NINTH ANNUAL REPORT

OF THE

U. S. AGRICULTURAL

EXPERIMENT STATION

FOR SOUTH DAKOTA,

FOR THE

FISCAL YEAR ENDING JUNE 30, 1896.

BROOKINGS, SOUTH DAKOTA.

Will A. Beach, Printer and Binder, Sioux Falls, S. D.
GOVERNING BOARDS.

REGENTS OF EDUCATION.

Hon. F. D. Adams, Pres. ......................... Groton
Hon. L. T. Boucher, Vice Pres. ................ Eureka
Hon. E. T. Sheldon, Sec’y ....................... St. Lawrence
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Dr. G. J. Coller ............................... Brookings
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Hon. N. W. Egleston .......................... Chamberlain
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Dr. G. J. Coller, Regent Member.
Hon. A. H. Wheaton, Trustee Member.
Jno. W. Heston, Pres. of College.

Jas. H. Shepard, Director ..................... Chemist
E. C. Chilcott, Vice Director .................. Agriculturist
T. A. Williams ................................. Botanist
Dice McLaren ................................. Zoologist
N. E. Hansen ................................. Horticulturist

F. G. Orr, Secretary and Accountant.

ASSISTANTS.

A. B. Holm ................................. Soils
J. M. Trueman .............................. Dairy Science
W. H. Knox ................................. Chemistry
LETTER OF TRANSMITTAL.

To the Honorable
CHARLES H. SHELDON,
Governor of the State of South Dakota.

SIR:
I have, in compliance with the law, the honor herewith to transmit the Ninth Annual Report of the United States Experiment Station of South Dakota for the fiscal year ending June 30th, 1896.

Very respectfully,
JAS. H. SHEPARD,
Director.
DIRECTOR'S REPORT.

JAS. H. SHEPARD, Director.

The fiscal year 1895-6 has been one of extreme vicissitudes for this Station. Numerous and unnecessary changes on the Station Staff has unavoidably made good work impossible.

Early in August, 1895, the heads of the departments of Agriculture, Horticulture, Zoology, Dairying and Chemistry were dismissed in the midst of the working season without any opportunity to complete the work begun, and some of those departments remained without a head until all opportunity of accomplishing work worthy of note had passed. Moreover when new men were appointed they were necessarily strange to the state, and were unable therefore, in some instances, to take up the work where their predecessors had left it; nor were they able in so short a time to originate and develop new lines of work, moreover the newness and pressure of college duties tended in the same direction. The work in irrigation which was well under way became a total loss.

The departments suffering the most severely from the foregoing causes were the departments of Agriculture, Chemistry and Dairying. The departments of Horticulture and Zoology fared better. The work accomplished will be recited in the appended reports of the various departments.

Early in May, 1896, the Governing Boards were reorganized. This reorganization was immediately followed by a complete reorganization of the Station Council and a complete change in the methods of administration was inaugurated. The first step taken was to separate the duties of the President of the College and of the Director of the Station. A separation which all our better institutions are now recognizing as a necessity and one which must soon come to all. A Director was chosen and this choice was soon followed by the election of a new President of the College, who is ex-officio, a member of the Station Council.
The next important step taken was to concentrate the work of the Station forces on fewer lines of experimentation. In pursuance of this policy the department of Veterinary Science and Dairying were cut off from the Station roll. At the same time the former heads of the departments of Agriculture and Chemistry were recalled and a partial specialization of the work of these two departments was ordered. In addition to the changes just recited one resident member from each of the Governing Boards was made a member of the Station Council with power to vote and take part in the deliberations and discussions of that body. At the same time the powers of the Station Council and the Director were increased. A series of definite regulations were adopted which govern both Station work and the expenditure of Station funds. Thus constituted the new Council entered upon its work with zeal and enthusiasm which promise most gratifying results in the near future.

Through the kindness of Professor Corbett, now of the West Virginia Station, the garden work was written up and the results are given in Bulletin 47. The results of the investigation of the shallow artesian wells of the state will soon issue in bulletin form.

Just at the close of the year Professor Williams accepted a place with the United States Department of Agriculture, Division of Agrostology, thus leaving the Department of Botany without a head. This vacancy was immediately filled by the election of Professor D. A. Saunders, to the vacant chair. With the advent of Professor Saunders a slight change was made in the lines of work in his department, the Biology reverting naturally to the department of Zoology while Entomology was united with Botany.

Upon assuming charge of the Station work the executive department was organized with the idea of greater economy, the back correspondence, a large amount of which had been allowed to accumulate was brought up to date and with the efficient aid of Secretary Orr, who was appointed to succeed Mr. Hewit, the neglected business affairs of the Station were speedily placed in good condition.

At the same time earnest endeavors were begun to complete the files of the Station Bulletins, from other Stations, which had been sadly neglected. This work is still in progress.
The College and Station herd of dairy cows was by order of the Governing Boards thoroughly inspected for tuberculosis. The state veterinarian, Dr. Elliott, was called for and in accordance with his diagnosis and recommendations, four of the cows and four calves were slaughtered. Careful post mortem examinations were made and in the case of the short horn, Maggie Hughes, photographs were taken. The inevitable inference drawn from the post mortem examination was that the herd had been infected for an extended period, so deep-rooted had the disease become, especially in the case of Maggie Hughes and in Barca, a thoroughbred Guernsey. Near the close of the term the herd was transferred from the Station to the College and this work has been continued under College supervision.

The Station buildings which were sadly in need of repairs have been thoroughly repaired and painted and a model silo has been constructed. From the financial reports it will become evident that generous additions have been made to the Station equipment. Through the generosity of the John Deer Co. the Station has been enabled to make thorough tests of the new Secretary Plow which promises to be of great value throughout this state. The work in Soil Physics has been generously provided for and a report of the work in progress along this line may be found in the report of the Agriculturist.

During this season work on the irrigated farm in the James River Valley has been renewed. The excellent results obtained will be related in a forthcoming bulletin.

The Station has rendered efficient aid to farmers in all parts of the state in combating insect pests. A more detailed account of this work appears in the report of the Zoologist.

Careful and extended experimentation has been in progress during the working season of 1895-6 to obtain hardy fruit, forest and ornamental trees and shrubs and hedge plants adapted to this section. A more complete account is to be found in the report of the Horticulturist. Bulletins reciting results will be issued in due season.

The Station is still investigating forage plants as will appear from the reports of the Agriculturist, the Botanist and the Chemist.
During the year four Bulletins have been printed and distributed; No. 45, on Forage Plants; 46, on Building Creameries; 47, on Tomatoes, Beans, etc.; 48, on Three Injurious Insects. Bulletins 6 and 7 have also been reprinted.

U. S. EXPERIMENT STATION OF SOUTH DAKOTA,

IN ACCOUNT WITH

THE UNITED STATES APPROPRIATION, 1895-6.

Dr.

To Receipts from the Treasurer of the United States as per appropriation for the fiscal year ending June 30, 1896, as per act of Congress approved March 2, 1887.............. $15,000 00

Cr.

| By Salaries | $9,637 40 |
| Labor | 2,157 45 |
| Publications | 866 18 |
| Postage and stationery | 176 48 |
| Freight and express | 159 09 |
| Heat, light and water | ...... |
| Chemical supplies | 141 27 |
| Seeds, plants, and sundry supplies | 392 81 |
| Fertilizers | ...... |
| Feeding stuffs | 79 78 |
| Library | 29 66 |
| Tools, implements and machinery | 222 58 |
| Furniture and fixtures | 37 20 |
| Scientific apparatus | 402 34 |
| Live stock | 10 00 |
| Traveling expenses | 13 95 |
| Contingent expenses | 15 00 |
| Building and repairs | 658 86 |

Balance

Totals $15,000 00 $15,000 00
We, the undersigned, duly appointed auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Secretary of the U. S. Experiment Station of South Dakota, for the fiscal year ending June 30, 1896; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress, approved March 2, 1887.

Signed,

F. D. Adams, Pres. of Regents,

E. T. Sheldon, Sec. of Regents, Auditors.

A. H. Wheaton, Pres. Trustees.

Attest:

F. G. Orr, Custodian.

ABSTRACT I—SALARIES.

a. Director and administrative offices, No. 5*... $2,311 54
b. Scientific staff, No. 6*.......................... 4,207 77
c. Assistants to scientific staff, No. 20 ........... 3,118 09
d. Special and temporary services.................. ....

Total.............................................. 9,637 40

a, b, * These numbers are averages. In May the Veterinary Department was abolished. The executive officers are now reduced to two (2). The Dairy Department was also turned over to the College.

a, * Eleven different scientific workers have appeared on the roll during the year, but six was the largest number at any one time. The number is now five (5).

c. This includes six regular assistants, such as Dairyman, Engineer, Assistant Chemist, two Foremen, and one Teamster. It also includes fourteen details working about three hours per day and averaging about $10.00 per month.
ABSTRACT 2—LABOR.

a. Monthly empls.; No. ...; Avg. rate ...; Amt. ...
b. Daily " No. 21; " " $1 50; " $372 63
c. Hourly " No. ...; " " 12 1/2c; " 1,784 82

Total ........................................ $2,157 45

a Remark—These are included in c Abstract 1.
b Remark—Hourly labor was performed by College students. It is difficult to state the exact number. Probably from 150 to 200 have done hour labor during the year.

ABSTRACT 3—PUBLICATIONS.

a. For printing 4 Bulletins No. of pages 108, (total editions each 10,000). .................. $347 62
b. For printing Annual Report, No. of pages 24, (total editions 2,000) .......................... 63 76
c. For envelopes for Bulletins and report ...................................................... 75 00
d. Other expenses .................................................. 379 75

Totals ............................................... $866 13

(d) Remark—This includes engravings, cuts, photos, blanks, binding, reprinting bulletins 6 and 7, and press bulletins in Collegian.

Abstracts 4, 5 and 6 not filled out.
The Station and College are housed in the same buildings. It would be impossible to estimate how much the Station receives from the state for the items in Abstract 6.

ABSTRACT 7—CHEMICAL SUPPLIES.

a. Chemicals ........................................ $67 49
b. Other supplies .................................... 73 78

Total ............................................. 141 27

ABSTRACT 8—SEEDS, PLANTS AND SUNDARY SUPPLIES.

a. Agricultural ..................................... $246 77
b. Horticultural .................................... 115 69
c. Botanical ......................................... 14 00
d. Entomological .................................. 1 70
e. Miscellaneous ........................................ 14 65
Total ........................................ 392 81
e. Includes Veterinary, Chemistry and Executive Departments.
Abstract 9 not filled out.

ABSTRACT 10—FEEDING STUFFS.

Hay and oats for teams used on Station Farm and Garden ........................................ $79 78
Remark—Balance of team maintenance furnished by Station and College farm.
Abstract 11 not filled out.

ABSTRACT 12—TOOLS, IMPLEMENTS AND MACHINERY.

a. Repairs ........................................ 69 58
b. New purchases ................................ 153 00
Total ........................................ 222 58

b. Hay rack ........................................ 3 65
   Force pump .................................... 4 50
   Typewriter .................................... 69 00
   Mower ......................................... 49 60
   Small tools ................................... 26 25

ABSTRACT 13—FURNITURE AND FIXTURES.

Lumber for Bulletin case, Agricultural Dept ............................ 2 80
Botanical case .................................... 4 00
Pigeon hole case for Secretary's office ............................ 30 40
Total ........................................ 37 20

ABSTRACT 14—SCIENTIFIC APPARATUS.

Bacteriological apparatus ........................................ 17 02
Microscopical apparatus ........................................ 17 38
Photographic supplies ........................................ 8 38
*Soil Physics apparatus .................................... 352 08
Sundries ........................................ 7 48
Total ........................................ 402 34

*Work in Soil Physics just commenced.
ABSTRACT 15—LIVE STOCK.

a. Horses ........................................................ $...

b. Cattle ...........................................................

c. Sheep ...........................................................

d. Swine (one boar pig) ........................................ 10 00

e. Poultry ...........................................................

f. Sundries ........................................................

Total ....................................................................... $10 00

ABSTRACT 16—TRAVELING EXPENSES.

a. In supervision of Station work ............................ $13 95

b. In attending farmers' institutes and other meet-

ings ........................................................................

Total ....................................................................... $13 95

a. Expended in supervision of Station work on irrigated

farm at Mellette, S. D.

ABSTRACT 17—CONTINGENT EXPENSES.

Photo prints .......................................................... $1 00

Soap, Horticultural Department ............................. 50

Soap for Dairy ...................................................... 2 50

Association membership fee ................................. 10 00

Registering stock .................................................. 1 00

Total ....................................................................... $15 00

ABSTRACT 18—BUILDING AND REPAIRS.

a. New buildings (silo) .......................................... $302 01

b. Improvements (estimated) .................................. 50 00

c. Repairs ............................................................. 306 85

Total ....................................................................... $658 86

c. Includes repairs to water pipes, barns, sheds, etc., for

farm.
EXPLANATORY NOTE TO SUPPLEMENTARY STATEMENT.

The College and Station each possess an undivided interest in 400 acres of land, together with buildings and other necessary appliances.

The state funds are drawn upon as the needs of the Station or College may require. All receipts from the farm, gardens, dairy, tuition, land rents, etc., are placed in one local fund which is drawn upon in the same manner as the state funds. The Station and College are housed in the same buildings.

In making the within supplementary report the heat, light, water and traveling expenses are estimated at the Station's proportional share. All other sums expended as shown by this statement are taken from the Secretary's books.
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<thead>
<tr>
<th>Description</th>
<th>Dr.</th>
<th>State</th>
<th>Tuition Fees</th>
<th>Miscellaneous</th>
<th>Total</th>
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<td>To receipts from other sources than the United States for the year ending June 30, 1896 ...</td>
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<td>$6,200 00</td>
<td>$1,595 50</td>
<td>$3,844 59</td>
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<td>By Salaries</td>
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<td>Heat, light and water</td>
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<td>675 00</td>
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<td>Chemical supplies</td>
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<td>Seeds, plants and sundry supplies</td>
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<td>Furniture and fixtures</td>
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<td>Scientific apparatus</td>
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<td>Live stock</td>
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<td>Traveling expenses</td>
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<td>Building and repairs</td>
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<td>300 00</td>
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<td>645 00</td>
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<td>Expended by College</td>
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<td>5,080 00</td>
<td>1,595 50</td>
<td>3,160 46</td>
<td>9,835 96</td>
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"Miscellaneous" includes farm and miscellaneous receipts, $3,409.69.
Receipts from land grant lands, $434.90.
AGRICULTURAL DEPARTMENT.

E. C. CHILCOTT, Agriculturist.

The principal lines of work undertaken in this department in the spring of 1895, were as follows:

Experiments in the application of manures to wheat and oats, and the effects of broadcast and drill seeding, and of subsurface packing. For the purpose of this experiment a field containing about eight acres was divided into twenty plats, each of which was given a different treatment as to time and manner of applying manure: These plats were again subdivided at right angles to the former subdivision and one half of each plat was sown to wheat and one half to oats. One half of the oats and one half of the wheat were sown broadcast and the other halves were drilled. One half of both the drilled and the broadcast of both wheat and oats was packed with a Campbell's Subsurface Packer.

Careful notes were kept and some interesting results were confidently looked forward to but as the department was left without a head from August until January the entire experiment was without value.

An experiment to test the comparative value of Indian Corn, Kaffir Corn, Jerusalem Corn, Brown Doura Corn, Yellow Milo Maize, Sorghum, Soja Beans, Rape, Spurry, Esparcette and Saccaline were under way but no results were obtained for the reason already stated.

Variety tests of a large number of varieties of wheat, oats, barley, corn, potatoes, peas and grasses were well under way but all met with practically the same fate as the foregoing.

A large amount of fodder corn was grown experimentally to test the varieties and methods of planting. A silo had been begun the previous year and it was the intention of the head of this department to finish it and to use the corn to fill it. But the silo was not built and the entire experiment was a total loss from an experimental standpoint; a portion of the feed, however, was saved and fed to the farm stock.

Work under the present management was not resumed until May 11th, which was too late to undertake much work for this season. Variety tests were made with several kinds
of corn and potatoes, and the experiments with forage crops conducted in former years were continued. A silo was built and filled with one hundred and twenty-five tons of corn and a bulletin will shortly be issued giving results of experiments with forage crops and describing the manner and cost of building and filling the silo.

Forty-five wether lambs have been purchased and they will be divided into five lots and fed experimentally, to test the comparative value of various grains and rations, and also to ascertain what profit can be realized in winter feeding common, native lambs for the spring market.

The division of Soil Physics has been created and placed under the supervision of the head of this department with A. B. Holm, B. S., as assistant. A tract of land has been set aside for the express purpose of experimentation in soil moisture. A careful topographical survey of the tract has been made, the results platted, and the tract laid off into one-tenth acre plats and permanently marked with iron stakes. Ten of these one-tenth acre plats will be used for the purpose of experimentation in the effect of subsoiling and plowing to different depths and at different times—spring and fall—and also to determine the effect of deep, shallow and no cultivation upon the soil moisture as follows:

Plat No. 3 was plowed September 16th with common stubble plow, four inches deep.

Plat No. 4 was plowed September 15th with common stubble plow, ten inches deep and packed with Campbell’s sub-surface packer.

Plat No. 5 was plowed September 15th with common stubble plow, eight inches deep and subsoiled with a John Deere “Bulltongue” subsoiler twelve inches deep, a total of twenty inches.

Plat No. 6 was plowed September 15th with a John Deere “Secretary” plow with the disk set seven inches and the subsoiler six, or a total of thirteen inches.

Plat No. 7 was plowed September 15th with a John Deere “Secretary” plow with the disk set six inches and the subsoiler three inches, or a total of nine inches.

Plats No. 12, 11, 10, 9 and 8 will be treated the same as 3, 4, 5, 6 and 7, respectively, except that the plowing will be done in the spring instead of in the fall.
A portion of each plat will be cultivated deeply, a portion will be given shallow cultivation, another will be lightly raked, a fourth will receive no cultivation, and still another part will be sown to grain and given no cultivation during the season. Those portions that are to be cultivated will be gone over once a week.

Soil samples for moisture determination will be taken to a depth of thirty inches, divided into four parts, from each plat at as frequent intervals as they can be handled in the laboratory, daily if possible, during the entire season of 1897.

A full set of meteorological instruments including soil thermometers and evaporimeters has been secured and a building erected for an observatory. A laboratory has been fitted up provided with drying ovens and sample boxes for the handling of one hundred and twenty samples of soil at a time. A Hilgard's Churn Elutriator has been procured and has been properly adjusted and is now ready for work, balances, evaporating and condensing apparatus, and in short, a complete outfit for the accurate and speedy making of mechanical analysis and moisture determinations has been procured and the work is well under way.

Twenty-four more of these one-tenth acre plats will be used for experimentations in the effect of the application of different manures at different times and in various ways upon the moisture content and crop producing powers of the soil.

Plat No. 17 had an application of 5,650 lbs. of coarse, fresh horse manure on September 20th, plowed 8 inches deep on the 21st.

Plat No. 18 had an application of 6,400 lbs. of well rotted cow manure on the 20th, plowed under 8 inches deep on the same day.

Plat No. 19 was plowed 8 inches deep on September 20th, and on the 21st, 5,740 lbs. of long coarse, fresh horse manure was spread on the surface.

Plat No. 20 was plowed 8 inches deep on September 20th, and on the 21st, 9,660 lbs. of fine, well rotted, cow manure was spread upon the surface.

Plat No. 21 was plowed 8 inches deep on September 20th. Horse manure is to be drawn from the stable during winter and applied to the surface.

Plat No. 22 was plowed 8 inches deep on September 20th.
Cow manure is to be drawn from the stable and applied to the surface.

Plat No. 23 is to have horse manure drawn direct from the stables and applied during the winter and plowed under in the Spring.

Plat No. 24, same as 23, except that cow manure is to be used.

Plat No. 25 is to have fine manure applied in Spring and disked in.

Plat No. 26 was plowed 8 inches deep on September 20th. Fine manure will be applied as a mulch after sowing in the spring.

Plat No. 27 was summer fallowed, (plowed in April and July, 1896). It will be plowed next spring and have fine manure applied as a mulch after sowing grain.

Plat No. 28 was summer fallowed, (plowed in April, July and September), to be sown in spring without manure.

Plat No. 29 is the same as 28, except that it has not been plowed this fall, but will be next spring.

Plat No. 30 same as 27, except that coarse manure will be used.

Plat No. 31 was plowed September 20th, 8 inches deep. Coarse manure will be applied as a mulch after sowing in the spring.

Plat No. 32, 5,025 lbs. fine, well-rotted cow manure was applied September 23d, and was immediately disked in about 4 inches deep.

Plat No. 33. Cow manure will be applied in spring and plowed under.

Plat No. 34. Horse manure will be applied in spring and plowed under.

Plat No. 35. Fine mixed manure will be applied in spring and plowed under.

Plat No. 36 will be disked in the spring and no manure applied.

Plat No. 37 was plowed September 20th, 8 inches deep. Fine manure will be applied in the spring and dragged in.

Plat No. 38 same as 37, except that coarse manure will be applied.

Plat No. 39 was plowed 8 inches deep September 20th. No manure is to be applied.
Plat No. 40 will be plowed in spring and no manure applied. All these plats, which have received about the same treatment for a number of years past, are to be sown to the same kind of grain in the spring. Careful notes are to be kept upon the growth and yield of each plat; and moisture determinations will be made from time to time as occasion seems to demand.

This experiment must necessarily continue for several years in order to give a fair test of the various treatments.

Besides the work already described, the regular work in variety tests and cultural methods with wheat, oats, barley, corn and potatoes will be continued.

A new set of grass plats will be sown in the spring representing all the native and introducing grasses that seem to promise to be of value for this section.

The work with forage and soilin crops will be continued, especial attention being given to Indian corn, rape, spurry, sand vetch, rye and field peas, which seem to be the most valuable crops for these purposes yet tried.

The subject of crop rotation will be taken up and several series of plants will be laid out to represent different systems of rotation. This is a line of work that can only prove valuable after continued trials and will become more and more valuable as it is continued from year to year under the same plan. Plans for this experiment are not yet fully matured but will receive careful consideration during the coming winter so that the field work can be taken up in the spring and carried on systematically and intelligently from year to year.

The head of this department has been relieved of most of the work formerly required of him in teaching in the Agricultural College and has also been provided with a residence on the farm which will enable him to devote nearly his entire time and energies to Experiment Station work. In all experiments in stock feeding he will be ably assisted by E. A. Burnnett, Professor of Animal Husbandry in the South Dakota Agricultural College.

With the hearty support and encouragement this department is now receiving from the Governing Boards, the President of the College and the Director of the Station, the people of the State have a right to expect more and better service than they have received in the past.
DEPARTMENT OF BOTANY.

D. A. SAUNDERS, Botanist.

The work planned for the ensuing year may be grouped under two heads.

First. Special attention will be given to the collection of all native plants likely to be of value for forage purposes. Specimens will be collected for analysis and description in order that the work so well begun in Bulletin 40 may eventually comprise a complete account of all the valuable forage plants of the state. Many of the more promising native grasses will be sown or transplanted in the grass garden and a study made of the effect of cultivation upon them. As many foreign forage plants as possible will also be obtained, especially those that have already shown an adaptability to climate and soil conditions similar to ours.

In order to make a study of the distribution of some of our useful plants and to obtain material for their analysis, a collecting trip has been planned for the months of July and August.

Second. The fungous diseases of our native plants will receive considerable attention and one group, the Powdery Mildews, will be especially studied. The insect enemies of economic plants, new and dangerous weeds, and the edible fungi of the state will also receive attention.

Professor T. A. Williams, the former head of this department, has prepared a report of last year's work, which is given below.

BOTANICAL WORK FOR THE YEAR 1895-6.

The principal lines of work for the past year have been:
1. A continuation of the study of forage plants.
2. A continuation of the work on the weeds of the state.
3. Experiments with certain fungous diseases of farm and garden crops and fruit and forest trees.

FORAGE PLANT WORK.

The work of collecting our native and introduced forage plants for the purpose of chemical analysis has been resumed
with the expectation of issuing of second bulletin, similar to bulletin No. 40, which it is intended will contain descriptions and chemical analysis of all the forage plants of the state not contained in that bulletin.

The seeds of a considerable number of varieties of promising forage plants have been obtained by purchase or by exchange and a new grass garden started which it is intended will ultimately contain all the species likely to be of value in our region.

The following notes will give an idea of the results obtained with the most promising of these plants.

Hairy Vetch (Vicia villosa). This is an annual plant, introduced from Western Asia. In the south it is used as a winter forage. On the College Farm seed sown on the last of May produced a growth which was ready for use by the 20th of July and remained fresh and green until the last of December. The plants began to blossom about the middle of July and continued to bloom until killed by frost in October. The yield of forage was good, the quality excellent, and stock ate it greedily.

The plant is an excellent one for summer feed as it withstands drought well, and is in its prime just at the time that pasturage is most likely to be short. It is very rich in nitrogenous matter and hence is a good forage to be fed in connection with corn-fodder, sorghum, oats or other grasses. The only thing against it is the difficulty in saving seed which makes it costly. It would do well sown with oats or rye in which case a smaller amount of seed would be necessary, the forage could be handled to a better advantage and a more evenly balanced ration could be obtained.

Teff (Eragrostis abyssinica). This is an annual grass, a native of Northwestern Africa which has recently received considerable attention in some parts of the country. It grows readily from the seed, reaches maturity in a short time and yields well, both seed and forage. It should probably not be sown until the ground is warm, as the young plants are likely to suffer injury from late frosts. The present season it was sown about the first of June and was in bloom early in August, reaching a height of about two feet. The plant is very leafy and produces an abundance of hay of fine appearance. We have made no tests as yet as to its palatability.
Yellow Lupine (Lupinus luteus). This is an annual plant of the Old World where it is used very extensively on sandy soils both as a forage and to improve the soil. It did very well this season on the College Farm and promises to be a good plant for soils that have been impoverished by wheat growing or are too sandy for many of the more important crops. It produces seed abundantly, matures early and yields fairly well. We have not been able to ascertain whether stock would eat it readily or not. In Europe it is fed in both green and dry states and the seeds are also regarded as valuable for feed on account of their richness.

Australian Saltbush (Atriplex semibaccatum). Seeds of this plant were obtained from the California Experiment Station and were planted the last of May. They germinated very readily and the plants made an excellent growth but very few seeds were formed when frost came. They are several species of atriplex which are used for forage, especially for sheep, in different parts of the country. The saltbushes thrive on soils containing too much alkali for ordinary plants and takes up the alkalies in such large quantities that they are used extensively in the reclamation of such soils. Some species of atriplex occur more or less abundantly throughout the western part of the state but all form a much less amount of foliage than Australian saltbush. Another species (Atriplex leptocarpum) which has also been introduced from Australia and grown at several of the Experiment Stations is said to seed abundantly. It is not unlikely that these plants may prove valuable in certain regions in the state where alkali soil is found or where sheep is raised extensively.

New Zealand Spinach (Tetragona expansa). Seeds of this plant were also obtained from the California Station. The plant is a fleshy annual and is a native of Australia, Chili, Japan and New Zealand. In its native state it grows along the sea coast.

Seeds sown the last of May germinates readily and the plants grew rapidly, producing an abundance of stems and leaves having an agreeable taste. They bloomed plentifully about the middle of August but no seeds were matured when frost came. New Zealand Spinach is used both as a vegetable and as forage for sheep and should be given further trial particularly on soils rich in alkaline or saline substances.
WEEDS.

The work of past years has been continued. Specimens of seeds, seedlings and mature plants have been collected and photographs made of all specimens that could be obtained in the fresh state. Considerable attention has been given to the distribution of the various species in the state and the effect of drouth and irrigation upon their development and dissemination.

In many parts of the state Pepper-grass (Lepidium intermediate) has been quite troublesome in pastures and grainfields. The plant has seeded abundantly during the dry seasons of the past few years and the over stocking of pastures and instubbing of grain gave it the best possible conditions for taking possession of the ground. It is an annual and is easily destroyed in the fields by ordinary cultivation. In pastures it can be kept in check by mowing at the proper season so as to allow the grass to develop. It only becomes troublesome in worn out pastures and these can be very materially strengthened by a good harrowing in early spring. The grass will be given new life and the weed will be checked by the harrowing.

The most notable addition to the weeds of the state within recent years is the tumbling mustard (Sisymbrium altissimum). In August of the past season a few fragments of a plant in fruit without flowers and leaves were received from Mr. Bushnell of Aberdeen with the statement that it was called "French Weed" and that it seemed very aggressive in its character. The material was insufficient for determination, only showing that the plant was a mustard but not "French Weed" which is the name applied to another cruciferous plant (Thlaspi arvense). Some of the seeds contained in the specimen were planted and from the plants obtained in this way we are able to determine the weed as Tumbling Mustard.

Mr. Bushnell in his letter stated the weed had been growing about Aberdeen for several years, but considerable correspondence at the time failed to obtain any more specimens. Since then the weed has been received from Bath and Sioux Falls and one specimen was found along the roadside near Bushnell in Brookings county. The weed is said to be very
troublesome in grain fields near Aberdeen and Bath and was found growing along the railroad track at Sioux Falls.

Tumbling mustard possesses several characters which render it a dangerous pest. The seeds are very small and produced in countless numbers in the long pods. They are capable of lying dormant in the soil for several years if covered too deeply, hence it is a difficult matter to entirely rid a field of the weed. Add to this the fact that it is a very rapid grower and readily assumes the tumbling habit and we undoubtedly have some very important requisites for a bad weed. On the other hand the plant is usually an annual (though it may become a biennial if conditions are favorable) and is easily killed by cultivation. It can be kept from going to seed by mowing. After seeds are formed they can be destroyed by burning if cut before the pods are ripe enough to burst open. The seeds start readily in the spring so that a field can be pretty thoroughly cleaned by first allowing the young plants to get a good start and then plowing them under. The field should then be sown to millet, oats, sorghum, or some other crop that can be take off early so that the field may be plowed again before the weeds can go to seed.

The weed is certainly liable to become a serious pest and though not so disagreeable as Russian Thistle, it is quite as difficult to get rid of. If allowed to get into the timothy fields, it will spoil them for seed growing purposes, for the seeds of the tumbling mustard are so nearly the size of those of the timothy that it is hardly possible to clean them out by either screen or wind.

In portions of the Sioux Valley, Maximilian’s Sunflower (Helianthus maximiliani) has become a bad weed in grain fields and has done considerable damage, sometimes causing the loss of the entire crop. Early fall plowing and the growing of crops which can be cultivated during the growing season is generally sufficient to keep this pest within bounds.

**FUNGOUS DISEASES.**

In this connection special attention has been given to the rusts and smuts of small grains, to potato scab, and to the leaf spot diseases of our fruits and forest trees and shrubs. Currant Anthracnose (Gloeosporium ribis) has caused con-
siderable damage to the currants on the College grounds. During the season of 1895 it was so bad that the bushes were almost defoliated by the last of July. Several fungicides were tried but Bordeaux mixture was the only one that gave anything like satisfactory results. The bushes sprayed with this fungicide were not only benefited last season but were much stronger and healthier looking the present season.

The herbarium has been increased by the addition of a considerable number of plants of the state, particularly of parasitic fungi, and by the purchase of Arthur and Hollways Uredineae Exsiccatae and the Current Centuries of Ellis and Everhart’s Fungi Columbiani.

The department is under obligations to the following persons and institutions for seeds of grasses and other plants:

Dr. Wm. Trelease, Director of the Mo. Bot. Garden, St. Louis, Missouri. Seeds of grasses and flowers.

Professor James Fletcher, Central Exp. Farm, Ottawa, Canada. Grass seed.

Dr. C. S. Sargent, Director of the Arnold Arboretum, Jamaica Plain, Massachusetts. Seeds of hardy trees and shrubs.

Professor F. Lamson-Schribner, Agrostologist, United States Department of Agriculture. Seeds of grasses and other forage plants.

California Experiment Station. Seeds of grasses and other forage plants.
Owing to reasons elsewhere stated, practically no work was accomplished in this department during the year of 1895-6. Upon assuming charge of the department again in May, work was commenced upon forage plants in continuation of the analysis recorded in Bulletin 40. This work is now well under way. The following plants are now in course of analysis:

Carex pennsylvanica, Stipa comata, Trifolium alexandrium, Panicum miliacum, Panicum miliacum, var. Sibericum, Polygonum ramosissimum, Ornithopus sativus, Festuca octifora, Carex laxiflora, Elymus sibericus, Muhlenbergia ambiguia, Spergula arvensis, Hordeum pusillum, Heirochloe borealis, Calamagrostis montanensis, Vicia villosa, Eragrostis abysinica, Lupinus luteus and Spartina gracilis.

This department will also co-operate with the work in soil physics by way of soil analysis. These two lines of work will be the principal ones followed throughout the coming year.

A bulletin on the shallow artesian wells of the state will record results obtained in the spring and summer of 1895.
DEPARTMENT OF ZOOLOGY.

Dice McLaren, Zoologist.

The work of the Zoologist has been mainly along four lines:

1. A zoological survey of Dakota biological conditions.
2. Experiments with the South Dakota cutworms.
3. Investigations of the fringed liver-worms of sheep.
4. Correspondence concerning pests and diseases.

The first of these lines is an attempt to answer some of the general questions of

I. ANIMAL BIOLOGY.

In September, 1895, the zoological survey began with a collection of the native fauna, the observations of their habits and environments. This research must of necessity extend through several years, before our injurious and beneficial animals will be fully known, and before the conditions of animal life throughout the state are ascertained. The effect of drouth, of abundant rainfall, and of irrigation upon animals are being noted, and the various means of increasing the number of insect-eating song birds are being studied.

2. SOUTH DAKOTA CUTWORMS.

An extended series of breeding experiments with the native cutworms (Noctuidae) have been carried forward, that the weak periods in their life history may be ascertained and cheap and effective remedies applied at those times. In these experiments, I was ably assisted by Fred K. Luke. The results will appear in a future bulletin, but to meet existing conditions, the following summary has been published:

Cutworms are the larvae of owlet moths which lay their eggs in weedy or grassy places. No eggs will be laid on ground which is kept free of vegetation, especially in summer and early autumn. Burning weedy or grassy places will kill many of the eggs and young cutworms. Burning the stubble rapidly just before plowing has proved an effective remedy against cutworms and other grain insects. For gardens, orchards and small fields the best plan is to poison the
cutworms with bran mash bait colored with paris green. Mix one part by weight of paris green or london purple with fifty parts of dry wheat bran till all is slightly colored. Moisten the bran or mix with watery molases, so it may be formed into balls. Drop tablespoonfulls of the bran mash, or the poisoned bran-balls in rows three feet apart each way over the infested patch. Cover the bran with a little soil. The cutworms will eat the poison and crawl away to die. If the poisoned bait be put out when the seed is sown or dropped in the holes when transplanting, the cutworms will be killed before they can damage the crop. Keep cultivated ground free from weeds and grass so that there will be no cutworms to live through the winter.

3. FRINGED LIVER-WORMS OF SHEEP.

At the request of a number of sheep breeders, the investigation of a cestode parasite living in the bile ducts of sheep was begun. Microscopical examinations were made, and the parasite found to be the fringed liver-worm of sheep (Thynosoma actinioides, Dies) which is believed to kill more prairie sheep than any other internal parasite. The following summary of its habits was published for the immediate use of farmers.

Throughout the year the adult fringed liver-worm lives in the older sheep, which are continually passing the eggs or embryos. The smaller worms appear in lambs two months old, but may be found in sheep of any age throughout the spring and summer. This fringed cestode requires at least six months and possibly ten to attain an adult size. When present in large numbers in sheep, it determines a disease which is not only detrimental to the value of the animal, but at times causes the death of large numbers. No medical remedy is known which will assuredly remove the liver-worms from the sheep. Effective measures may be taken to prevent the sheep from being infested, or to strengthen each sheep so that it may better withstand the ravages of the parasite, and thus carry it over the critical period. As the lambs and yearlings are the greatest sufferers, it is recommended that the lambs be taken to uninfected pastures and that the older sheep be plentifully fed in racks so that they may not eat food tainted with the egg-filled manure. For the same rea-
son the grain and an abundance of clear fresh water and salt should be given in troughs.

The life history of the embryo from the times it leaves the adult fringed cestode in the older sheep, until it enters the lamb, is unknown, and an attempt to determine this will be the aim of a special research during the coming year, in the hope that a weak period may be found, in which the parasite may be effectually combated.

4. PESTS AND DISEASES.

Many letters have been written in reply to requests for information, or remedies for injurious animals or diseases. The more important of these have led to the publication in the state papers, of the following articles: The fringed liverworm of sheep; remedies for cutworms; the elm caterpillar (Euyanessa and Grapta); the army worm (Leucania unipuncta) in South Dakota; the Dakota hessian or frit-fly; remedies for cabbage insects; the cornstalk diseases of cattle; and the Northwestern swine diseases. The bacteriological investigation of animal diseases, will form one of the lines of investigation during the coming year.

PROPOSED WORK.

During the ensuing year the following researches will be continued.

1. A special study of the life history of the fringed liverworm of sheep.
2. A bacteriological investigation of animal diseases.
3. Experiments with remedies for the animal pests of the farms, gardens, orchards and groves of South Dakota.
4. A general study of beneficial birds and other fauna, with especial reference to the effect thereon of the drouth, as contrasted with abundant rainfall, irrigation or conserved soil moisture.
DEPARTMENT OF HORTICULTURE.

NILES E. HANSEN, Horticulturist.

The writer assumed charge of the Department of Horticulture in September, 1895. The experiments with tomatoes, beans and other garden vegetables begun by Professor L. C. Corbett in the spring of 1895, were completed with the aid of Mr. Fred K. Luke, the assistant in Horticulture, and the results were tabulated by Professor Corbett and published in Bulletin No. 47.

During the fall of 1895 a quantity of seeds of the hardiest American and Russian varieties of apples and plums were obtained from the South Dakota and Iowa State Fairs; from the Russian apple orchard at the Agricultural College at Ames, Iowa; and from the winter meetings of the Minnesota and Iowa State Horticulture Societies. A large number of seedlings have been thus obtained and their fruiting will be awaited with much interest. This work of obtaining seeds of the hardiest known varieties from mixed orchards has been continued the present year from the Minnesota, Iowa and South Dakota State Fairs, and in the College and Station orchard at Brookings.

Many new seedlings of the plum and apple have been obtained from various parts of the Northwest, and are being tested in the College nursery. Some work of crossing American and Russian apples was begun. Several hundred apple, plum and cherry trees of many varieties were added to the orchard. An extra number of Virginia crabs, Hibernial and Good Peasant were planted to test as a stock for the top-working of less hardy varieties which fail from sunscald of the stem. Some of these were top-budded this fall, as an experiment, while the others will be top-grafted next spring.

Several thousand grafts of the most promising varieties of the apple, mostly the best Russian varieties and their American seedlings, with new Northwestern seedlings of unknown parentage, were made at the Station during the winter and a good stand and growth were secured the past season. Several hundred seedlings of the wild crab were grown with a view to testing as a stock for the cultivated apple; also sev-
eral large fruited sports of the wild crab were grown in nursery, and seeds planted of several of these sports from trees grown near choice cultivated apples.

Several thousand native plum seedlings were grown from seeds this spring for grafting and budding with promising new varieties especially some new South Dakota seedlings.

The native sand cherry (Prunus pumila) is receiving attention as a fruit plant and a stock for the native plums.

Several varieties were selected and propagated in nursery, both on native plum and on sand cherry stocks. By repeated seedling reproduction under higher cultivation it is hoped to improve the fruit in size and quality. Three thousand sand cherry seedlings were planted in nursery as stocks for budding and grafting the native plum.

A large quantity of seeds, cuttings and plants of many new Siberian and East European shrubs, trees and hedge plants was planted, including one importation. This fall, 1896, nearly forty pounds of the pits of the hardiest known type of the Russian cherries were received from the Imperial College of Agriculture at Moscow, Russia. This cherry comes true to seed, as the writer learned in a trip to Russia in 1894.

The surplus new trees and plants thus propagated at the College and Station will be distributed in small lots for trial throughout the state.

The native species of fruit are receiving attention with a view to improving the fruit in size and quality by cultivation and selection, and by crossing and hybridizing with cultivated varieties. Collections from the Black Hills, from Manitoba, and from the native timber a few miles from the Station, were planted. In vegetables the cultivation of the native Nightshade or Stubbleberry (Solanum nigrum) was begun with a view to improvement by cultivation and selection. The fruit of this specie is extensively used by residents of this state for sauce and preserves.

One attempt was made to improve our wild prairie rose (Rosa arkansana). Over 1100 blossoms were carefully emasculated, covered with paper sacks, and later pollinated with some of the best cultivated varieties, such as General Jacqueminot, Meteor and American Beauty. Many seeds were obtained which will be planted next spring.
The wild grape vine is receiving attention as a stock for the cultivated varieties. A number of plants were started in the vineyard and nursery last spring. This proposed crown-grafting is to obviate if possible the root-killing which prevents successful grape culture over a large part of the state.

Subsoiling for garden crops is being tested. A tract of land was subsoiled to a depth of 18 to 20 inches with an Iron King Subsoiler. The past season various garden crops have been grown, half on the subsoiled land, and half on fall plowing. The variety and cultural tests of tomatoes were continued with special efforts to early varieties. The results will appear in a bulletin now in course of preparation. The wet season probably made the effects less marked than would have been the case in a dry season.

There was a good crop of fruit in the College and Station orchard the past season. The report on this and other orchards in the state will appear in a fruit bulletin at an early date.

The United States Division of Forestry added about two and a half acres to the forestry plantations of the Station this spring and will add more next spring. The trials include new species of conifers from the Black Hills, the Rocky Mountain regions and Northwestern Minnesota.

It will be noticed that the work done the past year is according to the writer's "Outline of proposed experiments for the Department of Horticulture and Forestry" as published in the Eighth Annual Report of this Station; page 20. The outline will be followed as closely as possible and extended as occasion offers.

A variety test of new small fruits will be begun next season, and the work of importing new and promising fruits, trees, shrubs, plants and vegetables continued.