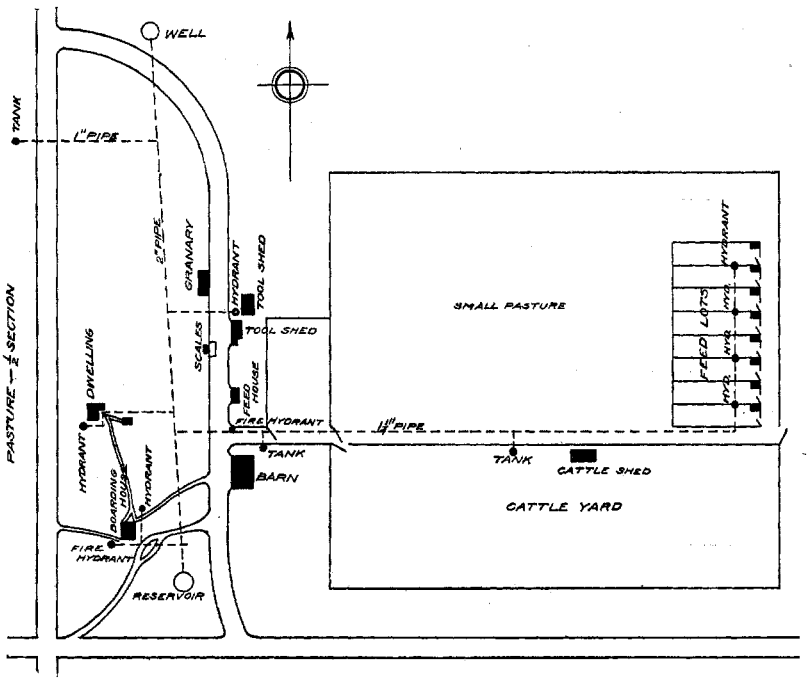


Plate 2. Plat of buildings and feed-lots.

Plate 3. Alfalfa, fifty-seven days after seeding on sod.

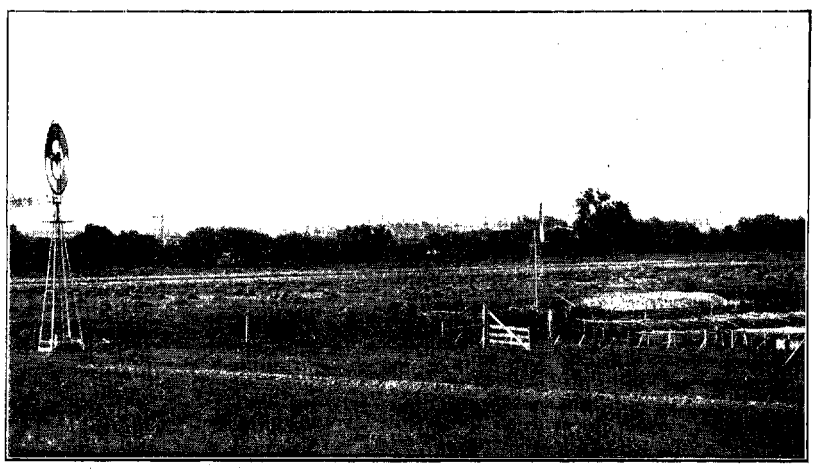


Plate 4. Small-grain variety garden, 1903.

Plate 5. Harvesting small plats of wheat.

Plate 6. Thrashing wheat from small plats.

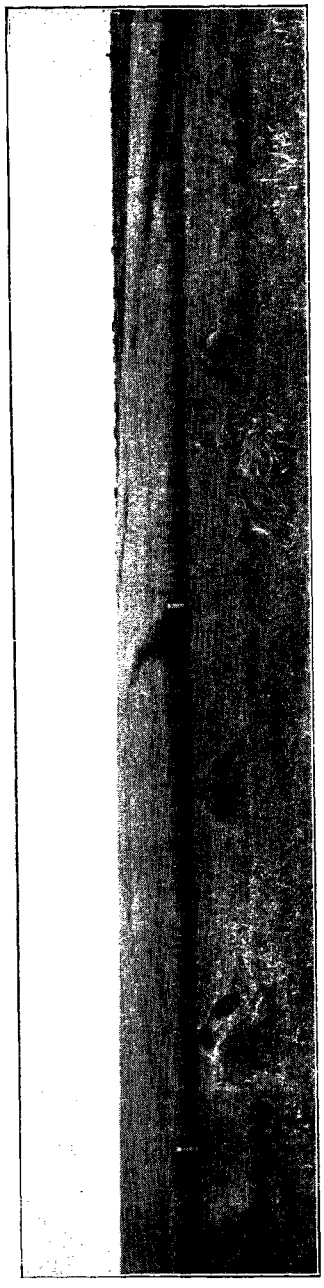


Plate 7. Wheat experiments. Acre plats.

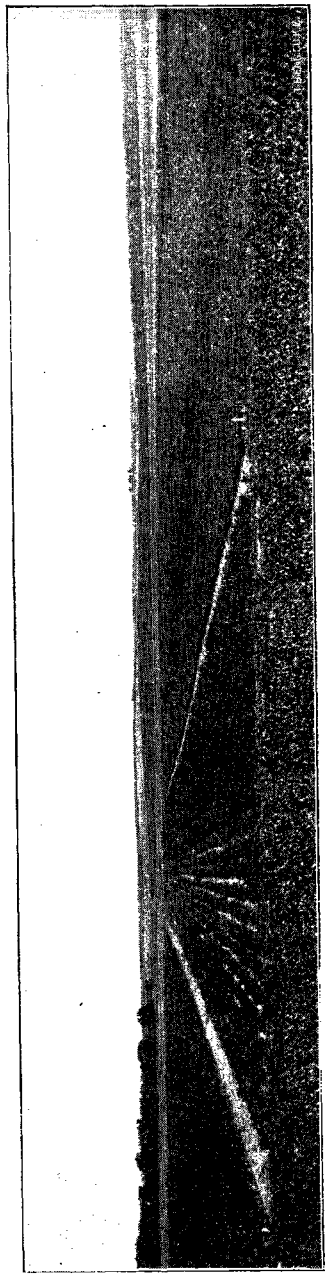


Plate 8. Irrigated field.

Plate 9. Irrigating corn.

Plate 10. Kafir-corn, sorghum and pencillaria; 1. Irrigated. 2. Not irrigated.

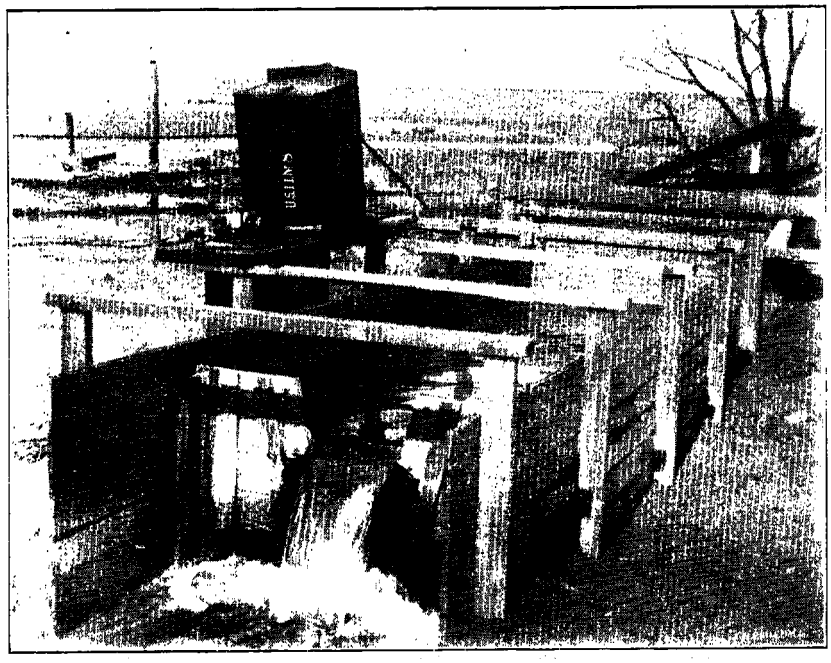


Plate 11. Weir for measuring water used in irrigation.

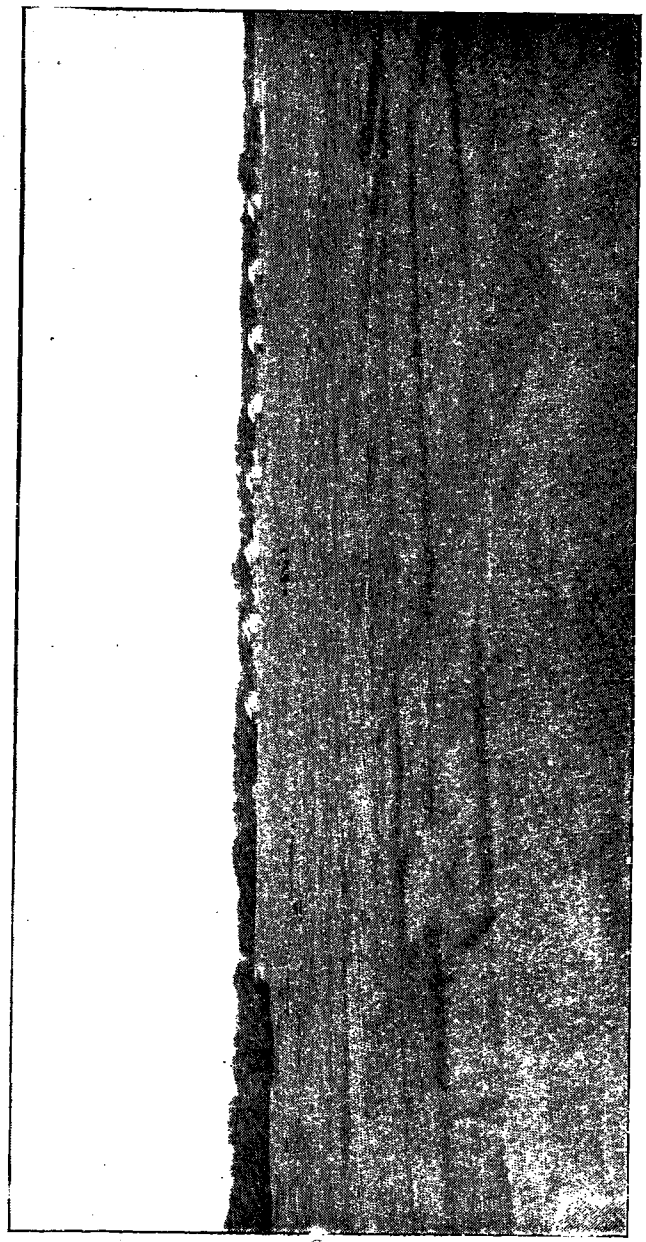


Plate 12. View of feed-lots in the distance.

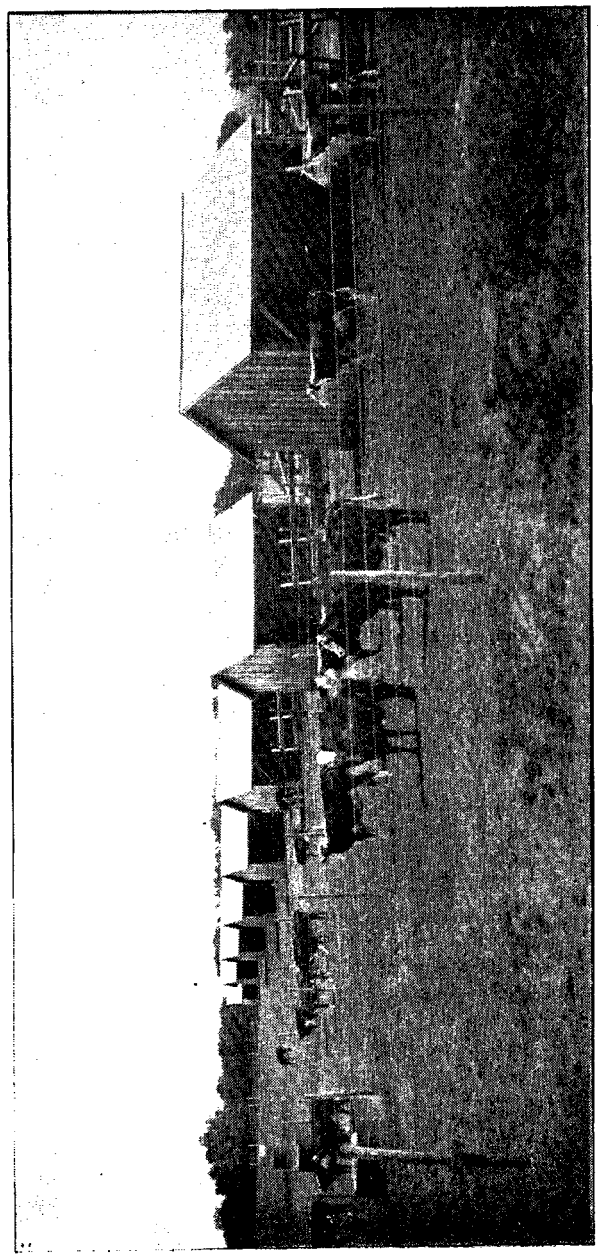


Plate 13. Feed-lots.

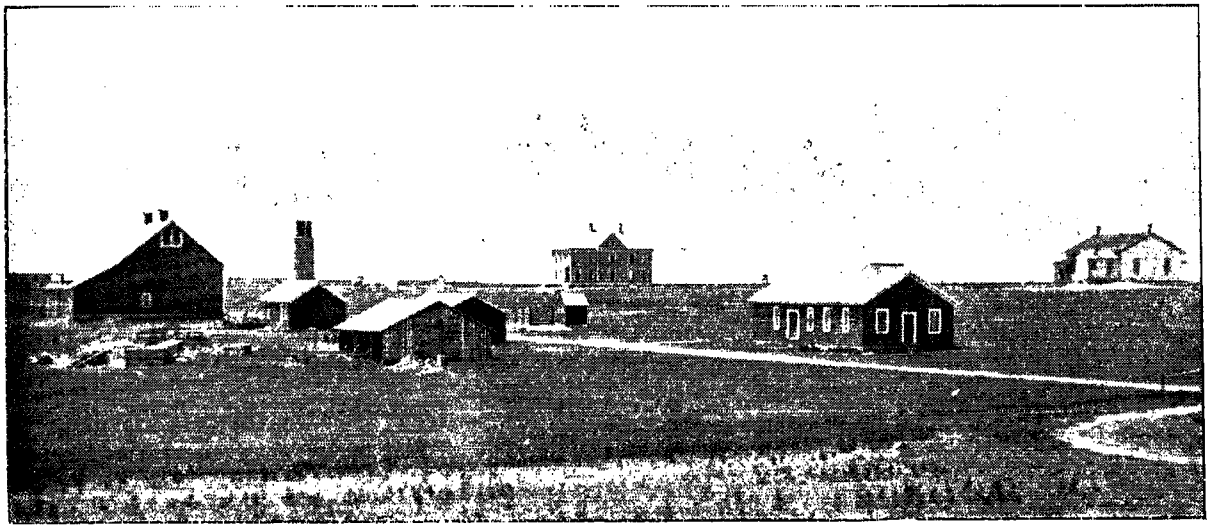


Plate 14. View of buildings, from the north.