EXPERIMENT STATION

OF THE

KANSAS STATE

AGRICULTURAL COLLEGE.

REPORT FOR 1894,

CONSISTING OF THE

SEVENTH ANNUAL REPORT

AND

BULLETINS 46 TO 48.

MANHATTAN, KANSAS,
1895.

KANSAS STATE AGRICULTURAL COLLEGE.

BOARD OF REGENTS.

HON. W. D. STREET, (1896,) **President* ..... Oberlin, Decatur Co.
HON. HARRISON KELLEY, (1896,) *Vice President* ..... Burlington, Coffey Co.
HON. ED. SECREST, (1895,) *Treasurer* ..... Randolph, Riley Co.
HON. E. D. STRATFORD, (1895,) *Loan Commissioner* ..... El Dorado, Butler Co.
HON. C. B. HOFFMAN, (1897,) ..... Enterprise, Dickinson Co
HON. C. E. GOODYEAR, (1897,) ..... Wichita, Sedgwick Co.
PRES. GEO. T. FAIRCHILD, *(ex officio) Secretary* ..... Manhattan, Riley Co.

I. D. GRAHAM, *Assistant Secretary*, Manhattan.

*Term expires.

STATION STAFF.

COUNCIL.

GEO. T. FAIRCHILD, LL. D., *Chairman*,
President of the College.

GEO. H. FAILYER, M. Sc.,
Professor of Chemistry.

E. A. POPENOE, A. M,
Professor of Entomology and Zoölogy

C. C. GEORGESON, M. Sc.,
Professor of Agriculture.

N. S. MAYO, D. V. S., M. Sc.,
Professor of Physiology and Veterinary Science.

A. S. HITCHCOCK, M. Sc.,
Professor of Botany.

S. C. MASON, M. Sc.,
Professor of Horticulture.

I. D. GRAHAM, A. M., *Secretary*.

ASSISTANTS.

J. T. WILLARD, M.Sc. ..... *Chemistry*
FRED. A. MARLATT, B. Sc. ..... *Entomology.*
F. C. BURTIS, M. Sc ..... *Agriculture.*
D. H. OTIS, B. Sc. ..... *Agriculture.*
J. B. S. NORTON ..... *Botany.*
F. C. SEARS, B. Sc. ..... *Horticulture.*
F. W. DUNN, B. Sc. ..... *Irrigation.*

KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN, KAS., January 31, 1895.

To His Excellency Governor E. N. Morrill:

DEAR SIR—I herewith transmit, as required by act of Congress approved March 7, 1887, the seventh annual report of the Experiment Station of the Kansas State Agricultural College, for the year 1894, including the financial statement to June 30, 1894.

Respectfully yours, GEO. T. FAIRCHILD,
Secretary Board of Regents.

EXPERIMENT STATION

OF THE

KANSAS STATE AGRICULTURAL COLLEGE

MANHATTAN.

SEVENTH ANNUAL REPORT—FOR THE YEAR 1894.

FINANCIAL STATEMENT.

REPORT OF THE TREASURER.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN—Herewith is submitted my report of receipts and expenditures on account of the Experiment Station for the period between July 1, 1893, and March 31, 1894:

Received from the treasurer of the United States	$11,250 00
Paid approved vouchers, Nos. 1 to 178	9,893 70
Balance paid to Ed. Secrest, Treasurer elect	$1,356 30

JOSHUA WHEELER, *Treasurer.*

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN—Herewith please find a report of my expenditures and receipts on account of the Experiment Station for the period between April 1 and June 30, 1894:

Received of Joshua Wheeler, ex-Treasurer	$1,356 30
Received from the treasurer of the United States	3,750 00
Total	$5,106 30
Paid approved vouchers, Nos. 179 to 271	$5,106 30

ED. SECREST, *Treasurer.*

REPORT OF THE SECRETARY.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMEN—Herewith is submitted the following report of the financial affairs of the Experiment Station of the Kansas State Agricultural College for the year ending June 30, 1894. The several items of this ac-

count are covered by vouchers approved by the disbursing officer, certified by the Secretary, and allowed by the President and Board of Regents. The accounts covering the Station fund are kept in a separate set of books, as provided in the act of Congress under which the Station was organized, and duplicate vouchers covering every item of expenditure made during the year are on file in the office of the Secretary:

DR.

To appropriation for the year ending June 30, 1894, under act of Congress approved March 2,1887	$15,000 00

CR.

June 30. By salaries	$9,913 30
Labor	1,942 37
Apparatus	440 70
Supplies	456 22
Printing	1,833 45
Stationery	26 14
Postage	27 55
Library	133 13
Live stock	21 10
Traveling	94 32
Freight	92 19
Telegrams	4 53
Membership A. A. A. C. & Ex. Sta.	15 00
Total	$15,000 00

I. D. GRAHAM, *Secretary.*

REPORT OF THE FINANCE COMMITTEE.

We, the Finance Committee of the Board of Regents of the Kansas State Agricultural College, having duly examined vouchers Nos. 1 to 271, for $15,000, received and expended on account of the Experiment Station during the fiscal year ending June 30, 1894, and having diligently compared the same with the books of the Secretary, hereby certify both books and vouchers to be correct. Respectfully submitted,

C. B. HOFFMAN,
C. E. GOODYEAR,
HARRISON KELLEY,
Committee.

To the Secretary of the Treasury, Washington, D. C.:

I, Geo. T. Fairchild, Secretary of the Board of Regents of the Kansas State Agricultural College, hereby certify that the above-named persons have held the various offices designated, and that the signatures affixed above are genuine.

Witness my hand and the seal of the College, this 31st day of January, 1895.

GEO. T. FAIRCHILD,
Secretary of the Board of Regents.

[SEAL.]

REPORT OF THE COUNCIL.—1894.

To the Board of Regents of the Kansas State Agricultural College:

GENTLEMAN —In presenting the seventh annual report of the Kansas Experiment Station, covering the calendar year 1894, with the financial statement for the fiscal year ending June 30, 1894, we find ourselves, for the first time since the organization, compelled to explain the lack of definite results. The disastrous drought of 1894 made the results of nearly all field experiments so meager and uncertain as to preclude publication, and other lines of investigation have been hindered somewhat by unfavorable conditions. Accounts of the work are given herewith. Three full bulletins have been published, covering several subjects, as follows:

OUTLINE OF BULLETINS.

BULLETIN No. 46. May, 1894. Botanical Department.

Rusts of grain, II [pp. 1-91]: Containing a continuation of observations and experiments on rusts recorded in Bulletin No. 38. It was proved that the common wheat rust, *Puccinia rubigo-vera,* passes the winter in the tissues of volunteer or winter wheat, in the mycelial condition, and that the uredo-spores retain their vitality and germinate the following spring. From the observations upon *Puccinia graminis,* there is no evidence to show that this rust survives the winter by either of the methods mentioned. Inoculation experiments show that one grain is infected only by uredo-spores taken from the same kind of grain, and that there is therefore no danger of rust spreading from one kind of grain to another. The time of incubation was proven to be about 13 days. Spraying experiments proved that some fungicides would greatly decrease the amount of rusts, but that the expense of a thorough application of the material precludes the probability of spraying being a commercially successful method of prevention.

BULLETIN No. 47. August, 1894. Farm Department.

Experiments with wheat [pp. 11-16]: Containing results for 1894 of wheat continuously without manure, wheat in rotation plats, and tests of 51 varieties.

Experiments in feeding steers, II [pp. 17-31]: Containing results of feeding 10 steers, divided into two lots of five each, for 150 days on corn, one lot being fed on soaked corn and the other on dry shelled corn, showing the amount of grain and fodder eaten and the gains made by each lot. The steers were fed in open lots, provided with sheds for shelter. It also shows the amount of corn passing through steers undigested, under the conditions named, and hence the amount that will be available for hogs placed after them.

Experiment in feeding hogs [pp. 25-28]: Containing results with four half grown hogs placed behind each of the above lots of steers, careful records being kept of their gain and the amount of feed consumed, with a view to ascertaining the effect on hogs following steers fed on dry and on soaked corn, respectively.

BULLETIN No. 48. December, 1894. Farm Department.

Six years' experience with ensilage [pp. 33-40]: Containing statement of construction of silos, ensilage crops, method of harvesting, and results of experience with ensilage. These results show that, of 1,046.22 tons put away, 807.91 tons of sound ensilage were taken out, 109.44 tons were rotten, and 128.87 tons were lost curing; or 77.2 per cent of the total amount put away was good feed, 10.5 per cent was rotten, and 12.3 per cent was lost. This ensilage was fed for an average of 165 days each year to an average of 51 head of cattle, the average daily feed being about 32 pounds. At this average feed, and estimating that 77.2 per cent. of the amount of ensilage put away will be good feed, enough ensilage can be grown on 10 acres to last a herd of 25 head 192 days.

Some forage plants [pp. 40-42]: Containing results of experiments with crimson clover, flat pea, *Vicia vilosa,* and sacaline.

Renovating a prairie pasture [p. 43]: Containing results of harrowing an exhausted pasture and seeding to tame grasses.

OTHER WORK.

CHEMICAL DEPARTMENT.—No bulletins were issued during the year. Our experimental crops, consisting of sorghum and sugar beets, were entirely destroyed by the unprecedentedly severe drought, and no results were obtained. We especially regretted the loss of the sorghum crop. It will be remembered that we have been growing sorghum with a view to improving it in sugar content since 1888. One line of work has been to select the richest stalks from several of the best sorts and preserve the seed for planting the next year. Some of these best sorts are old and well-tried ones others are new ones that have been recently introduced in this country, and still others are new crosses. We have conclusively shown that judicious selection of seed results in an appreciable improvement in the quality of the crop. We have continued these selections for six years, having secured sorghum of a most excellent quality. We have for a few years past distributed to many farmers of the state small quantities of our second selections of seed, having planted the first selections ourselves. We had preserved in the season of 1893 most promising strains and crosses. All kinds were planted early, on ground in good condition. The seed started well, and an excellent stand was secured. During the forepart of the season a good growth was made, owing to the light showers that kept the surface soil wet but did not reach any depth below. When these showers failed, and the extremely hot weather of July and August came on, the growth was stopped and the seed tops dried up without setting any seed. As a result, we lost all seed planted, and in some cases the chain of selection was broken, so it will be difficult to take it up and continue it without loss to the work. In so far as seeds of the selections of 1893 were left over from the planting of 1894, they will be planted next spring, and the work taken up as it can best be. It is hoped that the future will show the loss to be less serious than it now appears to be.

In the case of the sugar beets, the loss is simply that of this crop since

we are making no attempts to improve beets. They have been brought to a high grade by a long course of culture and selection in Europe. Our tests have been those of soil and climate. The department has given considerable attention to the work of irrigation and the work of installing the experiment station at Garden City.

DEPARTMENT OF HORTICULTURE AND ENTOMOLOGY. —*Irrigation.* —The most important feature of work undertaken by the horticultural department during the season of 1894 was that of garden irrigation. The College grounds and buildings are supplied with water by a six-inch main, which enters the grounds from the east, from the city waterworks. A two-inch pipe connected with this, and laid below the surface, extends northward 685 feet through the experimental grounds. This is supplied with a meter, by means of which all water passing through it is recorded, and an account is kept of the water used upon every plat. This pipe may be cut out from the main in winter to prevent freezing. Six delivery pipes, fitted with three-fourths-inch Fuller bibs, admit of the attachment of hose to deliver the water where needed. The ground irrigated from this slopes to the south at the rate of about six inches to 100 feet. The water for the most part has been conveyed to the plants by small trenches along the rows, but in some cases, as the strawberries in part, it has been sprayed directly upon the rows. There have been under irrigation the past season the following plots: One acre of strawberries, one-half acre of grapes, one acre of vegetables.

Subsoiling. —The surveyed plat of ground, containing 17 plats of one-tenth acre each, which were treated with fertilizers in 1892, was divided into four equal plats, two of which were plowed in the spring to the ordinary depth of 6 inches, and the other two plowed to the same depth and subsoiled 10 inches deeper. The four plats were planted alike with vegetables— cabbage, cauliflower, onions, parsnips, Irish potatoes and tomatoes being used. Observations were kept as to growth of plants, resistance of drought, and temperature of the soil. These will be continued with a view to finding out how long the effect of the subsoiling may be observed.

Grapes.— The trial of varieties of grapes, it is believed, can only be most valuable by a long continuation of the observations already begun as to hardiness, productiveness and quality of fruit of the various sorts. Experiments in winter protection, bagging of fruit and spraying with fungicides are continued.

Nursery Work.— The series of experiments as to best length of stock and cion in apple grafting was continued by planting another large series of grafts. A considerable block of seedling peach trees was grown and budded for future use. Experiments have been carried on in the propagation of the numerous varieties and species of grapes represented in the vineyard, and young vines of most varieties are now in stock.

Orchards.— Experiments have been continued in the spraying of apple trees against fungous diseases, and observations continued upon susceptibility

of different varieties to attack. The protection of peach trees against frost, by laying down and covering with straw, is continued, and a small plantation of cherry, plum and apricot trees has been made, with the intention of treating them in the same way.

Vegetables.— Experiments with second crop of potatoes for seed have been continued, and promising new varieties of potatoes have been added to the trial lists. There have been added to the permanent list, 4 varieties of apples, 12 trees; 2 varieties of cherries, 6 trees; 1 of currants, 6 plants; 9 varieties of grapes, 17 vines; 6 varieties of plums, 13 trees; 1 variety of peaches, 12 trees.

Entomological.— The very dry weather and the condition of vegetation were unfavorable to insect development, and few opportunities offered for new work in entomology. Besides the everyday work of collecting and recording notes on common species, matters reserved for future discussion in proper connection, the chief new observations relate to the onion thrips. In the garden under irrigation, several varieties of the onion made good growth, but toward the end of July the loss of healthy color and the spotting of the leaves called attention to the presence of the onion thrips, not heretofore noticed in our gardens. Its numbers were sufficient to bring considerable damage to the plots, causing the withering and falling of the leaves, and measures were taken for its repression. On the 20th day of July, a thorough application of kerosene emulsion in spray resulted in the destruction of about three-fourths of the insects at their work. A repetition of the application the following day practically freed the leaves from the pest, but the weakened plant in many cases failed to recover. The thrips, though minute, appear in extraordinary numbers, and the work of this multitude of sap-sucking insects seems to result, in the onion, in special disaster. In the present case, though the insects had but just made their presence known when the work of their destruction was undertaken, the plants had already suffered enough to injure most of them permanently.

The grape-cane borer *(Amphiceus bicaudatus)* has been previously noted at length in the publications of this Station. The past spring showed them present in abundance in the vineyard, and working into the canes. As a possible means of destroying the adults in this stage of their work, the use of Paris green was suggested, and accordingly, on May 2, certain rows were sprayed with Paris green in water, in the proportion of 1 ounce to 20 gallons. An examination of the vines on the 4th of May showed, on the sprayed rows, no live beetles, while on the rows unsprayed, the beetles were at work in the usual numbers. The poison lodged about the buds on the bark of the canes of the sprayed vines seems enough to kill the adult, or to deter it from work, but the present observations do not determine which.

FARM DEPARTMENT.—The following experiments were undertaken by the Farm Department, but had to be abandoned by reason of the dry weather:

Wheat Experiments.—Hot-water treatment for stinking smut; methods of seeding; seeding at different dates; early and late plowing for wheat; influence of the quality of seed wheat on the yield; effects of compacting the seed bed; amounts of seed wheat to the acre; and the effects of pasturing wheat.

Corn Experiments.— Planting corn at different dates; comparison of early, medium and late corn; comparison of butt, middle and tip kernels for seed; frequency of cultivation; amount of cultivation; methods of cultivation; effects of removing tassels; test of 55 varieties of corn; subsoiling for corn; corn and soy beans for ensilage; improvement of corn by nitrogenous fertilizers; corn and Kaffir corn compared for fodder and grain.

Oat Experiments.—Test of 48 varieties of oats; amount of seed oats per acre; seeding oats at different dates; effect of quality of seed oats; fall and spring plowing and no plowing for oats; stage of ripeness at which to harvest oats; methods of seeding oats; treating seed oats with hot water for smut; and drilled and listed oats. These oat experiments were not altogether a failure, but the report on the results will be retained until another harvest, as they are not of sufficient value to warrant a report.

Miscellaneous Crops.— Trials were made on a small scale with new forage plants, *Lathyrus sylvestris* and sacaline, and with peanuts, cow peas, and soy beans. These will be reported on in a forthcoming bulletin.

VETERINARY DEPARTMENT.—During the past year the following subjects have been investigated as far as circumstances would permit:

A further study of and experiments with the Southern cattle ticks, with reference to their relation to Texas fever.

Bovine tuberculosis, with special reference to the milk of tuberculous cows and its liability to transmit the disease.

An investigation of sorghum, especially second-growth sorghum, with reference to its reputed poisonous effects when eaten by cattle.

Experiments and tests of various remedies, with reference to their remedial or curative effects in hog cholera.

A study of and discovery of the cause of a form of chronic mammitis (garget) of cattle.

An investigation and determination of the cause of the death of certain cattle due to feeding cornstalks.

The difficulty in procuring material for investigation, owing to the fact that many of the diseases occur only during certain seasons of the year and under peculiar conditions, accounts for the large number of subjects not sufficiently investigated to warrant publication.

BOTANICAL DEPARTMENT.— *Weeds.* — Observations and experiments on this subject have extended over three years. Many drawings have been made illustrating the seedlings, since it is important to discriminate between the species during the early stages. The vitality of the seed, the time and

conditions of germination, methods of propagation, and many other observations have been made, to increase our knowledge concerning those plants usually called weeds, and to suggest methods for eradicating or suppressing them.

Corn Smut.— This disease is due to the presence of a parasitic fungus. The crop affected is so important in Kansas that the loss from smut in the aggregate is considerable. During the past year (1894) this has been the chief subject of investigation. The time and manner in which the fungus gains an entrance into the corn plant is as yet unknown. This, of course, must first be ascertained, that methods of prevention may be based upon such knowledge. This is the problem that the Station is attempting to solve.

Miscellaneous.— Many other subjects of minor importance received attention from time to time. Among these may be mentioned, a botanical study and comparison of the cultivated varieties of onions, experiments on heredity in some cultivated plants, observations on fungous diseases, such as strawberry leaf blight and anthracnose of raspberry. In addition to original investigations, the Station is frequently called upon to furnish information. Many weeds, grasses, forage and other plants are sent for identification. Specimens of diseased plants are also sent, with requests for remedies. Such inquiries extend our knowledge concerning the subjects mentioned and are to be encouraged.

IRRIGATION.—GARDEN CITY.

In the spring of 1894 the Station undertook a line of experiments in irrigation. A 10-acre tract of land near Garden City, having a reservoir already constructed, was leased from Mr. J. M. Dunn by the Board of Regents for a term of 10 years. It was proposed to construct a well and erect a windmill to fill the reservoir, and to irrigate from this. The problems to the solution of which we directed our efforts are briefly these:

PROBLEMS.

Procuring and Storing Water.— A test of the supply of water and of its flow through the sand. A test of the pumping power of our windmill under varying but measured wind velocities. The loss of water from reservoirs by evaporation at different temperatures and wind velocities. The loss of water from reservoirs by seepage.

Although dealers' catalogues purport to give the work that the several sizes of windmills may be expected to do, they, as a matter of fact, have very little data to base these statements upon. Moreover, these statements, as made, are in no way comparable among themselves. Their crudity shows that they are based on neither experience nor theory. It is very important that the actual measured quantity of water raised by the several windmills, through a given height with a given wind velocity, should be known. By this means only may the work to be expected under any given circumstances

be known. The collection of such data was the aim from the first. The loss of water from exposed bodies of water by evaporation has been studied in other sections to some extent, but not under conditions prevailing in our plains regions. The measurement of evaporation and of the velocity of the wind, together with observations on the temperature of the air and of the water evaporation, would give us the required data on evaporation.

Use of Water.— It was proposed to study and compare methods of economizing water. It is believed that the development of methods that will make the same quantity of water go further in producing crops is equivalent to the discovery of additional supplies of water that can be secured and applied without additional cost. In the efforts in this direction, the following trials were undertaken: A test of the water-holding power of soils plowed as ordinarily, plowed very deep, and subsoiled; a test of the retentive power of soils deeply tilled, surface tilled, finely pulverized, mixed with barnyard and chemical manures; trials of the relative economy of applying large and small quantities of water, and of different intervals between the waterings. Attempts to determine the most profitable degree of moisture to maintain, having special reference to the maximum holding capacity of the soil.

Special Crops.— It was further planned to test the drought-resisting capabilities of certain crops, and to strive to find plants that require a minimum supply of water in the soil, as well as to strive to secure plants especially suited to irrigation because of the great value of the crop per acre, and to attempt to develop strains of plants that resist loss of water from their tissue to the surrounding air.

THE WORK.

While all these problems were within the scope of the work originally planned, it was not expected that all could be taken up the first season, and it was fully realized that valuable results in these lines could be realized only after several years of careful work combined with no small degree of skill and penetration. The methods to be pursued must be worked out, and much of the apparatus devised and constructed. Many of the methods first tried must necessarily be tentative, and be replaced by others as experience shows the necessity.

In accordance with the foregoing plan, the ground was prepared, apparatus for recording full data as to climatic conditions, water supply and wind velocity was secured, and a 16-foot Aermotor windmill was erected on a 30-foot tower, near the reservoir previously mentioned. The reservoir is 110 feet square, with embankments about five feet high. The station is located on the high ground, about three miles from the Arkansas river. The formation found in the immediate region had been but little explored for water, and it was uncertain what kind of material would be encountered, and of what quality the water-bearing sand would prove to be. As it was known to be about 30 feet to water, an open well was sunk, in

order to put a pump cylinder within a reasonable height above the water level. It was found that there are at this place 23 feet of so-called "plains marl"; then a few inches less than 23 feet of sand; below this a compact clay or soft shale. At the time the well was put down, the upper surface of the water was seven feet down in the sand, making 30 feet from the surface of the ground to the water, and nearly 16 feet of water-bearing sand above the underlying clay just described. A perforated 12-inch galvanized-iron casing was first used in sinking the well after reaching water, the sand being removed by an ordinary sand pump. Our casing was made at Garden City, and was poorly made. The sand proved to be so fine that it entered the casing through the perforations so rapidly as to make it necessary to abandon the casing and to use a strainer point. The perforated casing was removed, and an ordinary casing first sunk to the clay underlying the sand; then the strainer and suction pipe were put down and the casing withdrawn. The sand encountered was very fine, and packed together so as to let the water through very slowly. Although we used an eight-foot six-inch Cook strainer, it supplied far too little water for our large mill and pump. Later another strainer was added. This second strainer is a jacketed point six inches by six feet. It is 14 feet from the first, and is connected with the upright suction pipe just below the cylinder by means of a tee.

SUGGESTIONS AS TO WELL AND RESERVOIR.

The experience with well and reservoir, though somewhat limited, seems to point out the advisability of first prospecting the ground to learn the character of the sand from which the water is to be drawn. A change of a few hundred feet may make a great difference in the coarseness of the sand, and either site be suitable for the reservoir. If steps are taken to secure water first, and then construct the reservoir, etc., disappointment from insufficient water supply may often be avoided. A large reservoir has disadvantages. There is much greater surface, both at bottom and sides, for water to be lost by percolation, and a large surface from which evaporation can take place. In addition to these, it takes a longer time to fill a large reservoir sufficiently to get enough head to flow the water over the comparatively level fields. It would be better to use a small reservoir and empty it more frequently. It will seldom occur, if the use of water is judiciously managed, that there will be loss from inability to store the limited amount of water that any practicable reservoir will hold. Instead of a large reservoir, two smaller ones of the same total capacity as the large one will be more serviceable, since, with scant wind, one only need be used. By making these side by side, the division wall will be the only expense over the large single reservoir. Thus the advantages of both sizes of reservoir may be had at very little added cost.

We are satisfied that the plan first followed, of having a large perforated galvanized-iron casing let down in the sand, then using a common suction

pipe, has advantages. Care should be taken in constructing this casing. It should be made strong, so that it will stand forcing into the sand, and so that it will stand drawing out, if desired. The perforations should not be very large, lest the sand come in through them to too great an extent. But there is an advantage in letting the finest sand run in, pumping it out with the sand pump. Thus the casing will be surrounded with a layer of coaser sand that will let the water in more readily. The perforations should be abundant, so as to offer but little opposition to the water entering. The difficulties to be expected in the working of wells have been hinted at in what has gone before. The fine sand interferes with the flow of water to the strainer point, preventing the filling of the cylinder and causing hammering. If the water is not some feet above the upper end of the strainer, it may so sink in the sand before water can flow in laterally that air will find its way down through the upper sand, and thus the pump suck air, greatly interfering with its efficiency. The remedy must be either to find coarser sand or to put down more strainer surface. The solution may be an open well.

In constructing the reservoir, one thing should be carefully looked after, as it cannot be easily remedied afterward, viz., the prevention of unnecessary loss of water through the wall. The surface soil should be scraped off where the embankment is to be built. In this way a better connection between the wall and its foundation will be secured, and there will consequently be less leakage at this point. As the wall is built up it should be well settled. If the well has been put down first, as it is always prudent to do, water may be had for wetting the soil, thus being able to settle it better, and in these ways to reduce the seepage at the walls to a minimum.

WORK ON CROPS.

Our 10-acre tract of land is about 70 rods by 22 rods. This land was divided into three strips, running the length of the land. One of these strips was plowed about five inches deep, the second about nine inches deep, the third subsoiled to a depth of 16 inches, by running the subsoiler in the bottom of the nine-inch furrow. This was as deep as a team of five good horses could draw the subsoil plow in the new, compact soil of the region, and the plow could not stand greater strain, otherwise the ground would have been subsoiled to a depth of 20 inches. By laying out the plats across these strips, each crop was tried on each of the three kinds of soil, or, rather, on soil prepared by the three principal methods: subsoiling, deep plowing, and ordinary plowing. On the ground thus prepared were planted the following crops: By dry farming— navy beans, California tree beans, Irish potatoes, broom corn, Soy beans, red Kaffir corn, field corn, cow peas. To be irrigated —squashes, pumpkins, evergreen broom corn, golden broom corn, rice corn, brown Dhura, Jerusalem corn, white Kaffir corn, red Kaffir corn, field corn, sorghum, soy beans (three varieties), cow peas, sugar beets

(three varieties), garden beets, parsnips, carrots, melons, Irish potatoes, sweet potatoes, snap beans, garden peas, alfalfa (two varieties), clover from France, college grass mixture, *Lathyrus silvestris, Bromis inermis.*

Excepting in a few instances, a good stand was secured on the irrigated land, and all grew well and gave good yields. While full records have been kept of all data regarding preparation of soil, planting, watering, cultivating, etc., it is not deemed important to publish these details each year. They will be preserved and brought together with the later results for comparison. Their main value is from the comparisons that may be made.

Because of difficulties in securing water from our well, the crops would have suffered for water, notwithstanding the several good rains that visited that region, had we not secured water from the ditches conveying water from the Arkansas river. Mr. F. W. Denny, of the Garden City Irrigation Company, kindly gave us water from the company's ditches. This liberality of the Garden City Irrigation Company is greatly appreciated.

The general direction has been with the entire Council, but all details have been planned by a committee, consisting of the professors of agricultural chemistry, agriculture, and horticulture. The Station is indebted to Mr. John E. Frost, land commissioner of the Atchison, Topeka & Santa Fé railroad, for substantial aid in the way of transportation; also, to Mr. T. C. Mitchell, agent at Garden City for the Kansas City Pump Company, for securing wholesale rates upon portions of the plant, and the gift of a 12-inch cylinder for trial.

OBERLIN.—A plat of 10 acres, near the city of Oberlin, was leased from Mr. J. J. Foltz, for the purpose of testing the feasibility of irrigation from a well not less than 100 feet deep, with the plan of carrying on similar experiments to those already detailed as undertaken at Garden City. Upon this plat an open well has been dug, 105 feet deep, and a reservoir has been constructed. The plan is to develop this station as funds are available, letting the experience at Garden City guide in some sort as to methods and equipment.

THE STAFF.

Changes in the Council have been made by the promotion of Professor Mason to the chair of horticulture, and the release of Professor Popenoe from duties outside of the entomology. At the same time, Mr. F. C. Sears, B. Sc., was transferred from the College force to be assistant in horticulture. Mr. F. W. Dunn, B. Sc., a graduate of the College, who had had several years of experience upon irrigated lands in Colorado, was employed as assistant in irrigation, at Garden City.

GENERAL MATTERS.

The general correspondence of the Station has been carried on by the Secretary, special questions, as usual, having been referred to the several heads of departments. All accounts have been carefully kept, in accord

with the system heretofore followed. The system of accounts from this year on is provided by the secretary of agriculture for the United States, and the books of this Station have already been modified to meet its requirements.

The plans for the year 1895 include a continuance of the lines of experiment and research found so interesting in the past, with varieties according to the circumstances of the season.

Appended to this report is a summary of the Station inventory. It should be remarked that the Station, being a department of the College, has the use of College implements, apparatus and buildings to a large extent, so that the property inventoried does not in any particular represent the full facilities for investigation.

GEO. T. FAIRCHILD,
GEO. H. FAILYER,
E. A. POPENOE,
C. C. GEORGESON,
N. S. MAYO,
A. S. HITCHCOCK,
S. C. MASON,
Station Council.

SUMMARY OF INVENTORY—JUNE 30, 1894.

CHEMICAL DEPARTMENT.

Absorption apparatus	$15 40
Beakers	12 15
Bell jars	3 60
Beet pulper	2 25
Beet press	6 40
Bellows	7 00
Blower	4 60
Bottles:	
Copper oxide	1 80
Reagent	23 40
Salt mouth	49 75
Specific gravity	4 25
Weighing	6 75
Burners	21 40
Combustion tubes	9 80
Condensers	44 85
Crucibles, porcelain	8 20
Desiccators	6 00
Evaporating dishes:	
Porcelain	21 80
Glass	1 35
Agate ware	7 20
Nickel	2 25
Extraction apparatus	106 60
Filters and filter paper	17 15
Filter pumps	5 20
Flasks:	
Copper	12 25
Balloon	11 65
Erlenmeyer	15 00
Digestion	7 35
Filtering	4 95
Ordinary	12 90
Specific gravity	4 35
Washing	3 30
Fodder mill	50 00
Funnel and funnel tubes	8 45
Gas generator	5 00
Gas regulators	6 25
Glass tubing and rods	4 90

Graduated apparatus:	
Burettes	$16 45
Cylinders	6 55
Flasks	8 45
Nesslerizing cylinders	9 00
Pipettes	10 00
Tubes	5 40
Hydrometers and jars	11 40
Mortar, agate	12 00
Mortars, porcelain	2 40
Ovens, dry	17 00
Platinum ware	392 70
Scale, Troemmer's solution	20 00
Sieves	4 30
Spatulas	1 70
Supports for apparatus	34 15
Thermometers	8 75
Tongs	2 60
Water bottles	17 00
Watch glasses	2 90
Weights	11 20
Miscellaneous apparatus	88 70
Chemicals	56 45
Books	30 85
Office furniture	11 85
Total	$1,336 30

DEPARTMENT OF HORTICULTURE AND ENTOMOLOGY.

Horse tools	$85 00
Hand tools and garden apparatus	308 05
Office furniture and apparatus	336 90
Spraying apparatus	88 45
Apiary	39 25
General supplies	107 41
Books	62 92
Microscopes and accessories	547 43
Microscope supplies	36 09
Total	$1,611 50

FARM DEPARTMENT.

Buildings:	
Piggery (interior)	$200 00
Silos	275 00
Seed and storerooms	135 00
Cattle sheds	75 00
Water system	100 00
Work horses	350 00
Machines and implements:	
Belle City root cutter	40 00
Wagon	70 00
Iron harrow	11 00

Machines and implements—*Concluded:*	
Mowing machine	$65 00
Surface cultivator	15 00
Planet, jr., cultivator	8 00
Steel-beam plow	15 00
15-horse-power boiler	300 00
Flue cleaner	35 00
J. I. Case lister	40 00
Test churn	45 00
Buckeye grain drill	18 00
Babcock milk tester	10 00
Planet, jr., seed drill	8 00
Corn-cutting machine	25 00
Hand cart	9 00
Cultivator shield	2 00
Fanning-mill screen	27 00
Hay racks	20 00
Spades, shovels, hoes, etc	23 45
Platform and counter scales	25 00
Test bottles, thermometers	57 16
Buckets, baskets, and measures	6 35
Office furniture and books	187 40
Harness, halters, etc	46 75
Seed and storeroom	25 81
Hay caps	76 80
Feed boxes	7 75
Labels, plat stakes, etc	80 22
Sundry	21 06
Total	$2,455 75

VETERINARY DEPARTMENT.

Zeiss microscope and accessories	$409 25
Dissecting microscope and accessories	43 21
Stains and mounting media	15 65
Slips, cover glasses, etc	6 60
Sterilizing and incubating ovens	76 60
Flasks, beakers, bell jars, and damp chambers	39 50
Bottles and test tubes	10 40
Drugs and chemicals	12 00
Microtome and imbedding accessories	46 91
Hæmacytometer and stains	9 90
Balances and weights	19 90
Surgical instruments	110 70
Gas machine and burners	127 15
Office furniture	139 95
Books	23 93
Stalls, pens, and accessories	81 84
Live stock	14 00
General supplies	42 84
Total	$1,229 33

BOTANICAL DEPARTMENT.

Office furniture	$82 10
Cases and shelves	73 15
Dark room for photography	30 00
Zinc-lined culture room	165 00
Microscope and accessories, including 10 eyepieces and 10 objectives	624 40
Other microscopical apparatus	43 63
Bacteriological apparatus	62 55
Photographic apparatus	36 00
Drawing tools	23 60
Bell jars	117 40
Bottles, beakers, and other glassware	50 60
Spraying pumps	26 00
Pots and germinating pans	18 00
Hand thrashing machine	11 85
Balance and weights	14 63
Fascicles of fungi	28 00
Stakes	8 00
Specimen trays and reagent boxes	13 15
Sundries, utensils, tools, etc	139 42
Library—392 bound volumes and numerous pamphlets	594 18
Total	$2,022 24

GENERAL DEPARTMENT.

Card catalogue case, in library	$17 00
Bulletin case and drawers, in secretary's office	99 65
Autograph stamps	5 75
Pamphlet cases	18 48
Ink stand, rubber stamps, etc	2 55
Records and mailing lists	18 50
File boxes	6 05
General library, 241 bound volumes	271 25
Total	$439 23

GENERAL SUMMARY.

Chemical department	$1,336 30
Horticultural department	1,611 50
Farm department	2,455 75
Veterinary department	1,229 33
Botanical department	2,022 24
General department	439 23
Total	$9,094 35

LIST OF DONATIONS.

1894.

HORTICULTURAL DEPARTMENT.

J. W. Clark, Olathe, Kas.:
Three trees Park's Keeper apple.

Joel Horner & Son, Delair, N. J.:
One Homer's No. 1 grape.

T. V. Munson, Denison, Texas:
Two vines Jaeger's No. 43 grape.

JewelI Nursery Company, Lake City, Minn.:
Three plants North Star currant.

Northrup, Braslan, Goodwin Co., Minneapolis, Minn.:
One packet tomato seed.

D. M. Ferry & Co., Detroit, Mich.:
One packet tomato seed.

J. C. Vaughan, Chicago, Ill.:
One ounce asparagus seed and one packet muskmelon seed.

J. M. Thorburn & Co., New York:
One packet beans.

FARM DEPARTMENT.

R. L. Kepperling, Junction City, Kas.:
Sample of grass seed.

Chas. Stowell, Oketo, Kas.:
Sample of oats.

F. Barteldes & Co., Lawrence, Kas. :
Thirty-two samples of grass seed.
sample of sand vetch.
Sample of carrots.

Northrop, Braslan, Goodwin Co., Minneapolis, Minn.:
Sample of corn.

Department of Agriculture, Washington, D. C,:
Sample of alfalfa.

Hatch Experiment Station, Amherst, Mass.:
Three samples soy beans.

PREVIOUS PUBLICATIONS.

BULLETINS.

*No. 1, April, 1888, "Organization, Equipment, and Aims."
*No. 2, April, 1888, "Experience with Cultivated Grasses and Clovers."
*No. 3, June, 1888, "Life History of Two Orchard Pests."
*No. 4, September, 1888, "Experiments with Wheat."
*No. 5, December, 1888, "Sorghum and Sorghum Blight."
*No, 6, July, 1889, "Silos and Ensilage."
No. 7, August, 1889, "Experiments with Wheat."
No. 8, October, 1889, "Preliminary report on Smut in Oats."
*No. 9, December, 1889, "Experiment in Pig Feeding."
No. 10, May, 1890, "Notes on Conifers for Kansas Planters."
No. 11, July, 1890, "Experiments with Wheat."
No. 12, August, 1890, " Preliminary Experiments with Fungicides for Stinking Smut of Wheat."
No. 13, August, 1890, "Experiments with oats."
No. 14, December, 1890, "Winter Protection of Peach Trees, and Notes on Grapes."
No. 15, December, 1890, "Additional Experiments and Observations on Oat Smut made in 1890."
No. 16, December, 1890, "Experiments with Sorghum and Sugar Beets."
No. 17, December, 1890, "Crossed Varieties of Corn, Second and Third Years."
No. 18, December, 1890, "Experiments with Forage Plants."
No. 19, December, 1890, "Germination of Weeviled Peas—Garden Notes on Potatoes, Beans, and Cabbage."
No. 20, July, 1891, "Wheat."
* No. 21, August, 1891, "Stinking Smut of Wheat."
*No. 22, August, 1891, "Smut of Oats; Smut and Rust of Wheat."
No. 23, August, 1891, "Smut of Sorghum and Corn"
*No. 24, September, 1891, "Staggers of Horses."
*No. 25, December, 1891, "Sorghum for Sugar."
No. 26, December, 1891, "Varieties of the Strawberry."
No. 27, December, 1891, "Crossed Varieties Of Corn."
No. 28, December, 1891, "The Experimental Vineyard."
*No. 29, December, 1891, "Oats."
No. 30, December, 1891, "Corn."
No. 31, December, 1891, "Sugar Beets."
No. 32, December, 1891, "Feeding Stuffs, and the Development of Grain Crops." " Soy Beans."
No. 33, August, 1892, "Experiments with Wheat."
*No. 34, September, 1892, "Experiments in Feeding Steers."
*No, 35 December, 1892, "Actinomycosis Bovis, or 'Lumpy Jaw' Of Cattle." "Some Observations upon Loco."
No. 36, December, 1892, "Experiments with Sorghum and with Sugar Beets."

*Out of print. The annual reports for 1888 and 1889 contain the subject-matter of Bulletins Nos. 2 to 9, inclusive.

No. 37, December, 1892, "Experiments in Potato Culture."
No. 38, March, 1893, "Preliminary Report on Rusts of Grain."
No. 39, August, 1893, "Experiments in Feeding Steers, II."
No. 40, August, 1893, "Experiments in Wheat."
No. 41, December, 1893, "Effect of Fungicides upon the Germination of Corn."
No. 42, December, 1893, "Experiments with Oats."
No. 43, December, 1893, "Experiments with Sorghum and Sugar Beets."
No. 44, December, 1893, "Further Study of Native Grapes."
No. 45, December, 1893, "Experiments with Corn."
No. 46, May, 1894, "Rusts of Grain, II."
No. 47, August, 1894, "Experiment with Wheat." "Experiments in Feeding Steers, III."
No. 48, December, 1894, "Six Years Experience with Ensilage." "Some Forage Plants." "Renovating Prairie Pasture."

REPORT FOR 1888.*— CONTENTS.

Waste of Manure in Summering Manures in the Yard. Experiments in the Corn Field. Experiments with Wheat, including Bulletin No. 4. Forage Crops. The Milk and Butter Product as Influenced by Feeding. The Pressure of Ensilage on the Walls of the Silo. Relation of Rainfall to the Corn Crop. Shrinkage of Hay in the Mow. A Comparison of Varieties of Sorghum, including part of Bulletin No. 5. A Test of the Keeping Qualities of Sorghum. An Examination of Individual Stalks of Sorghum, with a view to Improving the Plant. A Trial of Fertilizers on Sorghum. A New Method of Milk Analysis for the Use of Dairymen. Spraying in the Apple Orchard. Observations upon Injurious Insects, including Bulletin No. 3. Trials of Varieties of Potatoes. Trials of Varieties of Peas. Trials of Varieties of Tomatoes. Sorghum Blight, including part of Bulletin No. 5. Hackberry Knot. Experiments in Fertilization of Varieties of Corn. Germination of Weed Seeds. The Fungous Parasites of Weeds.

REPORT FOR 1889 —CONTENTS.

Experiments with Corn, Wheat, and Forage Crops, including Bulletin No. 7. Silos and Silage, including Bulletin No. 6. Pig-Feeding Experiment, including Bulletin No. 9. Pigs from Mature and Immature Parents. Work upon Sorghum. Analysis of Feeding Stuffs. Composition of Corn at Different Stages of Growth. Ammonia and Nitric Acid in Atmospheric Waters. Comparative Trials of Garden Beans, of Peas, of Potatoes, of Tomatoes. Some Insects Injurious to the Bean. Loose Smuts of Cereals, including Bulletin No. 8. Crossing Varieties of Corn, First Year. Receptivity of Corn Silk.

REPORT FOR 1890— CONTENTS.

Summary of Bulletins 10 to 19, with index, and outline of other work undertaken.

REPORT FOR 1891— CONTENTS.

Summary of Bulletins 20 to 32, with index, and outline of other work undertaken.

REPORT FOR 1892 — CONTENTS.

Summary of Bulletins 33 to 37, with index, and outline of other work undertaken.

REPORT FOR 1893 — CONTENTS.

Summary of Bulletins 38 to 45, outline of other work, meteorological summary for 36 years, with index to both bulletins and report.

* Out of print.