

NINTH ANNUAL REPORT  
OF  
THE  
AGRICULTURAL EXPERIMENT STATION  
OF  
COLORADO  
FOR THE YEAR 1896

HOME STATION  
Fort Collins, Colorado, December 9, 1896



THE AGRICULTURAL EXPERIMENT STATION,  
FORT COLLINS, COLORADO.

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BOARD OF CONTROL:  
THE STATE BOARD OF AGRICULTURE.

Executive Committee in Charge:

Hon. A. L. Kellogg, *Chairman*,                      Hon. J. E. DuBois,  
Hon. J. J. Ryan,                                      Hon. A. S. Benson,  
President Alston Ellis.

STATION COUNCIL.

Alston Ellis, A. M., Ph. D., LL. D. . . . . President and Director  
W. W. Cooke, B. S., A. M. . . . . Agriculturist  
C. S. Crandall, M. S. . . . . Horticulturist and Botanist  
W. P. Headden, A. M., Ph. D. . . . . Chemist  
L. G. Carpenter, M. S. . . . . Meteorologist and Irrigation Engineer  
C. P. Gillette, M. S. . . . . Entomologist  
D. W. Working, B. S. . . . . Secretary  
    L. M. Taylor, B. S., Stenographer.

ASSISTANTS.

F. L. Watrous. . . . . Agriculturist  
J. H. Cowen, B. S. . . . . Horticulturist  
C. J. Ryan. . . . . Chemist  
R. E. Trimble, B. S. . . . . Meteorologist and Irrigation Engineer  
Emma A. Gillette. . . . . Entomologist

SUB-STATIONS.

P. K. Blinn, B. S. . . . . Superintendent  
Arkansas Valley Experiment Station, Rocky Ford, Colorado.  
C. A. Duncan, B. S. . . . . Superintendent  
San Luis Valley Experiment Station, Monte Vista, Colorado.  
J. E. Payne, M. S. . . . . Superintendent  
Rainbelt Experiment Station, Cheyenne Wells, Colorado.

# THE STATE AGRICULTURAL COLLEGE.

SECRETARY'S FINANCIAL STATEMENT OF THE EXPERIMENT  
STATION FUND FOR THE FISCAL YEAR ENDING JUNE  
30, 1896.

<i>Receipts.</i>	United States.	College.	Total.
United States Treasurer.....	\$ 15,000.00	\$ .....	\$ 15,000.00
Farm Products.....	.....	2,952.71	2,952.71
Overdraft .....	.....	65.23	65.23
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Total .....	\$ 15,000.00	\$ 3,017.94	\$ 18,017.94
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<i>Expenditures.</i>	United States.	College.	Total.
Salaries .....	\$ 9,224.36	\$ 1,468.28	\$ 10,692.64
Labor .....	2,304.48	333.30	2,637.78
Publications .....	522.40	235.40	757.80
Stationery .....	113.08	.....	113.08
Freight and express.....	70.68	18.11	88.79
Heat, light, and water.....	6.85	.....	6.85
Chemical supplies.....	54.30	30.60	84.90
Seeds, plants, and sundry supplies..	575.90	27.70	603.60
Fertilizers .....	96.00	75.00	171.00
Feeding stuffs.....	326.38	123.00	449.38
Library .....	19.04	.....	19.04
Tools and implements.....	222.31	132.00	354.31
Furniture and fixtures.....	36.29	.....	36.29
Scientific apparatus.....	123.48	.....	123.48
Live stock.....	1,029.50	.....	1,029.50
Traveling expenses.....	179.66	120.15	299.81
Contingent expenses.....	10.00	454.40	464.40
Buildings and repairs.....	85.29	.....	85.29
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Total .....	\$ 15,000.00	\$ 3,017.94	\$ 18,017.94

## LETTER OF TRANSMITTAL.

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HON. ALBERT W. McINTIRE,  
GOVERNOR OF COLORADO.

Sir—The Ninth Annual Report of the Agricultural Experiment Station, agreeably to Section 3 of an act of Congress approved March 2, 1887, is herewith submitted.

The station work, in its prosecution under schedule, has presented but few new phases since my last annual report. The Board of Control was reluctantly forced, by lack of finances available for the further support of all the sub-stations, to discontinue experimental work on the lands located in El Paso and Rio Grande counties. The possession of these lands is yet retained, and hope is strong that some way will be open for the resumption of active experimental work thereon at an early date.

It is known that this desirable end can not be reached save by legislative appropriation for sub-station support, as the authorities in control of the United States fund have prohibited the use of any portion thereof for experimental work other than that in operation at the Home Station.

Most persons conversant with the purposes of station work recognize the necessity of more of that work than can be done profitably at a single station. The conditions under which farm operations are carried on in Colorado differ greatly. The methods that are employed with satisfactory results in one locality may not be wholly applicable to another. There must be some way of noting these varying conditions and providing for successful effort under them.

The sub-station management, operative as it has been in four different sections of the State, has been serviceable in helping to apply general rules to particular conditions.

The continuance of experimental work at the sub-stations is in close line with the policy that seeks the betterment of one of the rapidly growing interests of the State. Our material interests are vitally connected with the prosperity of our farming communities.

Methods of agriculture must not be left in a primitive state. Each farmer must not be left to gain needed experience from his own unaided, and often abortive, efforts. The work of the experiment station should be planned to help him by showing clearly how his efforts can be made more far reaching and thus attended with greater profit.

The plan of co-operative work, now so successfully followed in many states of the Union, and in Canada, would be productive of good results if made a part of our station work. Through it, the number of persons making experiments, and records thereof, in agriculture and horticulture would be largely augmented. Useless duplication of effort would be avoided and each worker would be brought in close touch and sympathy with his fellows. The published results would be common property; of value to those instrumental in their accomplishment and suggestive and helpful to others as well.

These suggestions, and others found in the body of the report, are made in the hope that wise legislative action may provide better ways and means than are now within reach for making them effective.

Respectfully submitted,

ALSTON ELLIS,

*Director of the Agricultural Experiment Station of Colorado.*

Fort Collins, Colorado,

December 9, 1896.

## REPORT OF THE DIRECTOR.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—The year, whose station work is to be reported herein, began under peculiar conditions. At the close of the last year, it was pretty well understood that a change in station management was imperative. It was known, too, that the radical change which seemed necessary to carry out the letter of the law would arouse the antagonism of two classes of people—those who did not rightly understand the plan of station operations contemplated by the law and those who had some selfish interests to further in the continuance of the established order of things.

The "Hatch Act" of March 2, 1887, provides for the support of an "Agricultural Experiment Station" in connection with the college, in each state and territory, established under the provisions of the act of Congress bearing date July 2, 1862, and best known as the *first* "Morrill Bill." Congress, by the terms of this "Hatch Act," is required to make a special appropriation, annually, of \$15,000 to meet the expenses connected with the work of said station.

The provisions of the congressional act of 1887, were formally accepted by act of the General Assembly of Colorado approved March 25, 1889. Prior to the latter date, i. e. on April 4, 1887, the General Assembly had provided for the location of four sub-stations—one on the "Divide" in the northern part of El Paso county, one in the Arkansas Valley, one in the San Luis Valley, and

one in Delta county—and placed them under the control of The State Board of Agriculture. That body was authorized to spend such amount as was deemed necessary, in establishing these sub-stations, out of the United States appropriation before referred to.

The State has never appropriated a dollar to the support of any of these sub-stations. The act of the General Assembly, approved April 3, 1893, by which another sub-station, now known as the Rainbelt Station, was located at Cheyenne Wells, made an appropriation of \$2,500 for buildings and other permanent improvements.

At the beginning of the present year, nearly 800 acres of land, all reputed to be experimentally cultivated, were under the control of the Executive Committee, acting in the name, and by the authority, of The State Board of Agriculture. The money to carry on the extensive experimental work, or rather farm work, was taken from the United States fund and the receipts from sales of farm products.

The thought, expressed by some, was that these sub-station farms should be made self-sustaining; that is, that the crops raised should, when sold, meet a very large part of, if not all, the cost of labor and equipment. Managed as farms, the sub-stations presented no appearance, and gave no results, that entitled them to more favorable notice than adjoining lands tilled by enterprising farmers. In some instances the handling of these sub-station farms was the subject of unfavorable comment on all sides.

My first report, as Director, made earnest recommendation that all experimental work at the sub-stations be brought within narrower limits, and that farm operations, with an eye single to *profit*, be wholly abandoned. I felt, as others did, that the sub-stations as farms were not meeting the just demands of the people or fulfilling the requirements of the law.

In the summer of 1895, Dr. A. C. True, Director of the Experiment Stations, Washington, D. C., visited the College and made a careful investigation of the experiment station work then in progress and the manner in

which the United States fund for the promotion of that work was being expended. The result of this visit, and visits to a number of stations in other states, was the issuing of Circular No. 29, from the Office of Experiment Stations, under authority of the United States Department of Agriculture. The "Circular" is dated March 10, 1896. I am strongly tempted to give it in full, in this connection, because it is a clear and authoritative statement of what is required, in each state, in the way of experimental work under the provisions of the "Hatch Act."

A few quotations from the language of the "Circular" may serve a useful purpose:

"This Department holds that the expenditure of funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, for the maintenance of permanent sub-stations, is contrary to the spirit and intent of said act. The act provides for an experiment station in each State and Territory, which, except in cases specified in the act, is to be a department of the college established under the act of Congress of July 2, 1862. The objects of the stations as defined in the first mentioned act are evidently of such a character as to necessitate the services of scientific and expert workers. Most of the lines of investigation named in the act are general rather than local, and involve scientific equipment and work. The sum of \$15,000 which is annually appropriated by Congress under this act for each station is only sufficient to carry out a limited number of investigations of the kinds contemplated by the act.

"Thorough work in a few lines has been found much more effective and productive of more useful results than small investigations in numerous lines. When we consider the nature of the investigations, the amount of money provided for the work of each station, and the fact that the act expressly provides for only a single station in connection with each college, it becomes very clear that expenditures such as are necessary to effectively maintain permanent sub-stations ought not to be made from the funds granted by Congress to the States and Territories for experiment stations. The sums of money which can be expended for permanent improvements under the act of Congress aforesaid are so small that it is clear they were not intended to meet the needs of more than one station in each State and Territory.

"When the legislature of a State or Territory has given its assent to the provisions of the act of Congress of March 2, 1887, and has designated the institution which shall receive the bene-

fits of said act, it would seem to have exhausted its powers in the matter. The responsibility for the maintenance of an experiment station under said act devolves upon the governing board of the institution thus designated. If the legislature of the State or Territory sees fit to provide funds for the equipment and maintenance of other experiment stations and to put them under the control of the same governing board, well and good, but this does not in any way diminish the responsibility of the board to administer the funds granted by Congress in accordance with the provisions of said act.

“The performance of ordinary farm operations by an experiment station does not constitute experimental work. Operations of this character by an experiment station should be confined to such as are a necessary part of experimental inquiries. Carrying on a farm for profit or as a model farm, or to secure funds which may afterwards be devoted to the erection of buildings for experiment station purposes, to the further development of experimental investigations, or to any other purpose, however laudable and desirable, is not contemplated by the law as a part of the functions of an agricultural experiment station established under the act of Congress of March 2, 1887. Section 5 of that act plainly limits the expenditure of funds appropriated in accordance with said act to ‘the necessary expenses of conducting investigations and experiments and printing and distributing the results.’ ”

Prior to the issuance of the “Circular,” from which the foregoing extracts are taken, the question of curtailing, to some extent, the work undertaken at the substations came up for consideration in your Committee and a doubt as to the power, either of said Committee, or the Board represented by it, to cut off or materially to modify any portion of that work was expressed. An inquiry addressed to the State Attorney-General, Hon. B. L. Carr, brought a reply from which quotation is made: “There is nothing in the act of Congress which in my judgment contemplates the establishment of experiment stations other than those in connection with the several agricultural colleges and on and in connection with the agricultural college grounds. The purpose of the Act of Congress seems to be to have such stations under the charge and control of thoroughly-educated and scientific men, and to have them operated for scientific purposes and not merely for ordinary farming. It would

seem to be a diversion of the congressional fund if the same were to be applied to any other than purely scientific purposes."

Here we have two authorities, the highest outside of the courts of law to which we can go for legal advice, giving, independently of each other, substantially the same opinion. The officials at Washington have power to enforce their opinion by *act*. \*

\* Under the head of "*Experiment Stations*," the Hon. J. Sterling Morton, Secretary of Agriculture, in his annual report for 1896, says:

"Imperfect comprehension of the functions and duties of experiment stations on the part of governing boards and officers intrusted with the management of the stations has in many instances led to misdirected effort; in some to superficial work, and in others to expenditure of the public funds for work not contemplated in the original act."

"Some institutions have made the error of confusing work and expenditure intended for instruction with that intended for experimentation. Some stations expended large sums of money in what may have seemed experimenting, but was in reality the conduct and maintenance of large farms in which general crops (with, perhaps, some improved methods) were produced."

"The experiment station was not designed to be a model farm. There is neither warrant in law nor justification in circumstances for making it such."

"Another seeming misuse of funds has been brought about by the acceptance of donations of farms from enterprising citizens or from communities upon condition that permanent substations should be established upon them. Such farms have often been accepted without properly considering the nature of the soil of the land donated or the real needs of the locality. Thus much money has been wasted for building and equipments upon farms where only superficial and temporary experiments can be conducted."

"Some stations have endeavored to cover too many lines of work. Many stations were organized originally as so-called 'all-around stations.' They had a large staff of officers called 'agriculturists,' 'chemists,' 'botanists,' 'entomologists,' and 'horticulturists.' They paid small salaries, and, with few facilities for work, achieved small results. Most of the officers were obtained from the agricultural college faculties. They were allowed very little time from their teaching duties therein, and consequently could not thoroughly conduct experimental investigations."

"The experiment station act gives the land-grant agricultural colleges \$15,000 per annum especially for original research in agriculture. This is equivalent to 5 per cent. per annum upon an endowment of \$300,000 for each station. And this fund ought to be regarded as a sacred trust and devoted entirely to the advancement of agricultural science through conscientiously directed original research. If this course be pursued in all the institutions, as it has been faithfully pursued in some, practical agriculture will receive vastly increased benefits."

If our station is to receive any financial aid from the Government, it must be operated in conformity with the interpretation of the law reached by the authorities at Washington. The agents of the Government act agreeably to its statutes and can not be expected to govern their official course by the legislative acts of any particular state. Our State by its voluntary acceptance of the terms of the "Hatch Act" has become a beneficiary thereunder and should in good faith do the part to which it stands pledged.

I have made quotation herein of the opinions of the Attorney-General of Colorado and the Director of the Experiment Stations, acting in behalf of the United States, to show clearly the reasons that prompted the Committee in control of the sub-stations in Colorado to abandon active experimental work at the Divide Station in El Paso county and the San Luis Valley Station in Rio Grande county, and largely to reduce the experimental acreage at the Arkansas Valley Station in Otero county and the Rainbelt Station in Cheyenne county. Necessity is the mother of many things beside *invention*. It is just as difficult to make something out of nothing now as it ever was.

There is an erroneous idea in the minds of most Colorado people, who have any care for or interest in the Experiment Station, as to the nature and amount of work it should undertake. It is generally known that the Government makes annual appropriation of \$15,000 for the prosecution of experimental work in Colorado. Greedy eyes from every quarter of the State are fastened upon this appropriation and the desire to share in its distribution is without bounds. This idea of the right way of using the Government bounty has been fostered by the various Legislative acts establishing sub-stations and providing for their support by drafts upon the United States fund. This fund has proved wholly insufficient to secure satisfactory results in every part of the extended field in which experimental work has been attempted.

Consider the sum available for pushing station work, and then look upon it in progress in each of the five

scientific sections of the home station and upon four large experimental farms representing as many different sections of the State, and a conception of the thinness and worthlessness of some of it can be formed.

It can safely be said that but little of permanent value has resulted from the Colorado system of sub-stations. These sub-stations have had good supervision for what it has cost. It can not be expected that one who has fitted himself, by years of training, for planning and carrying into execution agricultural work on a *scientific* basis can be put in charge of one of these stations at a salary of from \$50 to \$70 per month. It is not strange that the management of our station work has provoked sharp criticism from those whose duty it is to guard against any misapplication of the Government fund.

Some sub-station or co-operative work seems called for by conditions existing in Colorado. This is readily admitted even by those who are in position to insist that no part of the Government appropriation shall be used in its furtherance. The feeling exists in the Department at Washington, that our State is not giving its Experiment Station proper support; that something more than the establishment of a number of sub-stations and putting them under the control of The State Board of Agriculture was implied in the Legislative act making acceptance, in the name of the State, of the congressional grant of 1887.

The people in the vicinity of the sub-stations, while differing in opinion as to the efficacy of their work, are almost a unit in desiring their continuance. Remonstrances against the abandonment of experimental work at the sub-stations at Monument and Monte Vista were prompt and vigorous.

At this writing, work at all the sub-stations is in a tentative condition. Its future will depend upon the financial help given it by the State. A small appropriation will enable The State Board of Agriculture not only to continue experimental operations at all the stations, but to render those operations more beneficial to the farming interests of the State than ever before. If those

who have been so earnest in remonstrance, in a direction where remonstrance was necessarily unavailing, will give active support to an effort that will be made to induce the State Legislature to make sure the permanency and value of sub-station work by needed financial support, their energy will be employed in a manner most promising of desirable result.

#### THE PRESENT STATUS OF THE SUB-STATIONS.

When it was decided a year ago temporarily to lease the sub-station lands in El Paso and Rio Grande counties, a Special Committee of the Board of Control was appointed with power to suggest, and approve of, the terms and conditions of leases to be drawn between the parties interested.

The Superintendent of the Divide Station, in El Paso county, having declined to remain as tenant, was requested to make sale of such products as were on hand, to the best advantage, and to ship the stock and all implements to the Home Station at Fort Collins. The carrying out of these instructions left the Divide Station without supervision or equipment. At a meeting of the Executive Committee, held March 31, 1896, the Director was authorized to rent the station property to a proper person on the best terms obtainable. Acting on this authorization, I put W. A. Diebold, of Table Rock, Colorado, in possession of the land and buildings as tenant. Mr. Diebold agreed to pay \$40 for the use of the premises for one year from March 1, 1896. He also agreed to pay \$7 for the hay that had been left on the grounds. At the present time, Mr. Diebold is in charge of the Divide Station. He reports the farm operations of the year as fairly successful.\*

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\* Mr. Diebold has made payment of all money due from him under the terms upon which he took charge of the station property.

Some statements from him, regarding the crops grown, are herewith given.

"The grain was almost a failure. Two acres of Chinese hull-less barley, sown June 5, caught the late rains and did well. Five acres of oats planted as deep as possible with a drill, April 11,

For the year ending November 30, 1896, the money account of the Sub-station is as follows:—

Superintendent's salary.....	\$	199.98
Labor .....		2.00
Other expenses.....		63.64

Total .....	\$	265.62
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There is a credit of \$36.85 derived from sales ordered to be made.

Charles A. Duncan, Superintendent of the San Luis Valley Sub-station, in Rio Grande county, became tenant of the property under the term of a lease that provided that he, having use of the station equipment, should farm the land for his own profit and at his own expense. He was also to do some stipulated experimental work and make report thereon at the proper time.

On November 15, 1896, after making out the annual inventory and forwarding to my office a brief report on the experimental work of the year, Mr. Duncan left the station property in charge of R. S. Sides. Information

yielded  $8\frac{1}{2}$  bushels per acre. On April 13, five acres were sown to oats broadcast. The amount of seed, per acre, in each case was  $1\frac{1}{2}$  bushels. The latter field did not stand the severe winds of the latter part of April and the first part of May. This field was re-sown, May 27, with hulless barley, the same being put in by harrowing so as not to damage the oats, then a light stand. The barley, owing to light covering, did not germinate until late; but the result was an excellent hay crop of oats and barley."

"The first field of barley yielded 16 2-3 bushels per acre. One acre of buckwheat—two varieties—yielded  $14\frac{1}{2}$  bushels. Four varieties of potatoes—Late Ohio, Rochester Rose, Maggie Murphy, and Prize Taker—were planted. Prize Taker produced nothing larger than a walnut. One 50-foot row of Maggie Murphy potatoes yielded 21 pounds. Late Ohio, planted May 20, 21, and 23, yielded 2,000 pounds per acre. Rochester Rose, hand planted May 17 and 18, six inches deep, yielded 4,000 pounds per acre. The summary of products is given herewith."

Potatoes, all varieties, large and small, 28,000 pounds.

Oats,  $42\frac{1}{2}$  bushels.

Barley, 33 1-3 bushels.

Buckwheat,  $14\frac{1}{2}$  bushels.

"*Bromus inermis* did not grow more than six inches, on account, perhaps, of the sowing being too heavy to stand the drouth. In 1895, I sowed  $1\frac{1}{2}$  acres on my ranch, using about seven pounds of seed per acre. The yield therefrom, this year, was 172 pounds of nice, clear seed, worth 20 cents per pound."

received causes me to believe that the station buildings and land are not in the best condition. Mr. Sides may be just the proper person to take charge of our station property at Monte Vista, but there is no agreement of any kind whereby he can be held responsible for the proper care of the property. Some action looking to the care, or disposition, of the station property at that point is desirable.

The account with the Sub-station stands as follows:—

Superintendent's salary (prior to date of lease.....)	\$	133.32
Water rent.....		75.00
Other expenses.....		5.88
		<hr/>
Total .....	\$	214.20

The receipts from sales of farm products are \$86.50.

On February 28, 1896, your committee decided to continue operations at the Rainbelt Sub-station, in Cheyenne county, until November 30, 1896. J. E. Payne, M. S., was appointed Superintendent at a salary of \$50 per month. Mr. Payne entered energetically upon the scheduled work. The report of his efforts will appear elsewhere. This Sub-station, Micawber-like, is "waiting for something to turn up." It ought to be kept in operation if money for its proper support can be secured. A three-year trial is not sufficient to demonstrate with any certainty the agricultural possibilities of the eastern portion of our State. The financial statement, covering a year, is as follows:—

Superintendent's salary.....	\$	600.00
Labor .....		90.95
Other expenses (improvements and equipment) .....		271.08
		<hr/>
Total .....	\$	962.03

A small credit from sales, amounting to \$5.20, is noted.

On January 30, 1896, the following resolution was adopted by the Executive Committee:—

*Resolved*, That A. L. Kellogg be authorized to lease all station land at Rocky Ford, not included in the special experimental area, for the current year on the best obtainable terms, the tenant to conduct his farm operations upon a plan to be agreed upon between him as one party and Mr. Kellogg and Superintendent Blinn as the other.”

Under the authority given in this resolution, one hundred and twenty (120) acres of station land were leased to Francis Harson. By the terms of the lease the Station is to receive one-half of all hay and one-third of all grain grown on the leased land.

The remaining eighty (80) acres of station land contain the station buildings, the orchard, the experimental plots, and fields upon which general farm products are grown. The appearance of this portion of the Station property has been much improved. Intelligent observers mark the change for the better in the condition of the orchard.

The yearly expenditures for station support are herewith shown:—

Superintendent's salary.....	\$	759.96
Labor .....		1,411.09
Other expenses.....		781.51
		<hr/>
Total .....	\$	2,952.56

Farm sales up to the close of the year amount to \$580.92.

The Arkansas Valley Station at Rocky Ford, Otero county, is the best sub-station under your control. The cessation of experimental work there would be a serious loss to the farming interests of the State. The land is eligibly located, being easily reached from the railroad station of the town. It affords the best possible conditions for the prosecution of that experimental work of most interest to the agricultural interests of the valley. Then, too, the people who come in touch with the station have ever shown the most lively interest in its welfare. There is little unjust criticism heard when people dis-

cuss the Station in conversation, or at public gatherings where the best methods of farming become the topics for consideration.

The Executive Committee, in control of station work, in planning the future of this Station, is brought face to face with a problem whose solution, at this time, is not readily apparent. The United States fund must, we are advised, be expended upon the station connected with the College, as a special department thereof. The same authority states in plain language that it is no part of the office of an experimental station to carry on farm operations as such.

With no available revenue for experimental work and with warning not to farm for profit, the open way for the continuance of sub-station operations is not clearly discernible. The carrying on of some "co-operative work," as has been suggested, is no way out of the difficulty; for the expense of this co-operative work can not be met by any draft upon the Government fund and there is no other within reach.

The land at Rocky Ford can not be handled, with any *experimental* value, so that expenditures and receipts will balance each other. A good farmer working for the preservation of the land and for what he could make it pay, would be able to meet all expenses, and more probably, out of sales of farm products; but no owner of the land, directing it through others, could bring about any such result. There would be no particular value to anyone in such result were it secured. The station, to meet any useful purpose, must keep the experimental side of its work uppermost. Some ordinary farm work is a necessity; but it is reasonable to require that no unnecessary effort be expended thereon.

The expenses of the Arkansas Valley Sub-station, under conditions now existing, will exceed the total receipts from sales at least \$2,000 annually; and it is well understood, by those conversant with the nature of the work done, that no part of this excess can be saved but at the sacrifice of the efficiency and value of the experimental work.

The present sum paid for supervisory work is surely not excessive. If station work is to have any present or future value, it must be under the direction of one thoroughly-equipped, by reason of his scientific attainments and wide experience, for its prosecution. The one possessing such necessary qualifications, and having the will to make effective use of them, would well merit a salary of not less than \$1,200 per year. Then, with a reasonable area upon which to carry on experimental work, the *labor* account ought to come within more modest limits. The labor bills, for the year, are about all that can invite criticism in the management of the Sub-station at Rocky Ford; and, possibly, they are not excessive when all the circumstances connected with the management are fully known.

As bearing upon the question of sub-station continuance, I quote the body of a letter from Dr. A. C. True, Director of Experiment Stations, Washington, D. C.:—

Dear Sir—"Referring to a report by Dr. Allen on his visit to your station last June, I wish to commend the management of the station on the action taken with reference to the sub-stations. I hope that there will be no relaxation of effort toward getting rid of this incubus and that the State legislature may be persuaded to deal generously with the station this winter. I fully believe that if you could have a relatively small amount of money for co-operative experiments in different parts of the State as circumstances may require, it would be far better than to maintain permanent sub-stations which at the best can be little more than stations for the trial of different kinds of crops."

#### THE WORK OF THE HOME STATION.

Ever since the life of the College began, important experimental work has been prosecuted on the college lands adjacent to Fort Collins. Prior to the receipt of the revenue obtained under the terms of the "Hatch Act," all expenses of the work referred to were met by orders on the tax-fund for college support and the receipts from farm sales.

The early reports of the Secretary of The State Board of Agriculture contain much matter which, under existing conditions, would find its way to the public by means of our station bulletins. The reports from the departments of Agriculture, Botany and Horticulture, and Chemistry, made before "The Agricultural Experiment Station" became a college department in February, 1888, present much interesting information upon questions of vital interest to "agriculture and kindred pursuits."

The present organization of the force engaged in station work at the College is simple and effective. The Executive Committee of the Board is the governing body. Acting under its authority, and in close union with it, is the Station Council composed of the following-named members of the College Faculty: President and Director, Agriculturist, Horticulturist and Botanist, Chemist, Meteorologist and Irrigation Engineer, Entomologist, and the Secretary of the Board of Agriculture. All the members of the Station Council, save the first and last named, are heads of scientific departments in the College and as such perform a two-fold office—instructor and experimental worker. In each of these departments, there is at least one assistant engaged wholly in station work and paid altogether from the station fund.

It is the duty of the Station Council to prepare annually, usually in January or February, a schedule of experimental work, for the Home Station and the Sub-stations, to be submitted to the Executive Committee for its approval. When thus approved, said schedule serves as a guide for all persons in any way connected with station work. The work of the Home Station is in the main scientific and possessed of permanent value. Certain records of that work appear in bulletin form and thus find their way to all parts of the country.

It has been suggested that our station work might be strengthened by so arranging class work in the scientific departments of the College as to give the chief officers therein more time and energy for experimental work. It is urged, with much force, that thorough station work necessarily calls for knowledge and skill of a

high order and that the best effort can not be put forth by those who have to do a large amount of teaching.

These suggestions naturally revive the oft-discussed question of the relations proper to exist between the College and the Experiment Station. It seems right to believe that, in the larger number of cases, the union of college and station work under one management brings the best results with the least outlay of effort and money. A well-equipped scientist can do, and direct, much teaching and experimental work, at the same time, if it is at all closely articulated. There is inexcusable waste in a plan that sends a worker from a class in algebra, to one in physics, and thence to a laboratory to engage in the analysis of soils, waters, or fertilizers; but waste is not apparent when the analytical worker gives a portion of his time to class-room and laboratory work in chemistry.

The question, after all, hinges on the ability and amount of the teaching and working force engaged. Give any of the heads of our scientific departments a proper working force and there will be no neglect of either college or station work. The total separation of the two kinds of work is not desirable in our institution. In our case, *union* brings economy with excess of strength.

The expenditure of the whole station fund upon the work of experimentation in progress at the Home Station will add very much to the amount and efficiency of that work. Three additional assistants of requisite scholarship and experience would give the experimental work now scheduled for the departments of Chemistry, Irrigation, and Entomology a rapid forward movement.

It is unwise to attempt the prosecution of many lines of experimental work at the same time. There is danger of attenuated results. Let us find out what is best worth doing and then do it with might and main. Again, the field chosen for experimental effort should be *domestic* rather than *foreign*; that is, our work should have some practical, close-in-touch relation to the great material interests of the State. What a vital question irrigation is to our people! How interested are our fruit-growers in everything that the entomologist can do

for the protection of their orchards! How instructive to the farmer, with unmarketable alfalfa and other stock-supporting products, are experiments in sheep and cattle feeding! How innumerable are the cases where the services of an analytical chemist are in high demand!

The completion of the new Chemical Laboratory will open the way for the rapid extension of the work of the Department of Chemistry, both in the way of college instruction and original investigation. Requests for chemical analyses come to us from all parts of the State. Some of these merit no more than respectful denial, since they are born of ignorance or prompted by selfish interests; others by reason of their relation to the general weal are worthy of prompt attention. I shall welcome the time when the resources we control will enable us to respond more readily to requests for analyses of soils, waters, and growths touching more intimately the farm life of our people. One reads with a feeling of regret this statement clipped from the columns of *The Mining Industry*—"There is nowhere any reliable analysis to be obtained of the water of any considerable number of Colorado springs. The State has more of them than any other in the Union. In a general way we know there are those which deposit iron oxides and sulphides, cinnabar, silica and probably all the alkaline metalloids. But no one has ever classified the leading ones to tell us whether they are alkaline, saline, acid, non-gaseous or carbonated, etc.

Coupled with Colorado's magnificent health-giving climate, these springs will some day make the State as famous as Baden-Baden is now."

I would like to see the fruit-growers of Colorado look with confidence to us for timely assistance in the management and preservation of their orchards. There should be opportunity for our station workers to visit any locality where personal observation is needed to acquire information precedent to intelligent planning of ways and means for helping the farming interests of that locality. The plan of sending a corps of workers, under the direction of our Irrigation Engineer, into the San

Luis Valley, last summer, to investigate the water supply of that portion of the State is a step in the right direction. The statement of results should follow a very thorough investigation, under a number of conditions; else injustice be done to some important interests in which the people of that region are deeply concerned. When college authority makes a report upon the resources of any part of the State, said report should present the *truth* no matter what selfish interests are unsettled thereby. The cost of the investigations made in the Valley thus far, is \$321.90. There are sections of Colorado unknown, save by report, to some of our station officers. Some change of class requirements that would leave these workers free, at times, for personal investigation outside of college territory seems desirable. At least more advantage should be taken of the long vacation season in which to make such investigation.

The Governing Board has never used any portion of the experiment station fund for college support. The College employes who do station work receive no undue portion of their compensation from the the station fund. No raid is ever made on the treasury of the station but, on the contrary, its money is guarded with jealous care. It is within bounds to say that the experimental work now in progress costs quite a sum in excess of the revenue for experiment station support. The college revenue always makes good any deficit in the station fund.

The members of the Station Council have rendered valuable service in farmers' institutes the past year. Never less than two members of the Faculty are detailed for service at each institute. No requests for institute workers are refused. Sometimes, it is true, home work of a pressing character compels us to ask a change of the date of holding the institute; but, the change being made, the attendance of some of our representatives at the institute sessions follows. The College and Station were represented at institutes held at Boulder, Longmont, Brighton, Las Animas, Monte Vista, Loveland, Canon City, Delta, Fort Morgan, Gypsum, and Glenwood Springs.

There is reciprocal advantage in this institute work. Those who give instruction receive it as well. The *practical* man is led to see things from a new point of view, and the *theorist* is forced to bring his theories to the test of experience.

#### STATION WORKERS.

Herewith are given the names of all persons regularly connected with station work, the positions filled, and the salaries received:—

<i>Home Station—</i>	Annual Salaries from
Names and Positions.	Station Fund.
Alston Ellis, Director.....	\$ 1,000.00
W. W. Cooke, Agriculturist.....	500.00
C. S. Crandall, Horticulturist.....	500.00
Wm. P. Headden, Chemist.....	500.00
C. P. Gillette, Entomologist.....	500.00
L. G. Carpenter, Meteorologist and Irrigation Engineer .....	500.00
D. W. Working, Secretary Station Council.....	400.00
ASSISTANTS.	
Frank L. Watrous, Agriculture.....	1,000.00
Jacob H. Cowen, Horticulture.....	1,000.00
Charles J. Ryan, Chemistry.....	900.00
Emma A. Gillette, Entomology.....	300.00
Robert E. Trimble, Meteorology.....	900.00
<i>Sub-Station Superintendents—</i>	
Philo K. Blinn, Rocky Ford.....	800.00
J. E. Payne, Cheyenne Wells.....	600.00
Total of Salaries.....	\$ 9,400.00
The yearly expense for labor is \$2,600.	

#### OUTLINES OF STATION WORK.

The schedules of station work for the year 1896 are herewith given for the reason that they properly form a part of the history of the Station for the year:—

## AGRICULTURAL SECTION.

*Farm Crops.*

- I. Testing of wheat on alfalfa sod compared with land in rotation.
- II. Testing of oats and barley on alfalfa sod compared with land after sugar beets.
- III. Testing of corn on fall as compared with spring plowing.
- IV. Testing of corn on land manured with sheep manure compared with ordinary stable manure.
- V. Testing of sugar beets on subsoiled land compared with land not subsoiled.
- VI. Testing of varieties of cereals and forage crops.

*Feeding Experiments.*

- I. Feeding pigs on alfalfa alone, alfalfa and a half ration of grain, alfalfa and a full ration of grain.
- II. Feeding sheep on standing corn.
- III. Raising early lambs on a commercial scale.
- IV. Feeding steers on grain, ensilage, and sugar beets.
- V. Feeding cows for milk on corn as compared with bran to accompany alfalfa hay and pasture.
- VI. Continuing the tests of cold deep setting compared with the separator for a small dairy.

## SECTION OF BOTANY AND HORTICULTURE.

- I. The study of the *flora* of the State, special attention being given to:
  1. The weeds of the farm and garden.
  2. Grasses, native and introduced.
  3. The various species and varieties of the *genera* Oxytropis and Astragalus.
- II. The further introduction to the garden of such wild fruit plants as can be obtained.
- III. Nursery tests of orchard fruits with a view to the study of the adaptability of varieties to this climate.
- IV. Tests of varieties of small fruits.
- V. Coöperative work with the Division of Forestry of the United States Department of Agriculture.

Under the first division of the schedule it is much desired that opportunity be afforded for an examination of the *flora* of the southern part of the State. There are several regions that have not been visited by botanists, and information concerning the characteristic plants of these regions is much needed.

Under the third division of the schedule, our lists of varieties of fruits that it seems desirable to add to the present collection, if filled, will involve an expenditure of about \$150.

In connection with the test of varieties of fruits a series of experiments with different methods of grafting is in progress. It is also proposed to make a series of crosses between varieties of plums, and also between varieties of strawberries.

SECTION OF METEOROLOGY AND IRRIGATION  
ENGINEERING.

- I. The Duty of Water:
  1. On a large scale, with the coöperation of canals.
  2. On different crops. This should be extended into different localities.
- II. Investigation of losses in carriage by seepage and evaporation.
- III. Return waters: continuation of previous investigations and verification of previous conclusions.
- IV. Irrigation survey of the State.

Some work has been done in this line before, but it has had to give way both because of lack of funds and of time.

My desire in this connection is to continue a systematic investigation of the water resources of the State, their character, best mode of utilization; a study of the methods of irrigation, their faults and advantages. For this particular season, I propose to confine my work to the San Luis Valley; the special effort being a study of the sub-irrigation and sub-surface waters. Nearly all the work so far done falls into a part of this general plan.

*Estimates:* The continuation of all work but that named in No. 4, will cost about \$175, including current expenses of various kinds—blanks, repairs, etc.

No. 4 for the whole season for the direct and indirect expenses will not require over \$300.

A partial promise of Government aid, in carrying out the work named in No. 1, has been given.

If the work outlined in No. 4 is approved, it should begin before the irrigation season opens in order to secure

the co-operation of those who can furnish the desired information. This co-operation is needed from the beginning to the end of the irrigation season.

#### CHEMICAL SECTION.

- I. Coöperative work with other Departments.
  - II. Work in connection with the Association of Official Agricultural Chemists, on fodders.
  - III. Experiments on the digestibility of the albuminoids of alfalfa hay to determine the relative value of new and old hay.
- I. The Chemistry of Irrigation:
    1. The composition of the ditch waters.
    2. The amount that flows off the irrigated land.
    3. The composition of this portion to see how much it takes up from the surface soil.
    4. The amount of water that percolates to different depths and the composition of the respective portions.
  - II. A study of the effects of growing beets upon alkali land.

This will embrace the following subjects:

    1. The amount of water flowing into the alkalinized area.
    2. The character of the strata through which the waters move, together with the size of the area drained.
    3. The change, if any, in the depth of the water level caused by irrigation of the area in question.
    4. The rate of evaporation from the surface and the amount of alkali deposited.
    5. The depth to which the alkalization takes place.
    6. The effect on the composition of the soil.
    7. The effect of beet growing upon the amount of alkali.
    8. The composition of the beets as to feeding value and for sugar.
    9. To determine whether a variety grown for tops only would not be better than varieties grown primarily for the roots yielded.

#### ENTOMOLOGICAL SECTION.

- I. Collecting and rearing insects for the purpose of determining food-habits and life-histories.
- II. Experiments for the destruction of insect eggs.
- III. Experiments with the "Grasshopper Disease."

- IV. Experiments to determine habits and remedies for "Woolly Aphis."
- V. Testing new insecticides.
- VI. Experiments for the destruction of miscellaneous insect pests.
- VII. Experiments in the Apiary:
  - 1. To determine the value of sugar as winter stores.
  - 2. Testing apiary appliances.
  - 3. Making a collection and list of native honey and pollen-producing plants with notes as to their possible value.
  - 4. Experiments to determine the nature of and remedies for the disease known as "Bee Paralysis."

## THE ARKANSAS VALLEY EXPERIMENT STATION.

ROCKY FORD, COLORADO.

### AGRICULTURAL DIVISION.

- I. *Cereals:*
  - 1. Comparative test of the cost and profit in barley, wheat, and corn growing. Five acres each.
  - 2. Test of the cost of production of corn on new alfalfa sod. Four acres.
  - 3. Test of varieties—barley, wheat, corn, and oats—on alfalfa sod. Two acres.
- II. *Grass and Hay Crops:*
  - 1. *Clover*—Comparison of the merits of red and crimson clover as a hay and seed crop; also to test the merits of each for green manuring in the old orchard.
  - 2. *Alfalfa*—Old wheat and corn land to be seeded to alfalfa, a portion of the field to be sown alone, the remainder to be sown with oats, to test the merits of seeding with and without grain; also to furnish feed for the station horses. Seven acres in all.
  - 5. *Pasture*—Pasture tests, observations on present field of *Bromus inermis*; also to make an addition of three acres, sown to rye, timothy, and orchard grass. Six acres in all.
  - 4. *Tests*—Plat tests of new and untried varieties on plats  $\frac{1}{2}$  acre each. One and one-half acres.
  - 5. *Irrigation*—Record of the number of irrigations applied to clover, in comparison to alfalfa, on new seeding.

GARDEN DIVISION.

I. *Vegetables:*

1. Test of new and untried varieties with detailed reports on cultivation and adaptability to this climate. Two acres.
2. Cantaloupes on alfalfa sod, to test the cost and profit per acre; detailed record of cultivation and irrigation. One acre.
3. Sugar beets. Test of varieties and cost of production on alfalfa sod. One-half acre.
4. Potatoes on alfalfa sod; test by early and late planting of all the most promising varieties that can be secured. Four acres in all.
5. Miscellaneous planting for exhibition purposes. One-half acre.

HORTICULTURAL DIVISION.

I. *Old Orchard:*

1. Observations on the effects of summer and winter pruning; also on inflorescence, setting, and fruit yields.
2. Comparative tests of the methods of cultivating an orchard—clean cultivation, rye, red clover, crimson clover, and buckwheat for green manuring.

II. *New Planting:*

1. Apples, peaches, pears, cherries, plums and prunes. any new and untried varieties. Five or six acres.
2. Small fruits—strawberries, currants, gooseberries, raspberries, blackberries, and grapes.
3. Forestry—addition to nut, shade, and ornamental trees.
4. Hedge row tests of different kinds. Wind-break around the orchard.
5. Additions of ornamental shrubbery and improvement of lawn around station cottage.

IRRIGATION DIVISION.

- I. Measurement of water applied to different crops.
- II. Observations on the effects of water applied at morning, noon, and night, on a plat of garden peas, the results to be determined by the date of blooming and the yield. The three portions of the plat to be, otherwise, under the same conditions. Notes to be taken on the temperature of the water.

## ADDITIONS APPROVED SEPTEMBER 21, 1896.

- I. Grain Culture: Test of varieties to be conducted for a series of years with detailed reports:
  - 1. On plats for preliminary results.
  - 2. The more promising varieties to be carried to a more practical test on field areas of an acre or more. Both fall and spring varieties to be tested.
- II. Winter Rye: To be sown as a station crop on land difficult to irrigate, to be seeded to alfalfa the first of May. Four acres.

## SAN LUIS VALLEY EXPERIMENT STATION.

MONTE VISTA, COLORADO.

- I. Experiments with grain on spring plowing:
  - 1. Sowing wheat on a plat on which the stubble has been burned, the land then being plowed shallow.
  - 2. Sowing wheat on plat deep plowed—8 or 10 inches—and then thoroughly rolled.
  - 3. Sowing oats on land, which was in oats last year, after irrigating and plowing.
- II. Some experiments in small plats:
  - 1. Testing same varieties of early potatoes.
  - 2. Testing some varieties of grasses. Notes on small plats of grasses sown last season will be taken.

## RAINBELT EXPERIMENT STATION.

CHEYENNE WELLS, COLORADO.

## FARM DIVISION.

- I. Wheat:
  - 1. Defiance. One acre.
  - 2. To be selected. One acre.
- II. Oats:
  - 1. Excelsior. One acre.
  - 2. Black Russian. One acre.
- III. Barley:
  - 1. Highland Chief. One acre.
  - 2. To be selected. One acre.
- IV. Corn:
  - 1. White Kansas King. Four acres.
  - 2. Colorado White. Four acres.
  - 3. Queen of the Field. Four acres.
  - 4. White Australian. Four acres.
  - 5. Selected corn on trial plats.

- V. Canes:
  - 1. Egyptian Rice Corn. Two acres.
  - 2. Milo Maize. Two acres.
  - 3. Kaffir Corn. Two acres.
  - 4. Sorghum. Two acres.
- VI. Broomcorn: Three varieties. Six acres.
- VII. Potatoes: Selected, on one and one-half acres.
- VIII. Field Peas: Canadian, one-half acre.
- IX. Beets: Selected, on one-fourth acre.
- X. Grasses: Selected, on trial plats.

GARDEN DIVISION.

- I. Small plats, selected vegetables including melons, pumpkins and squashes.
- II. Trees:
  - 1. Nineteen trees planted in the spring of 1895 have died.

	Planted.	Died.
Ben Davis.....	25	1
Winesap .....	10	0
Utter's Red.....	12	5
Missouri Pippin.....	3	2
Jeniton .....	12	1
Romanite .....	2	0
Bellflower .....	2	0
Grimes Golden.....	5	0
Red Astrachan.....	5	0
Russian Apricot.....	6	3
Early Richmond Cherry.....	12	2
English Morello Cherry.....	12	5
Total .....	106	19

- 2. Eight trees are lacking to fill out the plat under fence. Thus, to make good the loss of last year and to complete the planting of the plat, twenty-seven trees are needed.

STATION PUBLICATIONS.

Section 4, of the congressional act relating to experiment station begins as follows: "That bulletins or reports of progress shall be published at the said stations at least once in three months." The first bulletin

from the station was issued in August, 1887, The whole number of bulletins now in print is thirty-five.

<i>No.</i>	<i>Subjects.</i>	<i>Authors.</i>
1.	Reports of Experiments in Irrigation and Meteorology..	Elwood Mead
2.	Report of Experiments with Grains, Grasses, and Vegetables on the College Farm.....	A. E. Blount
3.	Concerning the Duties of the Secretary of The State Board of Agriculture, and Distribution of Seeds.....	Frank J. Annis
4.	Report of Experiments with Potatoes and Tobacco.....	James Cassidy
5.	Experiments in the Apiary.....	C. M. Brose
6.	Notes on Insects and Insecticides.....	James Cassidy
7.	Potatoes and Sugar Beets.....	James Cassidy David O'Brine
8.	Alfalfa: Its Growth, Composition and Digestibility.....	David O'Brine James Cassidy
9.	Soils and Alkali.....	David O'Brine
10.	Tobacco.....	David O'Brine James Cassidy
11.	Sugar Beets.....	C. L. Ingersoll David O'Brine
12.	Some Colorado Grasses and their Chemical Analysis.....	David O'Brine James Cassidy
13.	On the Measurement and Division of Water..	L. G. Carpenter
14.	Progress Bulletin on Sugar Beets.....	David O'Brine
15.	The Codling Moth and the Grape-Vine Leaf-Hopper.....	C. P. Gillette
16.	The Artesian Wells of Colorado and their Relation to Irrigation.....	L. G. Carpenter
17.	A Preliminary Report on the Fruit Interests of the State.....	C. S. Crandall
18.	Index Bulletin.....	W. J. Quick
	Special Bulletin "A" Concerning Subjects Investigated by the Experiment Station.....	
19.	Observations upon Injurious Insects, Season of 1891.....	C. P. Gillette

- 20. I. The Best Milk Tester for the Practical Use of the Farmer and Dairyman..... } W. J. Quick
- II. The Influence of Food upon the Pure Fat Present in Milk..... }
- 21. I. Sugar Beets..... } F. L. Watrous
- II. Irish Potatoes..... }
- III. Fruit Raising..... }
- 23. Colorado Weeds.....C. S. Crandall
- 22. A Preliminary Report on the Duty of Water.L. G. Carpenter
- 24. A Few Common Insect Pests.....C. P. Gillette
- 25. Progress Bulletin on the Loco and Larkspur..David O'Brine
- 26. { Garden Notes for 1893..... { Marion J. Huffington
- { Farm Notes for 1893..... { C. S. Crandall
- { Seeding, Tillage, and Irrigation.....Fred. Huntley
- 27. The Measurement and Division of Water. (Third Edition, Revised, of Bulletin No. 13).....L. G. Carpenter
- 28. The Russian Thistle.....C. S. Crandall
- 29. Strawberries and Grapes: Notes on Varieties.....
- 30. I. Farm Notes for 1894..... { W. W. Cooke
- { Notes on Tomatoes.....Frank L. Watrous
- { Marion J. Huffington
- 31. Hemiptera of Colorado..... { C. P. Gillette
- { Carl F. Baker
- 32. Sheep Feeding in Colorado.....W. W. Cooke
- 33. Seepage or Return Waters from Irrigation..L. G. Carpenter
- 34. Cattle Feeding in Colorado.....W. W. Cooke
- 35. Alfalfa.....Wm. P. Headden

Bulletin No. 35 is now in press. It would have been distributed ere this but for the printer's slow movements. The close of the year again finds us short of the required number of bulletins. The amount of *matter* presented in the three bulletins, issued within the year, is more than sufficient, if divided, to fulfill the statutory requirement before quoted. I think it advisable to issue a bulletin just as soon as investigation secures anything of value, without waiting for the preparation of *everything* that may properly relate to its title. Bulletins are like reports. It is not always the longest that contains the most.

The Eighth Annual Report of the Station was printed as a part of the Seventeenth Annual Report of The State Board of Agriculture. The Station report covered about 100 pages. Its cost, for an edition of 1,500 copies, was \$100. Bulletin No. 33 contains 64 pages. An edition of 8,000 copies cost \$330.55. There are 36 pages in Bulletin No. 34. The cost of the edition of 6,000 copies was \$135.40. The cost of Bulletin No. 35—8,000 copies—will not be less than \$600. It will contain at least 100 pages of printed matter and, in addition, 14 pages of plates. The half-tones printed upon selected paper and the necessary tabular work swell the cost to the sum named.

#### CONCLUSION.

In the preceding pages I have tried to set forth the present condition of the Experiment Station. I am of the opinion that the lines of work attempted should be drawn within narrower limits. A worker becomes lost in a large field, within which widely divergent operations may be going on. We speak of "intensive farming," and have a pretty clear idea of the meaning of the words. I would have that idea take possession of those who direct the progress of most of our station work. That work should be both scientific and practical—should be prosecuted by those able to plan and execute something original and join the product of such original investigation to the practical operations of the farm in a manner to render them more far-reaching in good results. The scientist seeks out principles and reasons with the purpose of making them serviceable in some work in progress, or needed. He needs to know conditions before he can hope to make his efforts available for modifying them. Here is where some weakness in station work is made apparent. Experimental work at the Home Station may be highly suggestive to farmers in northern Colorado but may be much less so to those working amid conditions quite different. Even should the sub-station management be continued under State patronage, it seems to me desirable to have other work, co-operative with that of the Home Station, in progress in other locali-

ties in the State. The cost of this co-operative work would be but trifling, being chiefly the expense of its inception and subsequent inspection by some station officer. As soon as some definite understanding is reached with reference to the future of the sub-stations, experimental work will be prosecuted with more certainty and with better outcome.

Respectfully submitted,

ALSTON ELLIS,

*Director.*

Fort Collins, Colorado,

December 9, 1896.



REPORT  
OF THE  
AGRICULTURAL SECTION.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—I have the honor to present herewith the annual report of the experimental work done by the Agricultural Section of this Station.

The work has gone on with but little interruption. The results have in the main been fairly successful. The nearest to a failure in the experiments was in the case of the sugar beets that were badly injured by the severe hailstorms of the early summer.

In cereal crops tests were made of wheat, oats, and barley the second year from alfalfa sod as compared with similar contiguous land that had not been in alfalfa. In each case the alfalfa sod produced much the better results; with wheat as 100 to 90; with oats as 100 to 60, and with barley as 100 to 45.

Tests were made with wheat from hand-picked seed and yielded some very fine grain running over forty bushels to the acre.

The work of the previous year was repeated on corn grown from seed that had been raised in various altitudes and latitudes. For the production of grain, the seed from Colorado has given as good results as that from any other state, but for growth of fodder for ensilage purposes, corn from a lower altitude and latitude has proved superior.

The third season's experiments on the use of ensilage are now in progress. It is yet too early to tell what will be the final verdict on ensilage in Colorado. The past two winters' feeding has, however, definitely settled the question for us of its adaptability for steer feeding. It has proved valueless for that purpose when the steers are fed outdoors in cold weather. It does not seem probable that any future work will change this conclusion. The above remarks apply both to corn ensilage and to ensilage made of alfalfa. It has been a favorite idea that alfalfa alone or alfalfa and corn together would make a perfect ration. This is frequently advocated by those who have never seen alfalfa ensilage and especially by those who have never lived in an alfalfa country.

If the process of ensilaging has value, this value must lie in one or more of three results. It must preserve the fodder more perfectly, or it must increase its palatability, or it must so prevent loss that the dry matter of the ensilage has greater feeding value pound for pound than that of the dry fodder. Alfalfa ensilage fails in all these particulars. Though the results of the investigations of the Chemical Department of this Station show enormous losses in curing alfalfa and handling it in the dry state, yet they are scarcely larger than the losses by fermentation in the silo. Stock eat dry alfalfa readily and greedily, so that making ensilage of it cannot increase its palatability; while our tests show that there is no gain in the feeding value of the matter itself. With no positive benefits, there is an increased cost of labor in filling the silo and feeding out the contents, that more than doubles the cost of feeding any kind of stock on alfalfa ensilage as compared with dry alfalfa from the stack.

There remains yet to be solved the question of the feeding of corn ensilage to sheep and milch cows. Some work done last winter seems to indicate that ensilage is a profitable feed for stock sheep and it is being repeated this winter as also are our former tests on ensilage to milch cows.

Some forage crops grown the past season have given very good results. This was especially true of the millets of which the Japanese stood about four feet high with very large seed heads and yielding nearly twenty-five tons of green forage per acre, equivalent to about six tons of well-cured hay. African millet yielded a still greater weight of forage on stalks six feet high, but the yield of grain was less and the grain shattered badly. The millets were sown May 25 and harvested the middle of September. These yields are larger than any we have previously obtained and seem to be due in large measure to the use of water in irrigation and to irrigating late in the season. The same general results were obtained with some new ensilage corns. One in particular, the "Giant Mexican June," produced stalks eight inches in circumference and at twelve feet high, the first of October, were just beginning to show a tassel and no sign of an ear. The yield was forty-two tons of green fodder per acre. The fall of 1896 was quite favorable to the growth of such crops and the above results are probably higher than could be generally expected.

The work in dairying has been carried out on the same lines as indicated in previous reports. The results so far obtained seem to indicate that the claims of separator manufacturers as to their advantage in a small dairy are not valid. The work is now being repeated before the results are published.

The series of feeding experiments with milch cows, begun some time ago, is still in progress. These experiments have for their general object the determination of how much alfalfa can profitably be fed to a cow; or, to put it in another way, whether there is anything else that can be profitably fed to take the place of part of the alfalfa.

Alfalfa is particularly rich in muscle or flesh forming material and rather poor in the heat or fat producing elements. The corn plant in all its parts, as well as sugar beets and the grain of oats and barley have the opposite properties. All book rules for animal feeding claim that a mixture of these two classes of foods will

give better results than either separately. Yet Colorado farmers largely feed wheat bran with their alfalfa instead or corn meal and good results have been reported from the feeding of cottonseed meal with alfalfa—a ration entirely at variance with all standards. It seems desirable that extensive tests be made to determine the reasons for the different results obtained by eastern and western feeders.

The experiments with sheep have been continued the past year and are still in progress. In connection with the Department of Zoölogy and Entomology some extensive tests have been made this fall on the dipping of sheep for the cure of scab. The results will be published by that Department in the near future in bulletin form.

The work of previous years in cattle feeding was continued last winter and the results embodied in Bulletin No. 34, of this Station, on "Cattle Feeding."

A bulletin on the "Birds of Colorado" will be ready for the press by the end of December.

Other work in feeding has made satisfactory progress during the year both in hog feeding and in the raising of spring lambs.

Especial attention has been and is being paid to the growth and feeding of barley with the expectation of making that the subject of the next bulletin from this Section.

One of the most interesting experiments of the year is in connection with the "Idaho Coffee Pea." This has been grown on the farm the past two years and has demonstrated its ability to make a large growth with plenty of water and a fair growth with a very limited supply. It belongs to the pea family; is grown in rows thirty inches apart and the plants six to twelve inches apart in the rows. Its growth on the farm indicates that it can be raised for about one cent per pound.

The taste is a very good imitation of true coffee. One would easily get to liking the taste of the pure Coffee Pea, but it would generally be used mixed half and half with real coffee.

A test was made a few days ago in the Department of Domestic Economy of this College on its merits compared with that of the best grade of pure coffee that could be found in the Fort Collins markets. Six members of the College Faculty scored the beverage, without knowing the source of any of them and the average score was ninety-seven for half coffee pea and half coffee as against one hundred for pure coffee.

Respectfully submitted,

W. W. COOKE,

*Agriculturist.*

Fort Collins, Colorado,  
November 30, 1896.



REPORT  
OF THE  
SECTION OF BOTANY AND  
HORTICULTURE.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—I have the honor to submit the following report on the work in charge of the Section of Botany and Horticulture:

Fruits.

Apples—The nursery which now contains trees one, two, and three years old is divided into two blocks, one located on low and naturally moist land under the Town Ditch; the other on higher and drier land watered from the No. 2 Ditch. The soil of both blocks is a clay loam, but that on the low land is black and heavy, while on the higher block it is lighter and easier to work. The apparent differences in the behavior of the trees on the two blocks seems, however, to be due more to prevailing differences in the amount of water present in the soil than to the character of the soil itself, or to other differences in the two locations.

In a previous report the injury from the extreme low temperatures of the winter of 1894-'95 was remarked upon. The greatest injury was done to the trees upon the low land and this was attributed to insufficient ripen-

ing of the late growth induced by the naturally moist soil. On the higher land the trees made less growth, but ripened better and showed less injury. During the winter of 1895-'96 the conditions were very different. There were no protracted periods of low temperature, very little moisture in the form of rain or snow, and an unusual amount of warm dry wind. For a great portion of the winter the soil was free from frost. Evaporation was continuous, reducing the soil moisture on the high land until there was not enough to supply the demands of the trees. Under these conditions the effects noted for the preceding winter were here reversed.

The trees on the low land escaped injury, while those on the dry ground suffered severely. The injury was manifest early in the spring in the shriveled trunks and branches of many of the trees. Young trees showed greater injury than did the older ones; some of the latter losing only the tips of the branches, but even these showed in the small growth made during the summer that their vitality had been much impaired. Had water been available for a thorough irrigation late in the fall it is probable that the injury would have been less, but I do not think it would have entirely prevented it. Shrubs and ornamental plants on similar soil that was thoroughly saturated by irrigation in November showed marked injury of the same character as shown by the apple trees.

As grown under the conditions above outlined there is no warrant for final judgment as to the hardiness of the varieties represented, or as to their adaptability to our climate, but for a comparison of the relative behavior of the varieties, and for convenience, we have classified those which have passed through two winters under three divisions, and enumerate them below as Hardy; Half-Hardy; and Tender. The first division includes those varieties showing only slight injury or none at all. The second, those that have killed back partially, but not to the extent of rendering the injury permanent. The third, those that have suffered severely, and do not give promise of recovery.

**HARDY**

ON LOW LAND.  
 Duchess.  
 Early Colton.  
 Fink.  
 Gano.  
 Gravenstein.  
 Isham Sweet.  
 Jonathan.  
 Liss of Seedling.  
 Mann.  
 Pewaukee.  
 Tetofsky.  
 Walbridge.  
 Wealthy.  
 White Winter Pearmain.  
 Willow Twig.  
 Wolf River.  
 Wyeth.  
 Yellow Transparent.

ON HIGH LAND.  
 Bailey's Sweet.  
 Ben Davis.  
 Dyer.  
 Gideon's Best.  
 Gill's Beauty.  
 Golden Sweet.  
 Large Striped Pearmain.  
 Maiden's Blush.  
 Martha Washington.  
 Minkler.  
 Newtown Pippin.  
 Nickajack.  
 Red Limbertwig.  
 Western Beauty.  
 White Bellflower.

**HALF HARDY.**

ON LOW LAND.  
 Aikin.  
 Alexander.  
 Arkansas Black.  
 Autumn Strawberry.  
 Beauty of Kent.  
 Benoni.  
 Big Romanite.  
 Buncombe.  
 Chenango.  
 Coffelt.  
 Colvert.  
 Cullasaga.  
 Early Harvest.  
 Early Red Margaret.  
 Early Strawberry  
 Fameuse.  
 Gideon.  
 Haas.  
 Indian.  
 Iowa Blush.  
 Little Romanite.  
 Lowell.

ON HIGH LAND.  
 Benoni.  
 Borsdorfer.  
 Buckingham.  
 Colvert.  
 Cooper's Market.  
 Delaware Winter.  
 Domine.  
 English Golden Russet.  
 Grimes' Golden.  
 Key's Winter.  
 King.  
 Kossuth.  
 Nelson's Sweet.  
 North-Western Greening.  
 Northern Spy.  
 Rankins.  
 Rhode Island Greening.  
 Salome.  
 Shiawassee.  
 Stark.  
 Vandevere.  
 York Imperial.

## ON LOW LAND.

McIntosh Red.  
 McMahan.  
 Mammoth Black Twig.  
 Milam.  
 Ohio Nonpareil.  
 Plumb's Cider.  
 Price's Sweet.  
 Rawle's Janet.  
 Red Astrachan.  
 Red Winter Sweet.  
 Roman Stem.  
 Seek-No-Further.  
 Shackleford.  
 Shockley.  
 Summer Queen.  
 Sweet Bough.  
 Talman's Sweet.  
 Vandevere.  
 Wagener.  
 Winesap.  
 Yellow Transparent.

## TENDER.

## ON LOW LAND.

American Golden Russet.  
 American Summer Pearmain.  
 Arkansas Beauty.  
 Autumn Swaar.  
 Belmont.  
 Blue Pearmain.  
 Brightwater.  
 Carolina Striped June.  
 Clayton.  
 Cooper's Early.  
 Crawford Pippin.  
 Early Pennock.  
 Fall Pippin.  
 Grindstone.  
 Huntsman.  
 Ingram.  
 Keswick.  
 Lady.

## ON HIGH LAND.

Autumn Swaar.  
 Brightwater.  
 Enormous.  
 Garden Ball.  
 Hatcher's.  
 Kinnard's Choice.  
 Langford.  
 Longfield.  
 Lord Nelson.  
 Loy.  
 N. Carolina Limbertwig.  
 Painted Lady.  
 Smokehouse.

## ON LOW LAND.

Missouri Pippin.  
Monmouth Pippin.  
Peck's Pleasant.  
Rainbow.  
Rambo.  
Red Bietigheimer.  
Red June.  
Red Winter Sweet.  
Rome Beauty.  
Shannon Pippin.  
Smith's Cider.  
Sops of Wine.  
Spitzenburgh.  
Summer Rose.  
Twenty Ounce.  
Utter's Red.  
Winter May.  
Yellow Bellflower.  
Yellow Horse.

The tract of farm land covering  $6\frac{1}{2}$  acres which was transferred to this department last spring for orchard purposes was given thorough preparation, and about five acres were planted with two year old station grown trees. The number of trees set was 480, representing 140 varieties. The work of planting was commenced as soon as it was known that water was available, but soon after starting the water was shut out and remained out for two weeks. All the hose obtainable was brought into use, and the trees within reach of the hydrant received water, but a few rows beyond reach got none until water was again turned into the ditch. These rows show many vacancies and will be replanted in the spring.

The soil in this orchard seems well adapted to the growing of trees, and with an assured water supply a fair test of the varieties under trial would be afforded, but the unusually scant supply of the past season made the starting of the orchard somewhat unsatisfactory. On the eighth of April there were shipped from the station nursery, for trial at the Rocky Ford sub-station 233 trees representing 77 varieties.

## Pears.

The following varieties are now represented in the station nursery:

Bessemianka.	Lawrence.
Buffum.	LeConte.
Clapp's Favorite.	Louise Bonne of Jersey.
Edmond's.	Mount Vernon.
Idaho.	Vicar.
Keiffer.	

An equal number of scions of each variety was grafted on French pear stocks, and on Quince stocks, and the trees have grown in contiguous rows in the low land nursery. None of the varieties named have done well on the Quince stocks. The dwarfing action of the stock seems to have gone beyond the limit of healthy growth, and the trees present a stunted and sickly appearance. On pear stocks the growth of all varieties has been good, but the Clapp's Favorite exceeds them all in vigor and appearance. All varieties were slightly injured by the low temperature of the winter of 1894-'5, but made a good growth the following summer, and came through last winter without injury.

## Plums.

The old plum orchard contains the following varieties.—

Coe's Golden Drop.	Miner.
Forest Garden.	Prairie Flower.
Little Blue Damson.	Russ No. 2.
Marion.	Wolf.

All have been in fruit for several years. We have no record of the age of the trees, or of their origin. All appear perfectly hardy. Coe's Golden Drop is an excellent plum of English origin, but is unproductive here. Of the other varieties, Wolf is the most productive and, although not of the best quality, is the most profitable for this section. A severe hailstorm on June 5th, did considerable damage to foliage and fruit.

In the spring of 1894 the orchard was extended south to the banks of the Town Ditch. In this addition are 13 rows containing 227 trees which represent 76 varieties.

Most of the trees were obtained from the East Shore Nurseries of J. W. Kerr at Denton, Maryland. A few were station grown from scions obtained from various sources.

A number of varieties flowered and set fruit this season, but owing to the hail of June 5th, ripe fruits were obtained from only four varieties, namely—Weaver, Speer, Cheney, and LeDuc.

In the matter of hardiness the trees exhibit all degrees, from perfectly hardy, to very tender and unsuited to our conditions. Classified on the basis of hardiness into the three classes—Hardy—Half-Hardy—and Tender, the varieties fall into groups as below. Each class is divided to indicate the species from which the variety is derived, and the place of origin is given where known.

HARDY.

*Prunus Americana.*

American Eagle, Missouri.	Minnetonka, Minnesota.
Cheney, Wisconsin.	Ocheeda, Minnesota.
Deep Creek, Kansas.	Rockford, . . . . .
Forest Garden, Iowa.	Rollingstone, Minnesota.
Hawkeye, Iowa.	Speer, Iowa.
Joe Hooker, . . . . .	Weaver, Iowa.

*Prunus Americana mollis.*

Van Buren, Iowa.	Wolf, Iowa.
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*Prunus hortulana Mineri.*

Idol, Illinois.	Miner, Pennsylvania.
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*Prunus pumila.*

Maryland.

*Prunus domestica.*

Little Blue Damson, Foreign.	Moore's Arctic, American.
Moldovka, Russian.	Silver Prune, Foreign.

Not classified.

Comfort.

## HALF HARDY.

Prunus Americana.	
Apricot, . . . . .	Maquoketa, Iowa.
Colorado Queen, . . . . .	Moon, . . . . .
Harrison, . . . . .	Peffer's Premium, Wisconsin.
Ida, Illinois.	Winnebago, Minnesota.
Illinois Ironclad, Illinois.	Kopp, Minnesota.
Kampeska, . . . . .	Wyant, Iowa.
Le Duc, Minnesota.	Yellow Sweet, Minnesota.
Leonard, . . . . .	
Prunus hortulana.	
Clark, Maryland.	Southern Beauty, . . . . .
Garfield, Ohio.	Whitaker, Texas.
Kauawha, Georgia?	World Beater, Tennessee.
Missouri Apricot, Missouri.	
Prunus hortulana Mineri.	
Prairie Flower.	
Prunus Maritima.	
Bassett, New Jersey.	
Prunus triflora.	
Burbank, Japan.	Ogon, Japan.
Prunus Simonii. China.	
Prunus domestica.	
Bradshaw.	Saratoga.
German Prune.	Shropshire Damson.
Lombard.	
Not classified.	
Champion.	Holt.
Hammer.	Spanish King.
Hattie.	Trabasche.

## TENDER.

Prunus Americana.	
Cottrell, Minnesota.	Purple Yosemite.
Hill Top.	Quaker.
Honey.	Wild Rose.
Prunus hortulana.	
Choptank.	Poole's Pride, Illinois.
Smiley.	
Prunus hortulana Mineri.	
Clinton, Minnesota.	Indiana Red, Indiana.
Forest Rose, Missouri.	
Prunus chicensis.	
El Paso, Texas.	

*Prunus domestica*.

Spaulding.

Minnesota, Sweden.

The orchard has been given clean culture during the summer. As a protection against "frost cracks" the trunks of all young trees have been wrapped with burlap.

Scions of two of the Japanese varieties Ogon and Burbank top-grafted in 1894, the Ogon on wild *Prunus Americana*, the Burbank on Prairie Flower, fruited in 1895 and again this season. Two other varieties top-grafted on Prairie Flower fruited this season. Yellow Aubert, introduced from Russia, and the German Prune, both of the *domestica* class. These are all desirable varieties deserving further attention.

Small fruits.

The block of small fruits was increased last spring by the addition of a number of the newly introduced varieties. The plantation now embraces the following—

BLACKBERRIES.	RASPBERRIES.
Red.	Ancient Britain.
Marlboro.	Ohmer.
Golden Queen.	Eldorado.
Cuthbert.	Snyder.
Turner.	Agawam.
Royal Church.	Erie.
Black cap.	Stone's Hardy.
Hilborn.	Wilson's Early.
Kansas.	Wilson Jr.
Carman.	
Gregg.	CURRANTS.
Purple cane.	Raby Castle.
Shaffer.	North Star.
GOOSEBERRIES.	Victoria.
Oregon Champion.	Red Dutch.
Smith's Improved.	Fay.
Industry.	Cherry.
Houghton.	Versaillaise.
Downing.	White Grape.

Strawberries.—

The number of varieties now represented on the station grounds is 73; of these 55 were in fruit this season. The qualities of about half of the fruiting varieties

were noted in bulletin No. 29, but for comparison with new introductions, and for still further trial, most of them are still retained. Of the varieties reported upon all but three maintain the estimate placed upon them. The Wolverton, Gandy, and Loudon which received favorable mention did not do well this season; the plants made but small growth, and were unproductive. The early varieties under trial were damaged to some extent by late frosts, and the product of all varieties was materially diminished by the destructive hail of June 5th.

A tentative classification based upon productiveness and vigor of growth as observed this season, into groups which we may call Good, Medium, and Poor, would separate the varieties as listed below.

Good.	Medium.	Poor.
Bederwood.	Barton.	Atlantic.
Belle of LaCrosse.	Beverly.	Bessie.
Captain Jack.	Boynton.	Bubach.
Crescent.	Cornelia.	Gold.
Cumberland.	Eureka.	Greenville.
Edward's Favorite.	Glendale.	Mark.
Edgar Queen.	Gandy.	Mrs. Cleveland.
Enhance.	Gov. Hoard.	Ontario.
Jessie.	Gypsy.	Timbrell.
Louise.	Haverland.	VanDeman.
Luella.	Ironclad.	Westlawn.
Parker Earle.	Jumbo.	
Pearl.	Lady Rusk.	
Stayman's No. 1.	Leader.	
Summit.	Lida.	
Warfield.	Loudon.	
	Lovett.	
	Manchester.	
	Monarch.	
	Princess.	
	Puritan.	
	Shuster's Gem.	
	Seedling of Downing	
	Thompson.	
	Tippecanoe.	
	Wilson.	
	Wolverton.	
	Yale.	

We here have 16 varieties in which good qualities predominate, and which have been sufficiently tested to warrant recommending them for planting. Parker Earle—Warfield—and Edward's Favorite head the list for *both* home use and market. Crescent and Captain Jack are valuable particularly as market berries. For home use only we consider Louise as the best, with Belle of La-Crosse and Cumberland next.

The 28 varieties rated as medium are by no means condemned, but none of them have for this season shown productiveness and vigor sufficient to warrant an unqualified recommendation. Further trial is needed before judgment is passed upon them.

The varieties classed as poor, 11 in number, do not seem suited to our conditions. Most of them came to us highly recommended, and in some localities they undoubtedly do well, but their behavior here warrants the rating as poor.

The following 18 varieties are recent acquisitions whose fruiting qualities have yet to be tested.

Annie Laurie.	Hatfield.	Longworth Prolific.
Aroma.	Hersey.	Margaret.
Bisel.	Ivanhoe.	Murray.
Brandywine.	Jay Gould.	Phillips.
Brunette.	Jucunda Improved.	Rio.
Cyclone.	Lady Thompson.	Tennessee Prolific.

With a view to the production of new varieties some work in crossing has been attempted. Pollination was performed on 124 flowers, and from these were obtained 88 perfect fruits, and 21 imperfect fruits. As the result of these crosses we now have growing about 500 seedling plants. There are also 39 strong seedlings derived from crosses effected in the greenhouse during last winter.

#### Grasses.—

During the past six years plat culture of grasses and forage plants has each year received some attention. There have been tested about 150 native and introduced species. Some that are valued in certain portions of the world prove weedy and worthless here, while others are as plainly of value for either pasture or hay, or for both.

The extension of the Mechanical Engineering Building last spring made the removal of most of the old plats necessary. New plats to the number of 36 were added in which were sown seeds sent us for trial by the Division of Agrostology of the U. S. Department of Agriculture. Some of these had been previously grown, and some were new.

Through the courtesy of Mr. George H. West of Greeley we received late in the summer, small packets of seeds of 75 species from the house of A. Le Coq and Co. of Darmstadt, Germany. It is the intention to sow these in the spring.

Herbarium specimens of all species grown have been preserved, and about 50 species have been photographed to record peculiarities in habit of growth. The accumulated notes on these grasses will be brought together for presentation in bulletin form as soon as possible, but I desire to record here the notes on a few of the species that have been tried, with our estimate of their value.

#### *Eleusine coracana* Gærtn.—African Millet.

An annual grass native in India, Africa, and South America. In both India and Africa it is cultivated for forage and also for the seed, from which a flour is made that constitutes an important part of the food of the poorer classes. The plants are rather coarse in habit; the stems are flat, leaves ample, and the digitate, many-flowered spikes produce seed in abundance. Seed was sown May 2; the plants reached a height of 20 inches, were in bloom August 20, and ripe by September 15. Our first experience with this grass was in 1890 when small plats were grown, with, and without irrigation. It showed ability to resist drouth, and without water grew 12 inches high and produced seed. On the irrigated plat the plants were double the height with a corresponding increase in leaves. Plats grown in 1891 and 1892 from seed raised here showed a marked diminution in the size of the plants. The grass will not stand pasturing, and the bulk of forage produced does not commend it as a hay grass.

Two other species of this genus—*Eleusine Egyptica* and *Eleusine Barcinonense*, were grown, but neither developed economic qualities equal to the species *coracana*.

*Diplachne imbricata* (Thurb.) Scribner.

This is an annual native in New Mexico and Arizona. Stems numerous 6 to 18 inches long, a few of them ascending, but the greater number prostrate. Growth slow, the plants not coming on flower until September. It does not appear to be of any value.

*Festuca duriuscula* L. Hard Fescue.

Seeds of this grass sown last spring did not germinate, but as we have grown it in previous years it may be mentioned here. It is found in the parks and mountain meadows of the northern part of the State at altitudes of from 7,000 to 10,000 feet in company with the Sheep's Fescue—*Festuca ovina*, apparently native. It is distinguished from the Sheep's Fescue by its taller and more robust growth, and its more open panicle. Under plat cultivation it grows two feet high, and produces a thick mass of radical leaves; it is somewhat stoloniferous, and maintains its character as a "bunch grass." We regard it as valuable for pasture.

*Muhlenbergia glomerata* Trin.—Spiked Muhlenbergia.

This grass is a native of Colorado. It is common in moist meadows, along streams, and on ditch banks. In some localities it forms a considerable portion of the hay from native meadows. The stems are erect, about two feet high, very leafy. During this season, and in previous seasons, as grown on the station plats it has shown the qualities of a good hay grass, and the commonly expressed opinion that it is valuable seems fully confirmed.

*Muhlenbergia sylvatica* Torr. Wood Muhlenbergia.

This grass is also a native, but less common than the preceding and inhabiting drier situations. It is slender, rather diffuse, about 20 inches high, yielding a small amount of forage, and is apparently of little value.

*Panicum miliaceum* L. Common Millet.

A coarse, leafy grass two feet high. It grows rapidly and ripens early. It makes an excellent green food for cattle, and for this use should be cut when the plants are in bloom. When over-ripe the stems become hard and are of little value. It is of Asiatic origin and was anciently cultivated for the seeds which served as an article of food.

*Panicum Texanum* Vasey. Texas Millet or Colorado Grass.

This is an annual, native in Texas where it is prized as a hay grass. As grown here the stems are from 8 to 20 inches long, decumbent, rising only a few inches above the ground. The leaves are short, broad, and very abundant. It promises nothing as a hay grass, but being strongly resistant to drouth may be valuable in pasture mixtures. It produces an abundance of seeds, and will doubtless prove persistent by self-seeding when once established.

*Panicum Crus-galli* L. Barnyard grass.

A very coarse annual introduced from Europe and widely distributed. Under plat culture it makes a strong growth two feet high. While it is grown in the south to some extent as a hay grass we look upon it here as a weed. It is not uncommon on ditch banks and in waste places.

*Eragrostis Abyssinica* Schrad. "Teff." "Hay Grass."

This grass was introduced from Abyssinia by the U. S. Department of Agriculture several years ago and distributed for trial. Reports of its behavior have been favorable. It has been grown on the station plats for two seasons, and we rank it as one of the best introduced grasses. It grows about 2½ feet high and produces an abundance of very long leaves. It is an annual and must be sown each year, but its erect habit and the large amount of forage produced recommend it as worthy of more extended trial on larger areas.

*Andropogon nutans* L. Bushy Blue Stem. Wood Grass.

A native perennial not uncommon in the natural meadows of the lower mountains, and along the streams on the plains. It is nutritious and acceptable to stock if cut before the stems ripen and become hard. We have sown the grass twice in previous seasons, but in both cases the seed failed to germinate. This season an even stand was secured. The growth was slow, and mainly confined to the production of radical leaves no flowering stems were formed. Late in the season the tendency to tiller was marked, and as the root systems are ample the plants seem prepared to make a strong growth next season. From observations on the wild plants I conclude that the species would not be a profitable one to sow alone, but at an ingredient of a mixture for moist meadows I think it has value.

*Bromus unioloides* (Willd.) HBK. Schrader's Brome Grass.

This grass has been grown on the station plats for four seasons. It is an annual of rather coarse habit yielding a fair amount of forage. It starts late in the spring and at first grows slowly, later the growth is more rapid, reaching a height of two feet, and blooming the first week in July.

*Bromus inermis* Leyss. Hungarian Brome Grass. Awnless Brome Grass.

Of all the introduced grasses grown on the station plats during the last five years this is the most promising. It is a strong growing perennial, but is finer, and has less of the rank weedy character than any other species of the genus that we have tried. It is among the first to start in the spring, and is the last to lose its green color in the fall. Extreme winter temperatures have no injurious effect, and it stands drouth remarkably well.

The flowering culms have an average height of 2½ feet, and the mass of leaves is about two feet high. The two features that most highly commend the grass are, its strong tillering power, and the abundance of the very

long leaves. While yielding a fair amount of hay, the qualities mentioned recommend it most strongly as a grass for permanent pastures. It is very persistent because of the abundant production of long underground stems, and this might make it objectionable when sown upon land used for rotation. The grass has been tried in many places and is generally regarded with favor.

Two species of Perennial Rye Grass—*Lolium perenne* L. and *Lolium Italicum* A. Br., both introduced from Europe, have been grown for several years. Both develop good qualities as pasture grasses.

In England they are valued as hay grasses, but their habit here does not indicate a sufficient crop to be profitable. They cover the ground with a thick mat of leaves, and recover quickly after mowing or grazing. Both start early and remain green until late, and we believe they could be used to advantage in pasture mixtures.

The genus *Poa* has been represented on the plats by several species, all natives of Colorado, and their behavior deserves mention. They are all fine, slender stemmed grasses, not so well adapted for hay as for pasture. The species making the strongest growth is the well known June Grass, or Kentucky Blue Grass—*Poa pratensis*—which covers the plat thickly with a leafy growth. It spreads by underground stems and is thus able to maintain itself even under adverse conditions. Its value as a pasture grass is recognized everywhere, and as a lawn grass it has no superior.

*Poa serotina* Ehrh. Fowl Meadow-Grass.

This is found along streams, and in moist native meadows. It is distinctively a moist land grass, and under plat culture quickly shows the effect of drouth. It produces no underground stems and unless in soil continually moist will soon be superseded by other grasses.

*Poa tenuifolia* Nutt.

Very common in the foothills and lower mountains. It does not form a sod, but grows in bunches, constituting a considerable portion of the forage on mountain

ranges. The leaves are usually short, and the stems slender and it seems to offer nothing of value under cultivation.

*Poa nemoralis* L. Wood Meadow-grass.

This species inhabits moist, and particularly shady spots along streams. It is very delicate in appearance, and on our plat grew to a height of from 12 to 15 inches, but does not produce forage enough.

The other species of *Poa* grown on the station plats were, *Poa arida* Vasey, *Poa alpina* L., *Poa lævis* Vasey, *Poa reflexa* V. & S., and *Poa cuspidata* Nutt; all of which are too small and delicate to be regarded as valuable for cultivation.

Of other native grasses grown I will here mention but one: the Rough Fescue, also called "Montana Bunch Grass," *Festuca scabrella* Torr. This is a mountain grass common at altitudes of from 8,000 to 10,000 feet.

It forms large bunches, often a foot in diameter, which commonly die at the center. Few stems are produced, but the long radical leaves are abundant, and are much relished by both horses and cattle. Under plat culture it grew vigorously, fully maintaining the characters developed in its native home. It does not stand drouth well, but in favorable locations would be a valuable addition to the pasture grasses. The main difficulty would be in obtaining seed sufficient for a start, as the plants produce it very sparingly.

Herbarium.

Very little time has been available for prosecuting the work of collecting. The most extended trip of the season was one of ten days' duration to the foot of the main range directly west of Fort Collins. About 3,000 specimens were secured on this trip.

Later in the season I spent one day at Golden, one in the suburbs of Denver, one at Palmer Lake, and three at Cimmaron and on Marshall Pass. This last trip was a disappointment owing to the extreme drouth prevail-

ing on the western slope. I intend distributing, during the winter, a list of our duplicates, and invite exchanges; hoping in this manner to increase our collection.

I have received for determination during the season 113 species; these have come from all parts of the State, many of them were weeds, and grasses about which the senders desired information. Often the specimens sent are fragmentary, and these in some cases require hours of time for satisfactory determination.

The letters of inquiry received are numerous. They embrace a wide range of subjects both horticultural and botanical. Attention to this correspondence occupies no inconsiderable portion of my time.

Respectfully submitted,

CHAS. S. CRANDALL,

*Botanist and Horticulturist.*

Fort Collins, Colorado,

November 30, 1896.

## REPORT

OF THE

### CHEMICAL SECTION.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—The force employed on station work is practically one man. The class work leaves no available time during the school year for the professor to devote to station work. The only way that I can devote myself to station work during the year is to place my assistant in charge of the classes.

During the year we have completed the work of our bulletin on Alfalfa, which is now in press. The material for another bulletin, on Alfalfa Hay, is nearly ready and we hope to have this prepared for publication within a few months.

We have undertaken a study of the artesian and river waters of the San Luis Valley. This work is in connection with the survey of the Valley being made by Professor Carpenter, of the Department of Engineering. This is merely a beginning of the work which I have suggested in two of my annual reports as desirable. I am of the opinion now, as I have been, that a study of the chemistry of irrigation would be acceptable and valuable. The work involved in such a study is large in amount, somewhat expensive in its nature, and requires attention.

We have found it impracticable to begin our study of the alkalization of the soil as planned. This work,

however, is simply put off because of the other work and has not been abandoned.

I was sent to Fruita, in June of this year, to examine into the alkalization of the soil which is taking place rapidly in the surrounding country. In this case the alkalization was, I believe, largely due to abundant irrigation, continued for several years, together with inadequate drainage. This case was worthy of study in detail. If systematic observations could have been made during the past few years, four or five, and complete records kept of them the information which they would have afforded would be of great interest to those engaged in the study of the soil. The people there have made some observations but they are mostly confined to the effects produced without due attention to their causes, their rate, or manner of action.

The Professor of Agriculture, W. W. Cooke, and myself were delegated to attend the Fair held at Glenwood Springs to select samples of sugar beets exhibited by contestants in accordance with the terms previously made known by the Association. I subsequently determined the sugar in these samples and furnished the proper persons a statement of the results. The object had in view was to learn, in this way, the probabilities of their being able successfully to cultivate the sugar beet in their soil, and under their climatic conditions, for the production of sugar. We were deterred from visiting the places where the beets had been grown by a severe storm which washed out the roads and bridges and otherwise seriously interfered with our work.

The beets which had not been washed, showed that they had been grown in widely differing soils. Some had been grown in rich, black, valley soils such as are frequently met with in our mountain valleys; others in clayey soils, etc. As it was a competition between the ranchmen of these three counties, Garfield, Eagle, and Pitkin, some had brought large beets, others small ones; and, while each one had taken his sample with the best intention, the lack of uniformity in selecting the samples and the probability that they were not average samples

detract greatly from the results obtained. Another point seemed to be indicated by the growth of the beets, i. e., that the soil had either been very rich or had been heavily manured before being sown to beets. The results of our sugar determinations showed that the percentage of sugar in the beets varied from nine to nearly fifteen per cent. The coefficient of purity varied greatly, relatively more than the sugar content. The highest coefficient of purity obtained was 86. The beets showing this coefficient contained the highest percentage of sugar and were, as a lot, the smallest beets exhibited. We examined fifteen samples, representing two varieties.

When we consider that the competitors in this test had had no previous experience in growing this crop for sugar, the danger of their having chosen an unfavorable soil for their experiment, the probabilities of improper cultivation, and the difficulty in selecting a representative sample, we consider the results as very encouraging.

The Station has, as usual, received some applications for gratuitous work. I try, in such cases, to comply with the requests, especially if the results are of real value and the work is really for the public. As before stated, we have more work on hand than we can get done, and work of this character interferes with us much more than the importance of the work can justify.

Respectfully submitted,

WM. P. HEADDEN,

*Chemist.*

Fort Collins, Colorado,

December 3, 1896.



REPORT  
OF THE  
ENTOMOLOGICAL SECTION.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—I have the honor to submit the following report from the Entomological Section of the Experiment Station for the year 1896.

The year has not been marked by any extraordinary outbreaks of injurious insects, but heavy losses have been sustained from the attacks of some of our common and ever-present pests. The west is noted for its hordes of grasshoppers, and I have no doubt that they occasion greater loss to the agricultural population of the State each year than any other insect enemy, not excepting the Codling Moth; but the cultivators of the soil have become so accustomed to giving the tithe of all they raise to these marauders that they think little of it and in most cases make no effort to destroy them. It was gratifying to learn that in those localities where the grasshopper disease was most prevalent last year there were comparatively few grasshoppers the past summer. Grasshoppers dying of the disease have been seen in numerous localities of the State the past summer and fall but there has not been the amount of rainfall and cloudy weather necessary to cause the rapid spread of the contagion.

The Leaf-rollers that have been so destructive to the foliage of fruit and box-elder trees in the northern

portion of the State for a number of years past were decidedly less destructive the past summer than in 1895, and they were less destructive in 1895 than in the year preceding. This decrease of injuries from these pests seems to be the direct result of a more extensive use of the arsenical poisons as there are very few parasites preying upon them. I should say, however, in justice to the birds, that they are becoming a very valuable aid in this work, and especially have I noticed flocks of blackbirds alighting in the trees and feeding upon the worms which they pick from the leaf-rolls.

The Flat-headed Borer in apple trees and one of the Cossid Borers in cottonwood trees seem to be increasing in numbers, the former more particularly in the orchards west of the range, and the latter in towns on the eastern slope.

The San Jose Scale (*Aspidiotus perniciosus*) does not occur in the State so far as I am able to determine and those who are purchasing fruit trees from nurseries outside of Colorado should take special precautions to avoid importing this, or other pests, on nursery stock.

The Codling Moth (*Carpocapsa pomonella*) has, at last, worked its way into every part of the State where apples are grown. It is a comparatively rare insect as yet in Delta county, especially in the North Fork districts. The use of arsenical sprays and the practice of bandaging the trees to catch the larvæ should be persistently kept up wherever apples are grown.

The Brown or Clover Mite (*Bryobia pratensis*) continues to be a serious pest on pear or apple trees in the mountain districts. Experiments that I carried on for the destruction of this insect the past season have shown that the eggs, which are laid in enormous numbers about the crotches of the branches and to a less extent all along the branches and twigs, can be easily destroyed during the winter, when the leaves are off, by applying kerosene emulsion in about twice the ordinary strength. The same application will also kill the mites after they hatch, but it is much more economical and easy to kill the eggs before the leaves are out in the spring.

Two serious insect pests, brought to the State from the east, have been reported to the station for the first time the past summer. One of these, the Apple Maggot (*Rhagoletis pomonella*) was taken by myself at Colorado Springs in August. This pest has been introduced without doubt, in infected apples from the east. Superintendent Blinn, of the Arkansas Valley Station, sent me the past summer a number of specimens of the Striped Cucumber Beetle (*Diabrotica vittata*) which he said was becoming quite abundant on melon vines. I also saw a few specimens of the beetle at Canon City last August.

#### ORCHARD INSPECTION.

On the 16th of last August I started on a brief tour of orchard inspection, going first to Grand Junction and making short stops at Delta, Hotchkiss, Paonia, and Canon City on the return trip. At Grand Junction, I was greatly assisted by B. C. Oyler, County Fruit Inspector, who kindly took me to some of the older orchards in that vicinity. I found a very large portion of the apples wormy. The crop being very light this year, the owners of the orchards thought it hardly worth their while to spray the trees and the worms, that would ordinarily be distributed through a large crop of fruit, were concentrated on the few apples that grew. It is a great mistake not to spray the light crops. By thoroughly treating these the heavy crops that follow would be almost free from infection.

Red Spider (*Tetranychus sp.*) was found quite abundant on plum, apple, willow, and currant. In some cases the currant bushes had dropped nearly all their leaves and, apparently, as the result of the attack of the spiders.

The Brown or Clover Mite (*Bryobia pratensis*) was abundant enough to be decidedly injurious to certain pear, cherry, plum, and apple trees as was evidenced by the bleaching of the foliage.

Pear Leaf-blisters, also the work of a small mite (*Prytoptus pyri*) was noticed on a few trees, but not abundant enough to do serious harm.

Cottonwoods about town were bored to a moderate extent by some insect, but they were not suffering nearly so much as they are in several places on the east of the range. Peach and plum foliage gave evidence of having been infested earlier in the summer by plant lice, but were nearly free of these pests at the time of my visit. Peach and apricot trees and grape vines were particularly free from insect injuries.

At Delta, the fruit crop was also light and consequently the injuries of the Codling Moth were showing more than in any previous year; but wormy apples were comparatively scarce, as this insect has not yet become abundant in the orchards of Delta county.

In the vicinity of Delta the conditions of the Red Spider, Clover Mite, and Pear Leaf-blister were almost identical with those at Grand Junction. While visiting the farm of Mr. W. H. Hastings, it was noticed that the foliage of the garden beans was all turning white and many of the plants dying; an examination showed the injury to be due to the attack of Red Spider. Peas and Prickly Lettuce were also in a similar condition only worse. The injury to these plants was due to the presence of enormous numbers of a little black and white Thrip (*Colcothrips 3-fasciata?*) which was in all stages of development upon the leaves.

The Cabbage Worm (*Pieris rapae*) and the Cabbage Louse (*Aphis brassicae*) were also found common upon cabbages.

Box-elder trees in the vicinity of Delta were infested by a very small leaf-roller which skeletonized the leaves, folded them, and then spun small white silken cocoons in the leaf-folds.

At Hotchkiss and Paonia, I was greatly assisted in my work by Mr. J. B. McGinty, Fruit Inspector for Delta county, who spent two days with me, taking me into many orchards in the vicinity. Delta county is fortunate in having so enthusiastic and well-informed a person as Mr. McGinty as inspector. This North Fork country may, indeed, be called a fruit-grower's paradise, as far as any trouble from insect pests is concerned. I was

in two orchards where wormy apples were found in small numbers. I was told that this year was the first that a wormy apple had been found in that part of the country. Red Spiders and the Clover Mite were found in small numbers only. The Rose Leaf-hopper (*Typhlocyba rosæ*) was rather abundant on apple trees in one or two orchards, but it could hardly be said that it was in injurious numbers. A single specimen of the Buffalo Tree-hopper (*Ceresa bubalus*) was taken near Paonia from an apple tree and was the only specimen seen.

At Canon City, Howard's Scale (*Aspidiotus howardi*) was found very abundant, and doing considerable injury in the little plum orchard where it was first found, but it seems not to be spreading badly to other orchards. Wormy apples here were extremely abundant. I scarcely ever saw more apples falling as the result of the attack of the Codling Moth. I believe the reason for the large number of wormy apples to be the neglect to attend properly to spraying, which a number of the orchardists think does not pay. Red Spiders and Clover Mites, though common in the orchards about Canon City, seem not to have done serious harm the past season.

Acknowledgments are due to the officers of the Denver and Rio Grande, and the Denver and Gulf railroads for their kindness in furnishing free transportation for the above trip which, otherwise, could not have been made.

All of which is very respectfully submitted,

C. P. GILLETTE,

*Entomologist.*

Fort Collins, Colorado,

December 7, 1896.



REPORT  
OF THE  
SECTION OF METEOROLOGY AND  
IRRIGATION ENGINEERING.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—The work of this Section of the Experiment Station has been conducted on the lines of investigation approved by you. In Meteorology the investigations bearing upon Agriculture and of value in throwing light upon the questions of irrigation have been the special objects of record. This in itself is a work which requires conscientious care in the observer, and unremitting attention from first to last in the careful record of the observations. The accumulation of these exact data is of primary importance in the study of the climate of the Station, and ascertaining the conditions which affect the practice of the agriculturist and the growth of crops. Only with a number of years' observation can safe deductions be drawn. The labor of reduction of the large number of observations is great, but as it is establishing a fund of exact facts which become increasingly valuable each year it is worth its cost. While definite conclusions can be drawn only from a series of years' records, the publications in the annual reports from year to year will give the public access to the data and make them useful to many. From the use made of the figures given

in the reports up to and including 1891, it would seem that they have been useful to many. The data are now extensive enough to warrant the reduction of some lines for the study of special questions.

Observations have been continued on the rise and fall of ground water, and an attempt to trace its connection with the change in water in neighboring canals; amount of loss by seepage, complementary to the investigations reported in Bulletin No. 33; the amount of water used on various crops; the changes in the flow of streams and the relation to the condition of the upper water shed; the amount of evaporation from water surface on lakes and confined areas, and simultaneous record of the wind for study in connection with it. These involve regular and exact observations which have been made principally by Mr. R. E. Trimble, whose care in every detail renders his work worthy of every recognition. Several self-recording instruments have been in use as hitherto. The driving in connection with the collection of these data and more especially in making the weekly rounds of the instruments, has amounted to over 1,600 miles. This has been done almost entirely by Mr. Trimble. An evaporation tank was placed in Lee's Lake during the summer, which, being on the road to other instruments, could be visited with little extra time. This was visited twice per week. On the same raft which served to protect the tank from the waves was arranged a rain gage. The information obtained from this series of observations promises to be more complete than that of past years where the curiosity of the small boy caused the loss of much of the value of the measurements. In this lake used the past summer, there is but one boat, and that a private one, so that the instrument has been under better control.

A nilometer was placed so as to record the rise and fall of ground water in a well near the sub-station near Monte Vista. The records in connection with the data of the flow of the neighboring ditches indicate an early response of the level of the ground water to the change of water in the ditches. The water rises and falls at

that place a number of feet during the year, and has risen some 12 or 13 feet since irrigation was commenced there some years ago. The record will be compared with other data from the Valley collected during the summer season.

There are now sufficient observations to warrant the labor for their reduction. This is if anything more laborious than the collection and recording of the observations themselves, in themselves no inconsiderable task. The only time when this can well be undertaken is during the college scholastic year, as with this Section, the summer season is the time when we can best carry forward the special investigations. But during the school year, with three to six hours with students in lectures and exercises, there is little time or freshness for fruitful original work. In consequence the data are ahead of the reductions and we have a number of subjects which warrant preparation into bulletin form. I hope to be able to arrange the afternoon so as to secure some portion of the day for developing our results.

In the summer a special investigation was begun in the San Luis Valley. This Valley on the Rio Grande in Colorado is the largest of the Rocky Mountain Parks, approximately 100 miles in length and 40 miles in width, with an area of 3,000 square-miles. It has many special questions arising from its peculiar conditions. Having been the bed of a lake, the surface is nearly level, slightly basin shaped, with alternate layers of sand and gravel extending to depths of over 1,000 feet in the axis. The artesian wells have been to some extent discussed in Bulletin No. 16. This investigation was planned to include the questions relating to irrigation and water supply, and especially studying the conditions of sub-irrigation of the Valley whereby the practice is to run water in the ditches without applying it to the surface of the land. The questions of the Valley have also raised international questions with Mexico, the latter country claiming that the irrigation in Colorado has interfered with the rights of her citizens. I visited the Valley in April, making arrangements with some observers for some observations and records, and obtaining the prom-

ise from some of the ditches of records of their discharges. At the close of the college year, I proceeded to the Valley. Mr. Stannard accompanied me, and made the measurements of the streams draining into the Valley, driving in that measurement about 1,000 miles. The key to many of the questions pertaining to the Valley was evidently at the lower end. On my first visit I found what I had suspected, though the maps were all wrong, that there was a short cut from the Conejos or the Pinos streams into the Rio Grande. In August, Dr. Headden and myself crossed from Antonito to Costilla, determining the important point that the water which escapes from the Valley must pass through the deep canon of the Rio Grande, whence the measurement of the stream in the canon includes that which is flowing from the Valley.

A nilometer was placed north of Monte Vista to determine the rise and fall of the ground water. There is an extreme change at that place in the height of the water, and the level responds quickly to the water in the neighboring canals. Mr. Duncan at the sub-station, attended to the instrument.

In measuring the seepage of the Rio Grande, aid was given by the superintendent of that Division, Mr. F. J. Anderson, the Water Commissioner, without whose aid it would have been difficult to find the heads of the ditches which were to be measured.

The investigation indicates greater results than I anticipated in recommending it for a subject of investigation. The Valley being one of magnificent distances, the traveling required exceeded my anticipations. Mr. Stannard, as already mentioned, drove over 1,000 miles, and I drove perhaps 700 in the aggregate. Another summer will be required to work forward to the best results.

Data were obtained from the railroad company and the extensive surveys of the canal companies; by connecting the two lines we were in possession of the levels of a large part of the Valley.

The seepage measurements of the Poudre were taken this fall by Mr. Trimble, aided by Mr. Hawley. The

measurement of the Platte from the mouth of the Poudre to beyond Sterling, not far from the state line, was also made. A storm prevented their going to the state line. Mr. Preston of the State Engineer's office, a graduate from the College in 1892, and Messrs. Hawley and H. A. Calkins, also College graduates, aided. The results show less inflow than last year, the year having been a dry one, less rain having been received and less water applied to the land.

I wish to acknowledge the aid furnished us by numerous persons where we have had occasion to obtain data. Many of them have put themselves to much trouble, have voluntarily accompanied us in some cases for a number of days, and have aided the work in every way in their power, and to the material saving of expense. Were the labor represented in the investigations all to be paid for, the expense would be beyond the sum that has ever been available.

To Frank Trumbull, Esq., of the U. Pac., Denver & Gulf, and Col. S. K. Hooper, of the Denver & Rio Grande we are indebted for the aid on their respective roads.

To P. J. Preston, H. A. Calkins, and R. W. Hawley we are indebted for volunteer service without compensation; the latter two aiding us by two weeks of time accompanied with considerable discomfort in camping in freezing weather. The officers of the Farmers' Ditch Company, in the San Luis Valley, Supt. F. T. Anderson, J. C. Ulrich, Mr. Warburton, of Monte Vista, and many others rendered aid.

Messrs. Lamb, Barnes, Boothroyd, and Mrs. Sherwood have furnished us observations regularly from their special localities; as well as have the superintendents of the various sub-stations. Mr. Horace McClelland has taken continuous interest in the record begun on his place some years ago of the amount of water applied to crops.

Thanking the Committee for their support, this report is  
Respectfully submitted,

L. G. CARPENTER.

Fort Collins, Colorado.

December 9, 1896.



REPORT  
OF THE  
SAN LUIS VALLEY EXPERIMENT  
STATION.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—I submit herewith the Ninth Annual Report of this Station. On account of no appropriation being made for 1896, only a limited number of experiments have been conducted. The schedule as adopted by the Station Council has been followed as closely as possible.

The general conditions of the past season have not been favorable for good results. During the spring and early summer the indications were all favorable for a good yield of grain and other produce, but during the latter part of the season the water supply was shut off and much damage resulted from drouth.

EXPERIMENTS WITH WHEAT ON SPRING PLOWING.

Two plats of wheat were sown, April 4, to determine whether the stubble in the soil had any effect on the growing crop. Wheat sown on spring plowing is generally a failure in the Valley. Most farmers are of the opinion that the cause is due to the stubble in the soil, keeping it in a loose condition so that it is easily dried out and that on that account grain sowed on spring plowed land suffered for moisture. This theory ought

not to hold good in the case of sub-irrigated land as an abundance of moisture is always furnished to growing plants as long as the ground remains sub-irrigated.

Plat No. 1 was sown on ground which had been plowed deep, the stubble remaining in the soil. After sowing the ground was thoroughly packed by rolling. The yield was fifteen bushels per acre.

Plat No. 2 was sown after the stubble had been burned and the ground plowed shallow. The yield on this plat was the same as on No. 1. During the growing season little or no difference was noticed in the condition of the grain. Both these plats sub-irrigated and compared favorably in results with summer fallowing or fall plowing. In other sections of the State, wheat on spring plowed land generally yielded from three to five bushels less per acre than on either summer fallowing or fall plowing. Wheat sowed on summer fallowing on the station farm yielded 18 bushels per acre.

The difficulty with spring plowing in the Valley seems to be that the stubble interferes with drilling and the seed is not put in the soil deep enough to prevent its being blown out during the spring when high winds prevail. On summer fallowing or fall plowing, the stubble has decayed and does not interfere with deep sowing. Neither of the above plats were injured by the wind in the spring, hence the comparatively fair yield.

A plat of oats was sown, April 25, on ground which had been irrigated and then plowed. The yield was ten bushels per acre. The low yield can be attributed more to the lack of moisture during the latter part of the season than to any other cause.

No results were obtained in the experiments with early potatoes owing to lack of water at the proper time for irrigation. The grass plats sown last spring were also destroyed by drouth. The plats sown last year were all winter-killed with the exception of *Bromus inermis* and timothy. Both these plats came through the winter in good condition and were not destroyed by the drouth.

Young alfalfa was also badly winter-killed. Little difference could be determined in the plats which were sown April 1, May 1, May 15, and June 1 of last year.

Respectfully submitted,

CHAS. A. DUNCAN,

*Superintendent.*

Monte Vista, Colorado,

November 7, 1896.



REPORT  
OF THE  
ARKANSAS VALLEY EXPERIMENT  
STATION.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—I take pleasure in submitting to you the Ninth Annual Report of the Arkansas Valley Experiment Station.

Owing to the change made by the Board in leasing a portion of the station property, and confining the experiments to eighty acres, a large amount of work was made necessary in platting and leveling and in changing and constructing drives, ditches, and fences. The schedule of experimental work has been closely adhered to in every instance where practicable. While the extra work prevented the carrying out of a part of the plans, the efforts of the season have placed the Station in better condition. The work can now be concentrated, close notes can be kept, and more accurate results, at less expense, can be secured.

IMPROVEMENTS.

The irrigation system for the land leased and that for the station were made separate. The headgate for the eighty acres was moved, thereby drawing the water from the Rocky Ford ditch where it first enters the first

forty acres; thence it is distributed by laterals over that area and conducted to the east forty acres by a newly constructed siphon under the public road which separates the two tracts. The water for the leased land was drawn from one headgate located at the upper corner of the rented field. This avoided dividing water between the station and leased land.

Twelve acres of alfalfa land were broken for experiment plats. The remaining portion of old grain land on the east forty acres was seeded to clover and grasses for field tests and rotation. About a tenth of the area was designed for a permanent pasture. The plats were all planned with convenient ditches and drives and the cross fences were transferred so that the eighty acres used for the Station would be enclosed to itself.

Decided improvements were made in the west field by changing and grading some of the ditches and drives. Bridges and culverts were placed where the laterals crossed the drives; a 14-foot bridge was built over the Rocky Ford ditch; four large dividing gates for distributing water in the laterals were made from lumber obtained in moving and remodeling the old hot house; the old orchard was pruned and a large amount of grading and leveling was done therein and on portions of the fields that were difficult to irrigate; about six acres of orchard and small fruit, for a variety test, were added; the lawn around the station cottage was improved; and trees and ornamental shrubs were set out on the grounds. The building of a shelter for the thermometers and the addition of a standard rain gauge improved the equipment for the weather service. Pig pens were built and some minor improvements made.

#### CLIMATIC CONDITIONS.

The season has been an exceptionally dry one. The water supply in the river was extremely short, at times hardly sufficient for domestic use. The spring was dry and there were many hard winds that dried out the ground as often as it was irrigated, making it difficult to keep it wet enough for new grass plats to start. The

highest temperature was reached in June, 101 degrees F. The average daily maximums of June, July, and August were 87 degrees, 90 degrees, and 90 degrees respectively. The rainfall was 8.36 inches as follows: March, .23 in., April, .55 in., May, 1.12 in., June, .47 in., July, 2.07 in., August, .47 in., September, 1.85 in., and October, 1.60 in. A late frost and high winds in the spring nearly destroyed the apple crop in this vicinity. The first light frost occurred September 28; the first killing frost, October 12. Where water could be had, the season was favorable to the growth of all crops. Alfalfa seed yielded heavily, corn did well, and melons and cantaloupes were produced abundantly.

#### INSECTS.

All the unfamiliar species of injurious insects discovered working on crops were sent to the Department of Entomology of the College for determination. The insects injurious to crops are the Codling moth; red spider, on raspberries; tomato worm; grasshoppers; cucumber beetles, on cantaloupes; and cabbage worms and lice on the cabbage plants. Grape-leaf hopper and the larvæ of the eight-spotted alypia were bad on some vineyards. Potato beetles and the potato stem borers did serious work on some of the patches in this vicinity. There were many other insects. With the aid of the sprayer and insecticides the Station suffered little loss from insects.

#### AGRICULTURAL DIVISION.

##### *Cereals:*

Three adjacent plats were prepared for a comparative test of the cost of producing barley, corn, and wheat. The previous year the land had grown a crop of corn and wheat of which each plat contained about an equal area and received the same relative attention. The estimate in these accounts is based on the material used and the labor involved in producing each crop, reckoned at the market value and the regular price of labor—one man, \$1.50 per day; a man and team, \$2.25 per day. To avoid an uninteresting tabulation of items an epitome of the notes will be given.

*Wheat*—Four and one-third acres were sown to Amethyst wheat, April 2, with a press drill, at the rate of seventy pounds per acre. The wheat came up well, and made a splendid growth. The ground received four irrigations, and the grain was harvested July 9, with a yield of  $33\frac{1}{4}$  bushels per acre. The expense of the crop was \$29.22, or  $21\frac{1}{2}$  cents per bushel.

*Barley*—The plat for the barley contained  $5\frac{1}{2}$  acres. It was sown in the same manner and it received the same cultivation and care as did the wheat. The growth was short, which made it difficult to bind. When threshed, it gave a yield of 40 bushels per acre. The expense was \$38.05, or 17 cents per bushel.

*Corn*—The plat of corn grew under less favorable conditions than the wheat and barley. It was planted May 15, but, owing to the uneven condition of the ground, it made a very irregular stand. It received one cultivation and two irrigations. The yield was 25 bushels per acre. The expense, for the  $4\frac{1}{3}$  acres was \$22.25, or 21 cents per bushel.

The following test of corn on alfalfa sod will make a more correct comparison with the wheat and barley.

*Corn on alfalfa sod*—A four-acre plat was planted, May 12, to corn. The alfalfa had been plowed and cross plowed in the spring. The stand of corn was excellent. It had two cultivations and as many irrigations. When gathered, the yield amounted to 39 bushels per acre. The expense on the plat was \$30.50, or  $19\frac{1}{4}$  cents per bushel.

The yield on this plat was estimated by gathering a portion of the corn.

*Test of varieties of corn*—Four kinds were received from different seed houses; Hickory King, Golden Triumph, Waterloo, Early Dent, and Golden Beauty. Golden beauty is the only one deserving mention. It is of a very beautiful yellow variety. In small plat test, it indicated a yield at the rate of 77 bushels per acre. The other varieties were badly mixed and are not so good as many common varieties in use.

*Test of varieties, wheat and other grains*—Three small plats were sown to India No. 3 and Royal wheat, and

smooth, Hulless barley. They did well for exhibition purposes. The main experiment on the test of varieties began October 1. Thirty varieties were sown, all of which have made a good start. The results will be reported in the next annual report.

#### GRASS AND HAY CROPS.

*Red Clover*—Two attempts were made to start a 2½ acre plat. The first was sown May 12, but dry, hot winds caused a failure. On July 1, the piece was reseeded with 14 pounds of seed per acre. It received four irrigations up to October 1. The plat gives evidence of a good permanent stand.

*Crimson Clover*—This plat was left until the first of July, when it was irrigated and the weeds plowed under. The ground was leveled and, July 15, 2¾ acres were sown to crimson clover, with a press drill, at the rate of 14 pounds per acre. It received the same care as the red clover; yet the stand, over a part of the plat, is very poor. The portion that has a fair stand, gives promise of an interesting test the coming year. As the conditions were unfavorable, the test of crimson clover in the old orchard was omitted this year.

*Alfalfa*—All the alfalfa hay land (forty-five acres) was handled by the renter. The hay was put up in good shape. The yield was four tons per acre, including three crops.

*New Seeding*—Two acres adjacent to the crimson clover were sown at the same time, and received the same attention, and made a most excellent stand of alfalfa. The remainder of the old grain land, about four acres, was seeded to alfalfa. The stand is so poor that it will be necessary to reseed in the spring. The alfalfa seed was put in so late that no grain crops were sown with any of it.

*Pasture*—The three-acre field of *Bromus inermis* has been used as a cow pasture. It had six irrigations. The plat of red clover was used as horse pasture. It required six irrigations to keep it growing.

Seven acres of old grain land were prepared for an addition to the pasture land. It was sown to timothy

and orchard grass, the last of July, but, owing to lack of water, it will require reseeding in the spring. The plat tests of pasture grasses gave no satisfactory results, owing to lack of water at the proper time.

*Irrigation*—There was no difference in the number of irrigations applied to the new seeding of clover and alfalfa. Another year's observations will offer better opportunity to decide that test. Owing to the varying character of the water supply in the ditch, the measurement of water applied to different crops was almost impossible. A self-registering instrument is needed.

The effects of irrigation applied at morning, noon, and night, were noted on a plat of garden peas. Only two applications were made, and rain intervened so that there was no perceptible difference in the three portions of the plat.

#### GARDEN DIVISION.

The test of garden vegetables was confined to a few untried varieties. The following test was chosen for exhibition purposes: hemp, broom corn, cotton, okra, ram's-horn bean, yard-long bean, devil's claw, chufas, serpent cucumber, and gourds. A few common vegetables, such as radishes, lettuce, cucumbers, peas, beans, and parsnips were grown.

*Hot beds*—For starting early plants an ordinary hot bed heated by stable manure was prepared. The bed was forty feet long and divided into three sections, for testing different kinds of covering. Section one was protected by window sash. Section two was covered with common muslin, each square-yard being treated with the following preparation: lime water, 2 oz. and linseed oil, 4 oz., mixed with a gentle heat. When cool, add two well beaten eggs. Apply with a brush and when dry give a second coat. Section three was covered with the plain muslin. Sections two and three had also board coverings that hinged at the upper side. During the day the board covers were hooked up so as to act as wind-breaks and to reflect the heat of the sun. At night, and on cold days, they were lowered to protect the beds. The board covers worked well. The best results were obtained from the glass covered section. The pre-

pared muslin gave better results than the plain muslin, as it seemed to hold heat and moisture better. The main hot-bed growths were cabbage and tomato plants. Some others, as peppers, cauliflowers, celery, and egg plants, were started; but owing to the seed, or to the soil in the hot bed, they were not a success.

*Onions*—Two varieties, the Gigantic Gibraltar and Red Weathersfield, were tried. The former proved much the better for this soil and climate.

*Cabbage*—Burpee's World Beater was a failure; Extra Early Cabbage from Scotland, good, but small heads; Christmas Drumhead, nearly a failure; Lupton, good heads of excellent quality; Danish Ballhead, a good late cabbage for this section.

Cauliflower was a failure on account of grasshoppers and worms. Soja beans grew rank but failed to mature seed.

*Sweet Corn*—Sweet corn is invariably a failure on account of worms. Early Fordhook seemed a desirable corn, but was all destroyed by worms. The Evergreen was badly eaten. New-12-rowed-Early Sugar was a good early variety, but was injured badly by worms. Moore's Early Concord, so far as known, is the only variety to be relied upon here, as it is not badly injured by worms.

*Tomatoes*—Of ten varieties tested, Ignotum and Fordhook's First were superior. Lemon Blush proved an excellent yellow tomato.

*Sweet Potatoes*—These are grown in this section with decided success. A small plat was tried on the Station, but the plats were started too late fully to mature the crop.

*Peanuts*—A small plat of Spanish peanuts was grown with success. They require the same cultivation as the common garden pea. Adjacent to the peanuts was a small plat planted to chufas or earth almonds. They gave an excellent yield, indicating a profitable crop for hog feed.

*Celery*—Celery was grown fairly well, but the conditions for success have not yet been ascertained. The plants were started in a cold-frame and set out near the bottom of a furrow. They were banked up as they grew.

*Melons*—Five varieties of water melons were tested. Kleckley's Sweet was the only one that promised to be any improvement over the old reliable Swink melon. The Kleckley's Sweet is a plain, dark green, oblong melon, very solid, and of excellent quality.

*Muskmelons*—Of five kinds tried, none equaled the little Netted Gem cantaloupe. The Early Hackensack and Banquet are desirable table melons, but are not solid enough for shipping.

*Cantaloupes on alfalfa sod*—To test the cost of production of cantaloupes on alfalfa sod, a record was kept of the expense of labor for one acre. The ground was broken in March and cross plowed and leveled in April, May 1, the ground was furrowed into rows 6 feet apart. Water was run through the furrows, and, May 4, the seed was planted in hills 6 feet apart. A splendid stand of plants was secured. The plat was cultivated and hoed three times, and irrigated eight times. The yield was 350 marketable crates, (of 40 to 50 cantaloupes each). Expense on the plat was \$17.50—a cost of five cents per crate. It was impossible to estimate the cost of marketing these, as, a great part of the time, there was no market for small lots. The cantaloupes were fed to the hogs. The usual cost of marketing cantaloupes, including crates, is from 20 to 30 cents per crate. The average price received by those who shipped car-load lots, by freight, was about \$0.50 net.

*Sugar beets*—One-half acre of alfalfa sod was sown to sugar beets with the view of determining the cost of production. Owing to the lack of proper machinery, and experience in growing beets for profit, the estimate is undoubtedly higher than should be expected. The alfalfa ground was broken in March, cross plowed and leveled. The seed was sown with a press grain drill, (by closing a part of the holes) at the rate of 16 pounds per acre. The rows were 20 inches apart. The moisture in the ground was not sufficient to sprout the seed and, June 18, the plat was flooded. A rather irregular stand of plants was the result. They were hand hoed and cultivated twice, received four irrigations, the last one Sep-

tember 1. Up to the time of this report, they were not dug, but the cost of raising was \$14.50. On the average yield of sugar beets, at this Station in previous years, the cost, before digging, would not exceed \$2 per ton.

*Potatoes*—Four early varieties, planted on April 7, were complete failures. They made an excellent growth of vines, and received the best of care, but not a potato set on the vines. This failure was evidently due to some form of blight.

*Test of varieties*—Eighteen varieties of potatoes were received from the San Luis Valley Experiment Station to test their yielding qualities, and to ascertain a reliable yielding potato in this section of the State. The first plat was planted June 1, on alfalfa sod. It received the best of attention. The area of each kind was small and irregular, and the stand poor in some cases. Instead of estimating the rate of yield per acre, the ratio of the seed planted to the amount of marketable potatoes harvested, is given in the following table as an index to the relative merits of the varieties, as determined by this year's test:—

Variety.	Ratio.
Snow Flake.....	2.6
Yankee Notion.....	3.0
Dictator .....	7.4
Vick's Perfection.....	3.4
Ohio's Fancy.....	2.8
Barclay's Prolific.....	5.9
Early Beauty of Hebron.....	4.3
Strawberry .....	4.5
Plymouth Rock.....	6.2
Negro .....	8.1
Arizona .....	3.8
Sterling .....	0.3
Westminster .....	4.6
Burbank's Seedling.....	8.6
Blue Victor.....	6.5
Empire State.....	5.0
People's .....	10.0
Late Ohio.....	8.3

A duplicate plat of the above varieties, and two acres of Blue Victors and Late Ohios, for a field test, were planted on alfalfa sod, June 20. They made an excellent stand, were cultivated, hilled up, and irrigated twice during the summer; but the vines made a very slow growth until late in the fall, when frost stopped the growths that were forming. When harvested, most of the varieties and a large part of the field tests, did not return the seed planted.

The seasons vary as to the date that potatoes may be planted with prospect of maturity. In 1895, those planted on June 25 were ripe Nov. 1. By continuing these tests for a series of years, the proper dates of planting potatoes may be determined approximately.

#### HORTICULTURAL DIVISION.

*Orchard and small fruits*—The ground in the orchard was leveled. The trees stood the shock of a very severe pruning of dead and useless limbs. There was no difference in the effects of the summer and winter pruning. The trees made a good growth in each case. A large number of the varieties bloomed, but a late frost, and the high winds, destroyed all but a few sets on a few trees. No apples worthy of mention, matured. Blight occurred on several trees, but was destroyed as fast as it appeared. A number of orchards in this vicinity show signs of blight. Pears bloomed, but no sets formed.

The uneven condition of the soil in the orchard, would not allow the tests planned for green manuring. Peaches bloomed, but only about two dozen late peaches ripened. Blackberries and dewberries bore fairly well. The vineyard made a good growth of wood but bore very little fruit.

*Strawberries*—Two attempts to establish a plat of varieties were made. With few exceptions the efforts were unsuccessful, due to the condition of the plants when received, in one case, and in the other, to the intense heat at the time of setting out.

*New planting*—According to the schedule, the fruit trees and shrubbery, named in the following tables, were

planted. The apple trees were received from the Horticultural Department of the College. The remaining portion was ordered from eastern nurseries and were received, apparently, in good order. They were set out with care, and received the best of attention, and the failure, in many instances, to grow, was due to the long time the orders were en route.

PLUMS.		No. Set.	No. Alive.
Shippers' Pride.....	3	3	
Tatge .....	3	3	
Coe's Golden.....	3	3	
Yellow Egg.....	3	3	
Lombard .....	3	3	
Abundance .....	3	0	
Satsuma .....	3	3	
Burbank .....	3	1	
York State.....	3	0	
Downing Mulberry.....	2	0	
Celestial Fig.....	2	0	

APRICOT.

Chinese Apricot.....	2	2
Alexis .....	1	1
American .....	3	3
Gold Dust.....	2	2
Japanese Hubbard.....	2	2

PEACHES.

Bokara No. 3.....	5	1
Crosby .....	5	0
Sneed .....	3	0
Elberta .....	3	3

QUINCE.

Champion .....	2	1
Orange .....	2	2
Meech .....	2	0
Japan Columbia.....	2	2
Fuller .....	2	0

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PEARS.	No. Set.	No. Alive.
Japan Golden Russet.....	3	2
Lincoln Coreless.....	3	2
Koonce .....	3	2
Lincoln .....	3	1

## CHERRIES.

Louis Philippe.....	2	1
Black Tartarian.....	2	0
Napoleon Bigarreau.....	2	0
Dye House.....	2	0
Lutovka .....	2	2
Windsor .....	2	0
Olivet .....	2	2
Governor Woods.....	2	1

## APPLES.

Porter .....	3	3
Coffelt .....	3	3
Roman Stem.....	3	3
Hatchers .....	3	2
Colvert .....	3	3
Martha Washington.....	3	1
Benoni .....	4	4
Fink .....	3	3
Indian .....	3	2
Gideon's Best.....	3	3
Brightwater .....	3	3
Little Romanite.....	3	2
Buncombe .....	3	3
Blue Pearmain.....	3	3
Gravenstein .....	3	3
Garden Ball.....	3	3
White Winter Pearmain.....	3	3
Western Beauty.....	3	2
Sweet Bough.....	3	3
Bailey's Sweet.....	3	1
Plumb's Cider.....	3	3
Willow Twig.....	3	3
Seek-no-further .....	3	3
Lowell .....	3	3

	No. Set.	No. Alive.
Gano .....	3	3
Talman Sweet.....	3	3
Gideon .....	3	3
Big Romanite.....	3	3
Geneton .....	3	3
Minkler .....	3	1
Jonathan .....	3	3
Shockley .....	3	3
Early Colton.....	3	2
Alexander .....	3	3
Early Pennock.....	3	2
Shannon Pippin.....	3	3
English Golden Russet.....	3	3
Lissof Seedling.....	4	4
Large Striped Pearmain.....	3	0
Autumn Swaar.....	3	2
Twenty Ounce.....	3	0
Painted Lady.....	3	3
Red Astrachan.....	3	3
Lord Nelson.....	3	1
Autumn Strawberry.....	3	3
Buckingham .....	3	2
North Carolina Limbertwig.....	3	2
Gill's Beauty.....	3	3
St. Lawrence.....	3	0
Jones's Seedling.....	3	3
Nickajack .....	3	3
Red Winter Sweet.....	3	3
Summer Rose.....	3	1
White Bellflower.....	3	3
Early Strawberry.....	3	3
Beauty of Kent.....	3	2
Grindstone .....	3	2
Fall Pippin.....	3	3
Arkansas Beauty.....	3	2
Rambo .....	3	1
American Sumner Pearmain.....	3	2
Huntsman .....	3	3
Newton Pippin.....	3	1

	No. Set.	No. Alive.
Smokehouse .....	3	1
Vandevere Pippin.....	3	1
Summer Queen.....	3	3
Keswick .....	3	0
Crawford Pippin.....	3	3
Red Limbertwig.....	3	2
Domine .....	3	3
Gideon No. 20.....	3	3
Winter Greening.....	3	3
Cullasaga .....	3	3
Milam .....	3	3
Langford .....	3	3
Ohio Nonpareil.....	3	1

## NUT TREES.

Thin Shell Walnut.....	2	2
Unknown Walnut.....	2	2
Persian Walnut.....	6	6
Praeparturien Walnut.....	4	4
Japan Walnut.....	2	2
Chaberte Walnut.....	2	2
Chinquapin Nut.....	2	2
French Franquette.....	2	2
Kentish Cob Filbert.....	2	0
Cosford Thin Shell Filbert.....	2	0
Butternut .....	2	1
Shell Bark Hickory.....	2	0
Papershell Pecan.....	4	2
Japan Pedigree Chestnut.....	2	0
Spanish Chestnut.....	2	1
American Sweet Chestnut.....	5	0
Soft shell Almond.....	2	1
Hard shell Almond.....	2	0
Benabume .....	2	2
English Filbert.....	4	4

## BLACKBERRIES.

Eldorado .....	2	0
Erie .....	6	0
Minnewaski .....	6	0

	No. Set.	No. Alive.
Taylor .....	6	0
Snyder .....	6	0
Kittating .....	6	1
Stone's Hardy.....	12	0

GOOSEBERRIES.

Pearl Gooseberry.....	2	0
Keepsake .....	2	0
Lancashire Lad.....	2	1
Chautauqua .....	2	1
Golden Prolific.....	2	0
Spineless .....	4	3
Industry .....	4	0
Downing .....	10	1

ORNAMENTAL TREES AND SHRUBS.

American Linden.....	4	4
Kilmarrick Weeping Willow.....	2	2
Cut Leaf Weeping Birch.....	2	2
Snowball .....	4	4
Lilac .....	4	4
Hydrangea .....	2	2
Virginia Creeper.....	2	2
Honeysuckle .....	4	2

CURRENTS.

Red Cross Currant.....	1	0
La Versailles.....	2	2
Cherry Currant.....	2	2
White Grape Currant.....	2	2
Champion Black Currant.....	2	2
Lee's Prolific Currant.....	2	2
Victoria Currant.....	2	1
North Star Currant.....	2	2
Highbush Cranberry.....	2	0

RASPBERRIES.

Shaffer .....	4	1
Nemaha .....	6	6
Ohio .....	12	0
Miller .....	2	1

	No. Set.	No. Alive.
Loudon .....	2	0
Royal Church.....	6	2
Gregg .....	6	0
Palmer .....	12	0
Japan Wineberry.....	2	1

#### WIND-BREAK AND HEDGE TESTS

The setting of a wind-break around the orchard was omitted for lack of opportunity. Only two hedge rows were set, one of California Privet, and the other of June roses. These were set along the drive south of the Station cottage. The lawns were improved, enlarged, and kept well mowed and irrigated. A quantity of flower seed was used in starting beds to ornament the grounds around the station cottage.

Respectfully submitted,

**PHILO K. BLINN.**

*Superintendent.*

Rocky Ford, Colorado,  
November 16, 1896.

REPORT  
OF THE  
RAINBELT EXPERIMENT STATION.

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*To the Executive Committee of The State Board of Agriculture:*

Gentlemen—I herewith present the Third Annual Report of the Rainbelt Experiment Station.

When I took charge, April 1, I found the farm in good condition. No crops had been planted, or had any land been prepared for planting. My having to find and buy the varieties of seed named in the schedule caused many of the crops to be planted quite late.

Severe hail storms which did much damage occurred May 30, and August 21. A light hailstorm, June 22, destroyed the cherry crop. Dust storms, May 5 and 6, cut off all small grain which was unprotected. Hot winds in August damaged crops badly. Below is a table which may give some idea of the weather during the growing season.

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MONTH	Max Temp.	Mean Max. Temp.	Min. Temp.	Mean Min. Temp.	Mean Temp.	Max. Daily Range	Mean Relative Humidity	Precipitation	No. of Rainy Days	Per Cent. of Cloudy Days	Prevailing Wind
April	85.4	69.8	10.5	35.5	52.0	52.8	60.8	3.4	4	32.0	S. E.
May	90.0	76.7	33.6	48.1	62.1	44.6	48.9	2.28	6	53.4	S. E.
June	98.0	87.4	42.4	54.1	70.8	47.8	53.8	3.03	8	41.0	S. E.
July	95.4	88.3	55.0	60.3	74.3	35.4	54.8	2.27	7	36.5	S. E.
August	101.3	88.8	41.0	59.9	74.3	44.6	57.3	3.07	2	36.0	S. E.
September	94.6	76.1	35.0	48.4	62.2	46.1	71.5	.84	3	57.0	S. E.
Total precipitation.....								14.90			

All hoed crops, and trees, were cultivated after each rain, and as often between rains as was necessary to insure the presence of a soil mulch. Culture ceased about the middle of July.

The heavy rain of May 30 packed the soil very hard in the lister furrows. A special harrow was made which was used to stir the crust thus formed in the furrows, and all listed crops were given one cultivation with this tool.

#### FARM CROPS.

*Corn*—Four acres each of Queen of the Field, White Australian, Colorado White, and White Kansas King were planted. Half of each variety was listed, and half planted across land stirred different depths. All were damaged so much by the hot winds in August that very little grain was produced. The effect of the different ways of preparing the land could not be seen. One-fourth of the White Australian was thinned to four feet apart in the row. This section grew to twice the height attained by the unthinned section, and did not succumb to the hot winds as soon as the thick corn.

May 26, one row fourteen rods long of each of the following varieties of corn was planted: Eclipse, Great Long White Flint, Will's Gehu 70-day, Improved Leaming, Pride of the North, Sanford's Early, New England Flint, Early Prairie King, Early Butler, Early Thompson, Queen of the Field, White Australian, White Kansas King, and Colorado White. A few ears were produced by Pride of the North. Every hill of Will's Gehu bore ears. The other varieties produced no seed.

#### SORGHUMS.

Two acres each of White Milo Maize, Egyptian Rice corn, and Red Kaffir corn, and one-half acre of White Kaffir corn were planted with a lister. None matured seed. The difference in growth on the various types of soil was visible throughout the season. There was ten times as much feed per acre on the heavy soil as on the light types of soil. The difference in moisture supply will not account for all the difference in growth, as heavy

soil in high places produced much better than the light soil beside it. Nearly all the land planted to the non-saccharine sorghums was of the lighter type, which accounts for the small yield. The different varieties produced as follows:—

White Milo maize, 2,200 pounds dry fodder per acre.

Egyptian Rice corn, 1,800 pounds dry fodder per acre.

Red Kaffir corn, 2,200 pounds dry fodder per acre.

White Kaffir corn, 2,000 pounds dry fodder per acre.

Two acres of Early Amber cane were planted May 28 upon plowed ground with a planter drill. It matured seed and was cut September 8, making a light yield of fodder.

May 26, rows 100 feet long were planted to varieties of sorghums. Early Amber cane, Kansas Orange cane, Fodder cane, Jerusalem corn, Large African millet, Brown Durra, Yellow Milo maize, White Kaffir corn, Red Kaffir corn, and Black Rice corn were tested. The seed was donated by Barteldes & Co., of Lawrence, Kansas. All except Black Rice corn gave a perfect stand. The Jerusalem corn and Brown Durra ripened seed, and were headed September 4. The Jerusalem corn yielded 1,416 pounds and the Brown Durra 2,950 pounds of dry heads per acre. Early Amber cane was ripe September 15. Yellow Milo maize and Black Rice corn were ripe September 20. The other varieties ripened but very little seed. No estimate was made of the yield of fodder, as the hail August 21 cut nearly all the fodder off, and the early varieties did not renew their foliage. But it was easily seen that the latter varieties produced the most fodder.

*Broom corn*—Two acres of each Missouri Evergreen, Tennessee Evergreen, and California Golden were planted. All were planted with a planter drill except one acre of California Golden, which was listed. The hot winds damaged it badly. The lay of the land and the kind of soil and subsoil seemed to influence the yield more than variety and difference in the preparation of the soil. In basins which caught the run-off water the plants flourished. Also on heavy, clay land the brush was worth cutting.

## SMALL GRAIN.

*Barley*—One acre of Highland Chief, one-half acre of Imperial Black Hulless, one-fourth acre of Mansury, and one-fourth acre of White Barley were sown April 20 on light hill soil. The dry weather in May destroyed nearly all of it. A part of the Imperial Black Hulless and Mansury was cut for hay.

*Oats*—One acre of Excelsior oats was sown April 7 and plowed in. April 21, one acre of Black Russian oats was sown. All were destroyed by the dust storms, May 5 and 6.

*Wheat*—One acre of Defiance wheat was sown April 7. A half acre of the same variety was sown April 21. Also one-half acre of Blount's No. 16 was sown April 21. All varieties were broadcasted and plowed in. The sandstorms damaged some portions of the plats so that only a small part of each showed a good stand at cutting time. All were cut for hay. It was noted that the wheat ripened very unevenly. Some spots showed wheat dead ripe while in other places, on the same plat, the wheat was still in the milk stage.

*Cultivating small grain*—Rows of several varieties of oats and rye were planted three and one-half feet apart and cultivated carefully. By this method, good samples of seed grew beside the field plats where the latter failed to make straw.

*Millet*—One-fourth acre each of Common, German, and Hungarian millet was sown June 12 on one of the plats where oats had been destroyed by the sandstorms. All gave a good stand, but were badly damaged by drought and hot winds. The crop revived after the rain of August 21, and a light mowing of hay was taken from the plats of German and Hungarian millet. The German millet gave the best yield.

*Hog millet, or Hirse*—A small plat was sown to hog millet, June 12. It was cut August 12, making about 1,600 pounds of hay per acre. The land upon which the hirse grew was plowed April 6 and planted to Soja beans. The beans were destroyed by hail May 30. The plat was

carefully cultivated from the time it was plowed until the Hog millet was sown. Sections of soil and subsoil are essentially the same on all the millet plats.

#### HORTICULTURE.

All the trees have made a reasonably good growth. Nearly all the currants and grape vines are dead. Gooseberries and raspberries are still holding their own. The Rocky Mountain cherry bushes were loaded with fruit, which the hail destroyed.

*Garden*—A small plat was planted to garden truck April 30. The onions and radishes were eaten by insects, but the peas, beans, and lettuce did well.

Melons, pumpkins, and squashes were planted June 12. A good supply of squashes was grown. Nothing else matured.

*Canada peas*—One-fourth acre of Golden vine pea was planted in rows by sowing in every third furrow. The first peas which set were picked the last of June when the vines began drying up. Rain revived the vines, and they bore a light crop of dry peas.

*Soja beans*—A plat was planted with seed furnished by Prof. Georgeson, of the Kansas State Agricultural College. The hail completely destroyed them, while Mexican beans and Canada Field peas revived and produced seed.

*Cow peas and beans*—June 20, one-fourth acre each of Mexican beans, Navy beans, and Black-eyed cow peas was planted. From the cow peas, fifty pounds of dry pods were picked. The others were full of green pods when frost came, but ripened very few seeds.

*Potatoes*—One and one-half acres were planted to Late Ohio, Vick's Perfection, Mammoth Pearl, and Mammoth Prolific. A small section of the plat was planted April 30. The remainder of the plat was planted May 22. Beetles attacked the vines as soon as they appeared. First, the Colorado beetle came. Its ravages were checked first by picking the mature beetles and crushing all eggs and larvæ found, and later by a friendly bug which fed upon the larvæ. The blister beetles (*Meloidæ*)

came in hordes about June 20. The vines were treated with Hammond's Slug Shot, Paris green and lime, and with Paris green and water repeatedly with no permanent results. The beetles would leave when the remedies were applied, but the vines would soon be again covered with them. Finally, in sheer desperation, we went over the field systematically every few days and killed the beetles with staves. In this way some of the vines were saved alive until the rain and hailstorm of August 21. After this no beetles were seen in the field, and the vines that were yet alive renewed their foliage and produced some tubers.

#### SUBSOILING.

In April, five acres were subsoiled twelve inches deep. Corn, broom corn, and Early Amber cane were planted across this plat and across two other plats of ground plowed four and eight inches deep respectively. No difference in the growth of the crops on the different plats could be seen.

#### ROOT INVESTIGATION.

Work in this line was confined to a study of the roots of Indian corn in different soils, and at various stages of development. Corn was planted eight feet apart on well-prepared ground and thinned to one stalk in a hill. Stalks were dug out and their roots traced 30, 45, and 60 days from the time of planting. The soil was a mulatto sandy soil about eight inches deep underlaid by a very fine-grained ashy-gray subsoil. In this soil, we found that the earlier whorls of roots grew down at an angle of about forty degrees and later whorls penetrated at greater angles until the sixth, and all whorls later than it grew almost straight down. Thirty days after planting, roots were traced two and one-half feet deep, and three feet from the plant. Later some roots were traced five feet deep and as far aside.

The earlier roots were small in all cases. The size gradually increased as whorls were added until the roots of the fifth whorl, where the roots grew to the maximum size. The upper whorls were sharply defined, but the

lower whorls were often so intimately blended that it required careful dissection to determine to which whorl a root belonged.

Some writers have claimed that the later whorls of roots which penetrate the soil almost perpendicularly are used to supply the plant with water, and differ in structure from other roots so as to be especially adapted to that work. A few specimens of roots from different whorls which I have hastily examined in cross section show essentially the same structure. A core of compact cells in the centre of the root is surrounded by a ring of ducts. These are surrounded by compact tissue and that by the epidermis. There is no doubt that the later roots *do* supply more water than the earlier ones. Being larger, the number of ducts is usually twice as many as in the first roots. The ducts appear to be the same size in all the roots. Specimens have been preserved for more careful examination.

When the corn was at its best, the roots of plants growing upon different types of soil were traced. It was found that in a black adobe soil, the roots grew near the surface, mostly in the upper foot of soil. In this soil, the roots did not grow to great length, but turned and twisted about very much. The one which grew deepest, was traced to thirty inches below the surface.

In a deep, heavy soil, containing much clay, the earlier roots were below the depth to which the cultivator reaches at six inches from the plant. All grew down at a moderately sharp angle, but did not grow so far from the plant as they did in the ashy or "gopher clay" subsoil. Very few were traced deeper than three feet, while the greater part of them fed in the upper two feet of soil.

#### SOIL EXAMINATION.

So many inequalities in the growth of crops were noticed, even on the same level and where all visible conditions were the same, that we decided to examine below the surface for causes. The preliminary work was done by digging holes three feet deep every five

rods each way all over the cultivated land. The holes were numbered and a map drawn showing the location of each one. The different types of soil were noted, and samples of each, as well as samples of soil varying from the types, were taken and preserved. While digging, the thickness of each stratum of soil, the variations from types, the presence of lime or volcanic dust, and all other peculiarities seen were noted. A section across the field shows some peculiar changes. In one place, there is an irregular piece of ground a few square rods in extent which shows a stiff, black soil on the surface. In the thickest part, this soil is three feet thick. It varies from that thickness to a mere feather edge, the edge being covered several inches deep by the surrounding mulatto soil. Both the black and the mulatto soils are underlaid by the same kind of subsoil.

It is hoped that before another crop is planted a part of the field may be examined more in detail so as to enable us to map the strata in sections showing their undulations.

A microscopic examination of the soils show that nearly all the grains are angular instead of being rounded as in many transported soils. In many places flakes having the appearance of lime were found in abundance. Some of these fragments resemble volcanic dust, deposits of which are found in a few places in this country.

#### CAPILLARY RISE OF WATER IN SOILS.

In making this test, the method used by Dr. Hilgard and Prof Loughridge and described in the "Report of the Work of the Agricultural Experiment Stations of the University of California for the years 1892-'93 and part of 1894," was employed. Three columns of soil were built up. One was the common mulatto sandy soil, another black adobe, and the third was "gopher clay." Samples of the "gopher clay" contain particles so fine that they appear as mere specks when examined with a microscope which magnifies 345 diameters. The following table shows the rate of the rise of water in tubes filled with the three different types of soil.

TIME FROM STARTING	ADOBE	MULATTO	GOPHER CLAY
2 hours.....	5 inches	8 inches	6 inches
14 hours.....	12 inches	17 inches	17½ inches
24 hours.....	14¼ inches	20½ inches	21½ inches
50 hours.....	18¼ inches	26¼ inches	27¾ inches
74 hours.....	20½ inches	27¾ inches	32¼ inches
6 days.....	23¾ inches	31¼ inches	37¾ inches
15 days.....	28¼ inches	34¾ inches	45 inches
30 days.....	32 inches	38 inches	51¼ inches
60 days.....	36 inches	41½ inches	58¼ inches
90 days.....	37¼ inches	43 inches	63 inches

The tubes are still standing, and the water is still rising in all. I hope to repeat this experiment using more types of soil.

#### WIND-BREAKS.

May 3, all of the small grain was up so that it could be seen a long distance. But May 5 and 6 a strong southeast wind blew so much sand across the field that all was cut off except what was protected. South of the east end of the plats was a field of cornstalks still standing. The grain north of these was completely protected, although the grain field was twenty rods wide. South of the west end of the small grain field was newly-plowed land. The grain north of this was not cut off. The grain between the two protected parts was either cut off entirely or left hanging by threads.

All the small grain in this neighborhood suffered in the same way from this storm. We found that furrows run east and west across a wheat field would lessen the damage done by the rolling sand.

In cutting fodder this year, I have left a few rows standing every five rods in order to protect the land from the ravages of the wind, and also to catch snow in winter.

#### ADDITIONS AND IMPROVEMENTS.

The buildings have been repainted this year. Material is now on hand for the construction of an imple-

ment shed and a cellar. During the summer, a sod wall wind-break twelve rods long and four feet high was built for experimental purposes, but was not used because the physical apparatus necessary for performing the experiment was not received in time. We hope to extend the wall and use it next year to determine the influence of wind-breaks upon evaporation. Fifty dollars' worth of tools and apparatus has been bought for use in studying the soil and conducting evaporation experiments. A combined lister and drill was added to the farm tools.

Respectfully submitted,

J. E. PAYNE,

*Superintendent.*

Cheyenne Wells, Colorado.

November 4, 1896.



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