

THE STATE AGRICULTURAL COLLEGE  
OF COLORADO

---

THE FOURTEENTH ANNUAL REPORT

OF

The Agricultural Experiment  
Station

---

For 1901

LETTER OF TRANSMITTAL.

---

To His Excellency,  
JAMES B. ORMAN,  
Governor of Colorado.

In accordance with the conditions of the act of Congress which requires a full and detailed report of the operations of the Experiment Station, I have the honor to present herewith the Fourteenth Annual Report.

The financial statement is for the United States fiscal year ending June 30; the other portions being reported substantially for the current year.

L. G. CARPENTER, Director.

# The Agricultural Experiment Station,

FORT COLLINS, COLORADO.

---

## THE STATE BOARD OF AGRICULTURE.

	Term Expires
HON. B. F. ROCKAFELLOW, - - - - - Canon City.	1903
MRS. ELIZA F. ROUTT, - - - - - Denver.	1903
HON. P. F. SHARP, <i>President</i> , - - - - - Denver.	1905
HON. JESSE HARRIS, - - - - - Fort Collins.	1905
HON. HARLAN THOMAS, - - - - - Denver.	1907
*HON. P. A. AMISS, - - - - - Pruden.	
†HON. W. R. THOMAS, - - - - - Denver.	1907
HON. JAMES L. CHATFIELD, - - - - - Gypsum.	1909
HON. B. U. DYE, - - - - - Rockyford.	1909
GOVERNOR JAMES B. ORMAN, PRESIDENT BARTON O. AYLESWORTH, } <i>ex-officio</i> .	

\* Resigned April, 1901.  
† Elected by the Board to fill vacancy.

---

### EXECUTIVE COMMITTEE—TO APRIL 30.

P. F. SHARP, <i>Chairman</i> .	B. F. ROCKAFELLOW.
P. A. AMISS.	JESSE HARRIS.
JAMES L. CHATFIELD.	

---

### EXECUTIVE COMMITTEE IN CHARGE.

P. F. SHARP, <i>Chairman</i> .	
B. F. ROCKAFELLOW.	JESSE HARRIS.

---

### STATION STAFF.

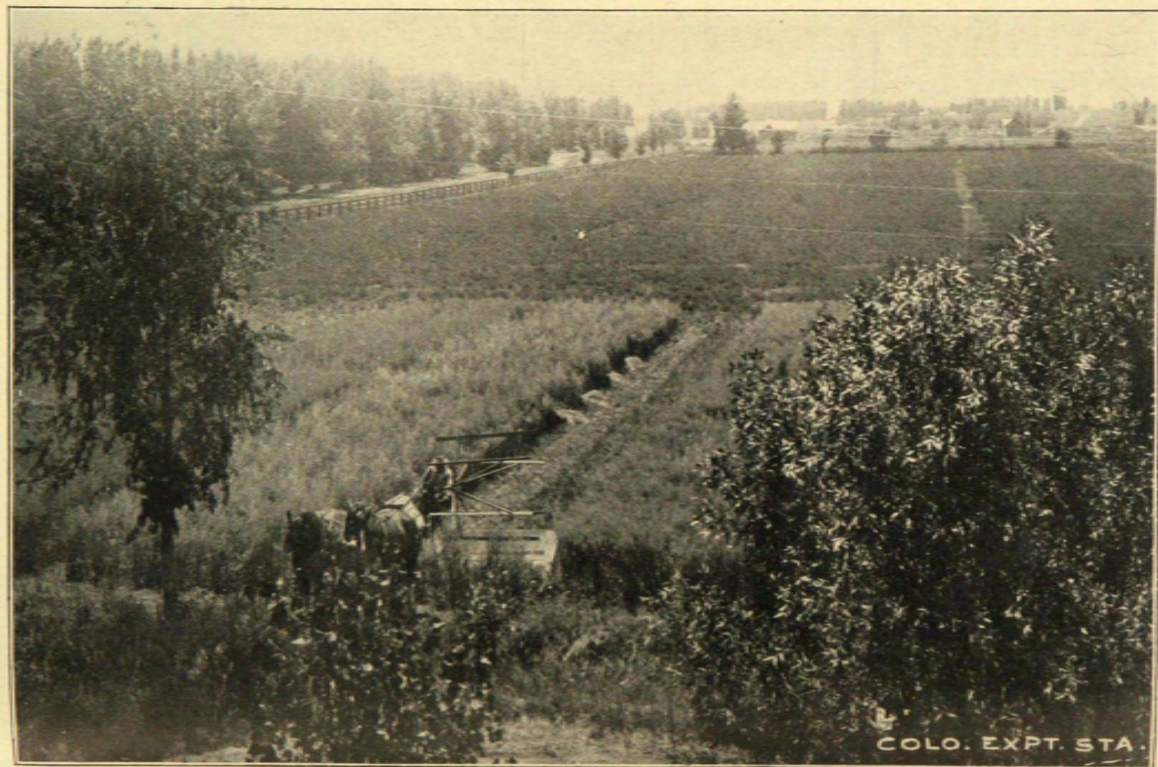
L. G. CARPENTER, M. S., <i>Director</i> ,	IRRIGATION ENGINEER
C. P. GILLETTE, M. S.,	ENTOMOLOGIST
W. P. HEADDEN, A. M., PH. D.,	CHEMIST
WENDELL PADDOCK, M. S.,	HORTICULTURIST
B. C. BUFFUM, M. S.,	AGRICULTURIST
R. E. TRIMBLE, B. S.,	ASSISTANT IRRIGATION ENGINEER
E. D. BALL, M. S.,	ASSISTANT ENTOMOLOGIST
* E. S. G. TITUS, B. S.,	ACTING ASSISTANT ENTOMOLOGIST
A. H. DANIELSON, B. S.,	ASSISTANT AGRICULTURIST AND PHOTOGRAPHER
F. M. ROLFS, B. S.,	ASSISTANT HORTICULTURIST
F. C. ALFORD, M. S.,	ASSISTANT CHEMIST
EARL DOUGLASS, M. S.,	ASSISTANT CHEMIST

---

### OFFICERS.

PRESIDENT BARTON O. AYLESWORTH, A. M., LL. D.	
L. G. CARPENTER, M. S.,	DIRECTOR
A. M. HAWLEY,	SECRETARY
† W. R. HEADDEN, B. S.,	STENOGRAPHER AND CLERK
A. D. MILLIGAN,	STENOGRAPHER AND CLERK

\* To June 1, 1901.  
† To October 1, 1901.



THE EXPERIMENTAL PLATS.

SECRETARY'S FINANCIAL REPORT OF THE COLO-  
RADO AGRICULTURAL EXPERIMENT STATION  
FOR FISCAL YEAR ENDING JUNE 30, 1901.

Dr.	U. S. Fund.	Special Fund.	Total.
From the Treasurer of the United States, as per act of Congress approved March 2, 1887.....	\$15,000.00		
Balance July 1, 1900.....		\$ 317.47	
Farm products.....		1,280.10	
Miscellaneous.....		306.87	\$16,904.44
By Salaries.....	\$10,773.53	\$ 209.51	\$10,983.04
Labor.....	691.20	136.61	827.81
Publications.....	1,546.99	179.80	1,726.79
Postage and Stationery.....	335.17	217.17	552.34
Freight and Express.....	15.82		15.82
Heat, Light, Water, Power.....	0	0	0
Chemical Supplies.....	6.43		6.43
Seeds, Plants, Sundrry Supplies.....	169.42	4.90	174.32
Fertilizers.....	156.00		156.00
Feeding Stuffs.....	10.60		10.60
Library.....	37.74		37.74
Tools, Implements, Machinery.....	19.15	14.50	33.65
Furniture and Fixtures.....	108.45	333.33	441.78
Scientific Apparatus.....	84.92	349.02	433.94
Live Stock.....	39.50		39.50
Traveling Expenses.....	944.59	113.70	1,058.29
Contingent Expenses.....	10.00	47.50	57.50
Building and Repairs.....	50.49		50.49
Total.....	\$15,000.00	\$1,606.04	\$16,606.04
Balance June 30, 1901.....		298.40	298.40
	\$15,000.00	\$1,904.44	\$16,904.44

A. M. HAWLEY,  
Secretary.

## REPORT OF THE DIRECTOR.

*To The Executive Committee:*

Gentlemen: I have the honor to present the following report as Director of the Experiment Station for the present calendar year. This also includes the reports of progress of the different sections.

## FINANCES.

As the fiscal year ends June 30, it is more convenient to report the situation at that time. For the fiscal year ending June 30, 1901, the receipts from all sources amounted to \$16,280.17. There was a balance of \$317.47 brought forward from the previous fiscal year, and \$298.40 carried forward, thus making the total expenditure \$16,606.04. For the current fiscal year the estimate of receipts is larger, due to the funds received from sales of property at substations.

## PUBLICATIONS.

Since the 1st of December, 1900, we have issued eight bulletins, one of which was in two editions. Two bulletins are now in press. We also issued six press bulletins and twenty-six special river bulletins, and two extracts from the regular report. The editions of the regular bulletins have had to be increased from 6,000 to 8,500. This means a considerable additional expense. The total number of copies of the report issued during the year was 1,500; and of the bulletins 51,000; of the press bulletins 22,000; of the river bulletins 10,000, making a total of over 85,000 copies, which have been distributed during the year. The number of pages thus distributed is over 1,500,000. In the number of pages and in the number of publications issued during the year we shall equal almost any station in the United States. 100 volumes of the publications of last year were bound with cloth covers for the use of offices and libraries and places where it was desirable to have bound copies. This has been a very desirable and acceptable edition.

Progress has been made during the year in binding the bulletins received from other Stations. This step has been necessary in order to preserve records which are very important in Station work. A great deal of time has been taken in attempting to complete our files of bulletins. We still lack some bulletins from a number of states, but the sets are gradually being completed, and as fast as this is being done, they are bound.

During the year the substations and the problems arising from them have taken an undue amount of time. Their affairs are now, however, more simplified than before, and it is hoped that in the future they will be in better condition. It is evident that in order that the substations may be an integral part of the main Station, so that the work done there may be of service in the larger plans of the Station, that the substations need be in closer touch with the main Station, and that there should be closer supervision. I will give a more complete statement of the affairs of the substations before closing this report.

#### THE PROBLEMS OF THE STATE.

This State is so large and with such a variety of conditions that the number of problems pressing for solution is greater than we can take up. When we recall that Colorado is as large as the states of New York, Maine, Vermont, New Hampshire, Massachusetts and Rhode Island together, and that in this area equal to Colorado, the six stations supported from the Hatch fund have not only been kept busy with the problems of this equal area, but the demand for their work has required several State Stations in addition, and that these States have appropriated over \$100,000 in addition to the \$90,000 from the government, it becomes evident that we cannot take up all the questions which arise in the area when we have an income of not over one-thirteenth as much.

There are so many problems peculiar to this State in the solution of which we can obtain little help from the investigations of other States, that our policy should be to refrain from lines where their investigations may apply to our conditions. There is even then far more work than we can take up. The temptation has been to take up problems and not carry them through to completion.

The development of the sugar beet industry is a gratifying result of the work of this Station, and of the other Stations in the United States as well as the Department of Agriculture. It is an industry of great promise, the rise of which is purely one of scientific investigation.

The work of the Station has proceeded pleasantly, and while we can realize defects, yet we can see a material improvement. In considering the conditions which may increase the efficiency of the Station work, we are first impressed with the multiplicity of duties devolving upon the Station workers. For the best results in scientific work, not only a peculiar aptitude is required, but the work can not be well performed if the worker's time is constantly interrupted, or if work is approached when one is mentally fagged. The higher class of scientific investigation requires a fresh mind, a condition to be attained for only a few hours per day. The work of teaching is pleasant and profitable to most

workers, and the greatest objection from the standpoint of the Station worker is that it breaks up the day. Even though the number of hours taken is not great, the day may be largely spoiled for investigation. From this standpoint, it would be better for the interests of the Station if the time of teaching on the part of the Station staff could be so arranged that some days of the week could be entirely free from such work, and given completely to investigation. This is one of the conditions which would probably increase the efficiency of our Station work. As it is, the work performed is apt to be far in advance of the published reports of the investigations. The preparation of bulletins and reports require in most cases considerable expenditure of consecutive time.

In the increase of usefulness of the Station, the development of our publications is also one of importance, and also the distribution of the bulletins. It is not only probable, but is known to be true, that a large portion of our bulletins reach people who do not make use of them. This is a condition which we hope to improve by making a classification of the names on the mailing list. At the same time, a classified mailing list is not a safe guide, because it so frequently happens that the very person who is the most interested in the bulletin is one whose line of interest is not indicated by his occupation. At present it would seem that without largely increasing the cost of distribution we must needs expect that a large part of the bulletins will not be used. We cannot expect to have results much greater than skilled advertisers who expect that only one person out of a great many will read their advertisements.

Another means of rendering our bulletins available to the public is through the medium of the Farmers' Institutes. These are good and form a supplement to the bulletin and printed reports; and are of value to the worker also, as they bring him in contact with the problems of the farmer in different portions of the country.

#### SUBSTATIONS.

During the past fiscal year only one substation has been in operation, that at Rockyford. In consequence of the refusal of the Department of Agriculture to countenance further expenditures, none has been made on the Stations at Cheyenne Wells, though investigations have been continued on the problems of the Plains.

#### THE DIVIDE SUBSTATION.

Since the last annual meeting of the Board, the affairs of the Divide Substation have been closed by the authorization of the Board. Our interests have been sold to Mr. W. A. Diebold for the sum of \$650, of which \$250 has already been paid. The re-



remaining \$400 bears interest at 6 per cent. per annum, and is to be paid within two years. The deed has been made out and is held in escrow by the First National Bank, of Colorado Springs.

#### THE SAN LUIS VALLEY SUBSTATION.

During the past year the affairs of this substation have been put on a better basis. The State Land Board had called for the return of the land to the State. It has been deeded back to the State Land Board by the authorization of the State Board of Agriculture. Prior to that time, our interests in the land had been sold to Mr. Oscar S. Wyland for \$1,900, to be paid in four payments; the first for \$400, in 1901; the second for \$500 in 1902; the third for \$500 in 1903; the fourth for \$500 in 1904.

Mr. Wyland already had possession of the place and had crops in the ground in consequence of a previous understanding and we felt under obligations to treat with him. The bargain, however, was very advantageous to us. The first note is secured by a chattel mortgage on the crops and hogs. The other notes are secured by lease from the State Land Board, which is assigned to us.

The personal property remaining at the Station was of little value. This was left with Mr. Wyland, and is a part of the improvements which he purchased.

In addition to this, there was some personal property in the possession of P. A. Amiss, consisting of one team of horses, one wagon, and other property of which we could obtain no clear description and which might be difficult to identify. This property was sold to Mr. Amiss for \$100 in cash. The money has been received and the transaction closed.

#### THE PLAINS SUBSTATION.

The Department of Agriculture having notified us that no further expenditure from the Hatch fund could be made at this Station, the plan of work has been along such lines as to cause no necessity for expenditure in connection with the Station itself. Mr. Payne has remained in charge, but with the title of field agent, instead of superintendent of the Station. The duty of the field agent is to investigate conditions in Eastern Colorado, and study the Plains with a view of finding out what has been, and is being done in agriculture, that may give promise of success. During the summer his trips have extended from the Arkansas river on the south, and nearly to the Platte on the north, and has covered a large portion of the country between these two points. He has lived in the house at the Station and made it his headquarters. The land at the Station was leased to J. W. Adams, who formerly worked at the Station, and as a condition of the lease, he was to take care of the fruit trees which were planted

near the house. The lease has been quite satisfactory and the place well cared for. The crop of sorghum which was grown produced a number of tons of forage.

As there is nothing to be done at the substation during the winter months, Mr. Payne has moved to Fort Collins, and the house has been rented for \$4 per month, during the winter to a school teacher in Cheyenne Wells. The understanding is, however, that the Plains investigations shall be continued as during the past season.

As the situation now is at Cheyenne Wells, the buildings and improvements belong to the Experiment Station, but the title of the land is conditional. These buildings were partly put up by money from the Internal Improvement fund and from local sources. The buildings are good but the demand for them at that place is small. Cheyenne Wells derives its principal importance as the end of a division for freight trains, and as an eating point on the railroad. It is likely that dining cars will soon be substituted, in fact an order was promulgated that dining cars should be run from October 10. This action, however, has been delayed. It is only a question of time until the importance of the place becomes less, and the value of our improvements will be correspondingly decreased.

There is no doubt under our title regarding our rights to the improvements, if it becomes necessary to withdraw. As it now is, we cannot spend any of the Hatch fund, and there has been no provision to expend any of the other funds of the Board for that purpose. We shall get very little for the improvements when it becomes necessary to sell. The sum received will be far less than the amount which has been spent for them.

#### THE ARKANSAS VALLEY SUBSTATION.

In the case of the Arkansas Valley Substation, a large part of the land was leased to tenants for cash or for a portion of the crop. About twenty-five acres are retained under the supervision of the Station, an amount which could be attended to by the Superintendent and one man.

The total amount expended for the fiscal year ending June 30, 1901, was \$1,726.43; the net receipts for the same time were \$1,148.46, making a net cost of \$577.97.

By action of the Board of Agriculture at the meeting in July and in accordance with a letter from Dr. A. C. True, it was decided to return to the State Land Board 160 of the 200 acres which had been put at our disposal for experimental purposes. With that authorization, the deed was transferred to the State Land Board. At the same time the Station also had twenty-four shares of stock in the Rockyford ditch; one of these shares had

been issued by mistake and the Board authorized its return to the Secretary of the Company. It had not been absolutely settled at that time whether the stock was to be returned to the donors in case of the abandonment of the Station or not. The records of the Board and especially those conditions upon which the Station was located at Rockyford would seem to indicate that it was an absolute gift.

The Board authorized the sale of the thirteen shares upon the condition that the purchaser should return the stock at any time of tender of the amount which he had paid. Since that time, the original donors of the stock have made claim that the stock by right belongs to them; that they gave it with the understanding that it was to be returned to them in case the Station was abandoned. The stock was given by individuals who gave from one to two or three or four shares each, and from the evidence now available, it appears the committee soliciting this stock made such representation to the donors. On the other hand, nothing has been found which would show that this was not one condition required by the Board; in fact, the records of the time would seem to indicate that the stock was to be in fee simple on the location of the Station. These donors will present their claims and perhaps be represented by a committee at this meeting of the Board. They will present such evidence as they may have which throws light on their arrangements with the Board at that time.

The improvements on the portion of the place which was relinquished were sold to G. W. Swink for \$1,500. Mr. Swink had the original lease on this tract of land and relinquished it for the use of the Experiment Station in the year 1888. He made payment of one-fourth in cash and the remainder in approved notes bearing six per cent. interest. He has arranged that additional security should be given by the retention of the water stock for which he had bargained, until the whole transaction was completed. If it should be deemed best to return the stock to the original donors, the question will arise as to whether additional security should be given.

In a letter dated June 1, Dr. A. C. True, Director of the Office of Experiment Stations, having general supervision of the Hatch fund, wrote definitely that he must insist more strongly that the use of the Hatch fund for substations should be discontinued. This seemed to be a prohibition of the use of the Hatch fund for these purposes. This being the case, the question of the policy to be adopted toward the Substation at Rockyford arises. The Hatch fund, which has been the fund that has maintained this Substation, and during the time since its establishment, something like a total expenditure of \$33,190.50 has been made. There have been receipts of \$11,393.09, making a cost of \$21,799.41. The net

cost of the Experiment Station has never been so small as during the past two years, when it amounted to less than \$1,000 each year. In the years previous to that time when the ground was under the charge of the Superintendent, the cost one year was as low as \$1,100 (\$1,070.80), and as high as \$2,900 (\$2,890.66.)

There would seem to be three courses open to us:

1. To discontinue the work entirely.
2. To continue as a garden tract in an experimental way, as it was during the past year. This would require the maintenance of a man, a team and tools; a total expense including the salary of the Superintendent of not far from \$1,800.
3. The use of the place only as a headquarters, retaining the improvements, house and grounds adjacent to it for the use of the Field Agent, permitting him to live there, and leasing the balance of the forty acres in such a way that we would not be responsible for any of the expense.

Under the ruling of the Department, it is still a question as to what extent it would sanction payment, except temporarily, of the Superintendent of the Station. In an official ruling some years since, the Department clearly stated its conception of the use of the Hatch fund. The Department recognizes the desirability of investigation in different portions of the State. It recognizes this as a proper charge upon the Hatch fund, where the work is of an experimental nature. Under this arrangement, it would seem possible for us to take up most of the investigations, or at least, part of them.

The work of the various sections is shown in the reports here appended.

Respectfully submitted,

L. G. CARPENTER,

Director.

## REPORT OF THE ENTOMOLOGIST.

I have the honor to submit herewith the annual report of the entomological section of the Agricultural Experiment Station for the year 1901.

## WORK WITH THE CODLING MOTH.

This insect occasions such heavy losses to fruit growers of Colorado each year that a considerable time has been devoted to a study of its habits and remedies. Much of the information gained had already been \*published in one place or another but comparatively little has appeared in bulletins or reports of the Experiment Station. I have therefore thought it desirable to summarize the more important observations and conclusions in this report. They are as follows:

*Life History.*

Eggs of the spring brood begin to be deposited upon fruit and leaves when summer apples, like the Duchess, are about three-fourths of an inch in diameter. The last eggs of the brood are not deposited until late in July. The late moths of this brood have continued to appear in our breeding cages in cellars, to July 24.

The eggs, according to our observations, have been almost entirely upon the smooth surface of the apples, a small proportion, perhaps 10 per cent. have been found upon the leaves. Very few (3 or 4 per cent.) of the eggs under observation have failed to hatch, but there has been apparently a large mortality among the young worms. The time for eggs to hatch in the laboratory has varied between 6 and 8 days, with an average time of about 7 days.

The earliest we have found eggs on the apples at Fort Collins was June 9. Last year the first eggs were found June 19; the eggs of the first brood became most abundant about July 3, and summer eggs were most scarce about July 21. On July 27 an increase due to the eggs of the second brood was noticeable. Second-brood eggs were most abundant about August 12.

*Larvae* of the first brood began leaving the apples about Fort Collins in the spring of 1901, July 1; they were coming down most rapidly about July 21. By August 15 the larvae were coming in very small numbers and some of them were of the second brood

\*Reports of Colorado State Board of Hort. for 1897, 1898, 1900, 1901 and Bull. 31, N. S., U. S. Dept. of Agr., Div. of Ent., p. 5.

as was shown in the fact that they began at about this date to live over till spring before pupating. The larvae of the second brood were most numerous under bands about September 10.

The time required for larvae of the first brood to develop varied between 12 and 24 days with an average time of 19 days.

The time spent spinning and pupating varied between 1 and 19 days with an average of 5.6 days. The greatest number pupated on the 4th day.

The time spent in the chrysalis by the summer brood varied between 10 to 21 days and the average time was 14 days.

For the entire cocoon stage the time varied between 12 and 29 days with an average of 20 days.

The time required to pass through these transformations at Fort Collins is no greater, according to our records, than at Rockyford, Canon City and Grand Junction where the summer temperature ranges considerably higher. The time spent in the complete summer life cycle has varied greatly but the average time has been almost exactly seven weeks.

Practically all the larvae taken at Grand Junction after August 10, and at Rockyford and Canon City after August 15, and at Fort Collins after August 20 live over till next spring before pupating. Occasional belated individuals are exceptions to the rule.

*Moths* from warm winter quarters may appear very early. Up to the time the orchards are in full bloom, we have found only about 10 per cent. of the moths hatched. At about this time they begin to appear rapidly.

The latest we have been able to rear moths of the second brood at Fort Collins has been September 16. The latest reported from other parts of the State by those who have assisted in the work have been as follows: Grand Junction, Sept. 12 (Silmon Smith); Canon City, Sept. 10 (R. J. Peare); Rockyford, Sept. 15 (H. H. Griffin); Palisade, Sept. 22 (C. H. Potter.)

#### *Miscellaneous Notes on Habits.*

While the second brood are generally thought to enter largely at the side of the apples because of the many worm holes seen there, our counts have so far indicated that 80 per cent. enter at the blossom end. Very many, however, enter by a very small hole, leaving no outside evidence, and then burrow to the surface on the side of the apple and keep the latter burrow open but not the entrance at the blossom.

Spring migration of the larvae is usually very light, but in a few instances they have come to bands in considerable numbers in certain orchards about Grand Junction during March and April.

Bands removed from a tree at 6 o'clock each evening and 7:30 each morning gave 414 larvae, 353 or 85 per cent. of which

came to the band during the night period and 61 or 15 per cent. came during the day.

By the use of bands we have taken from 17 per cent. to over 60 per cent. of the larvae on a tree as indicated by the number of wormy apples. The largest number of larvae from one band during the season is 1481. The tree was in a lawn and isolated.

Gathering apples daily from the ground gave us 16 per cent. of the worms from Duchess apples and 3.5 per cent. of the worms from Ben Davis trees as indicated by the number of wormy apples.

The saving of wormy fruit as the result of spraying twice with Paris green has varied in our experiment between 25 per cent. and over 90 per cent. The 25 per cent. saving was upon Duchess trees when the calyces of the apples had nearly all closed before the first application. The ninety odd per cent. was upon winter varieties.

#### LONG-TONGUED HONEY-BEES.

Bees from different parts of the United States were examined for the purpose of determining the range in length of the tongue of the honey bee. A progress \*report on the work was made at the Annual Meeting of the Colorado State Bee-keepers' Association in Denver, November, 1901, and the work is not yet fully completed.

I have found that thrusting a bee into boiling water kills it in the best way to leave the tongue extensible for study.

I have been unable, so far, to find any evidence of a long-tongued strain of Italian bees, though several advertisers of "long-tongued" or "red clover" bees sent bees for examination. Tongues of the German or black bee have ranged between 23.5 and 25 hundredths of an inch; tongues of Carneolans between 25.5 and 26 hundredths of an inch; tongues of Italians between 24.5 and 26 hundredths of an inch, and tongues of Cyprians between 25 and 27 hundredths of an inch. Tongues of *Apis dorsata* preserved in alcohol measured between 25 and 26 hundredths of an inch. Tongues of bumblebees measured in comparison varied between 43 and 58 hundredths of an inch in length.

In all cases the distance from the base of the sub-mentum to the tip of the ligula has been taken as the tongue-length.

#### SUGAR BEET INSECTS.

Considerable attention has been given the past year to observations upon sugar beet insects on account of the importance which the sugar beet crop is assuming in Colorado.

---

\*The paper is printed in full in Am. Bee Journal, Dec. 12, 1901, and in Bee-Keeper's Review, Jan., 1902.

The beet army-worm (*Laphygma flavimaculata*) was not seriously abundant but attracted some attention in the lower Arkansas Valley over limited areas. Where the arsenites were used promptly they were successful in killing the worms. Mr. H. H. Griffin, Field Agent of the Experiment Station, reports that he found best success from the use of strong mixtures. He recommends using Paris green in the proportion of a pound to 50 gallons of water.

*Nysius minutus*, one of the false chinch bugs, was unusually abundant in the State last summer attacking a variety of plants upon both the east and west slopes of the mountains. One of its favorite plants is the beet. In places, many young plants were killed by them and Mr. Griffin and others at Rockyford state that they attacked mother beets that were being grown for seed so badly in places as to seriously injure the crop. Prominent among the cultivated plants attacked by this bug about Fort Collins last summer were beets, radishes, cauliflower and strawberries. The weeds most attacked were wild mustard, a tumble-weed (*Monolcpis nuttallii*), yellow dock, lamb's quarter and Helianthus (sunflower). Many others were attacked to some extent.

Kerosene emulsion, whale-oil soap and Buhack were used in varying strengths for its destruction but almost without effect.

The accompanying cut shows the bugs about life-size on the leaves of yellow dock. (Fig. 1, Plate I).

The beet-louse (*Pemphigus betæ Doanc*), was received upon the roots of beets from the vicinity of Rockyford and were sent by Mr. H. H. Griffin. The lice were found when the beets were harvested. The lice were sent as mealy-bugs because of the powdery covering to the body. Beets having the lice upon them were said to be spongy and of poor quality. Mr. Griffin thinks they occurred in several fields near Rockyford last year. It seems probable that this louse must occur upon the roots of some native plant in that vicinity and that it is transferring its attention to the beets.

#### MISCELLANEOUS NOTES.

Howard's Scale (*Aspidiotus howardi*). This is a near relative of the San Jose scale and was discovered by the writer some years ago on plum and pear trees in Canon City, Colo. The scale seems to have been the cause of the death of a few plum and prune trees near Canon City in one small orchard where it was first found and it still occurs in small numbers in that locality. I have not known of its occurring outside of Canon City until the past summer when the inspector of Delta county, Mr. H. E. Mathews, sent me specimens of the insect and later took me to an orchard where pears and plums, particularly the former, were badly attacked by it.



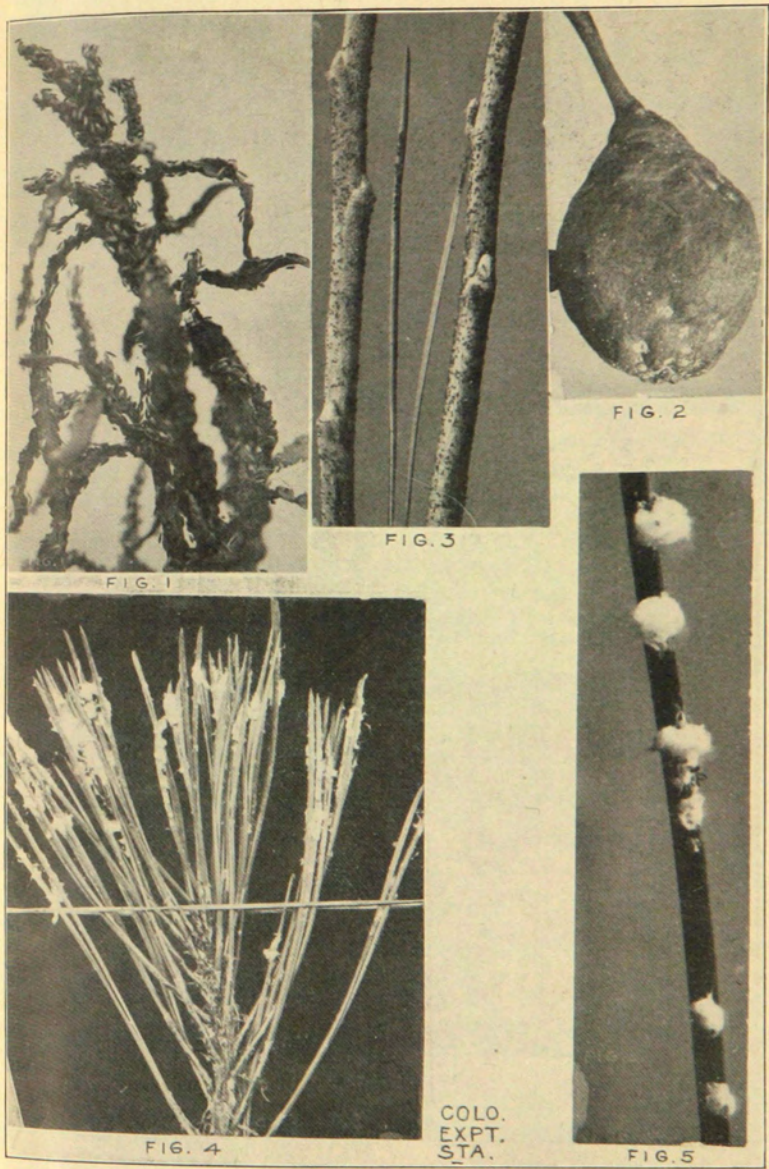


PLATE I.

Fig. 1. False chinch-bug (*Nysius minutus*) on leaves of yellow dock, nearly life-size. From photo by author.

Fig. 2. A young Bartlett pear, life-size, showing both young and adult scales of *Aspidiotus howardi*. The young scales are white. From photo by author.

Fig. 3. Two apple twigs showing eggs of apple louse, *Aphis mali*, and between these twigs two needles of *Pinus ponderosa* showing eggs of a species of *Lachnus*. Photo by author.

Fig. 4. A bunch of pine needles, natural size, showing the white waxy secretions of the lice. From photo by author.

Fig. 5. A pine needle much enlarged showing the masses of white waxy secretion covering the lice and their eggs. At (a) the eggs may be seen protruding from under the secretion. From photo by author.

COLO.  
EXPT.  
STA.



FIG. 6



FIG. 7

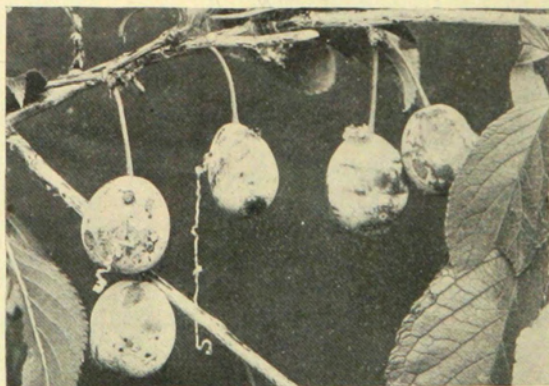


FIG. 8

GOLO. EXPT. STA.

PLATE II.

\*Fig. 6. The thistle butterfly, *Pyrautes cardui*, at plum blossoms; nearly life-size. From photo by author.

Fig. 7. A, peach leaf, life-size, showing cocoons of *Plutella crucifera*; B, one of the cocoons much enlarged showing its frail gauzy structure. From photos by the author.

Fig. 8. Plums, life-size, showing the punctures and gummy exudations caused by the plum gouger, *Coccotorus prunicida*. The black specks on the plums represent the punctures which are made either for the purpose of taking food or egg-laying. Photo by author.

\*A halftone from the same photograph was given in *Agricola Aridus*, Vol. 1, No. 3, p. 7.

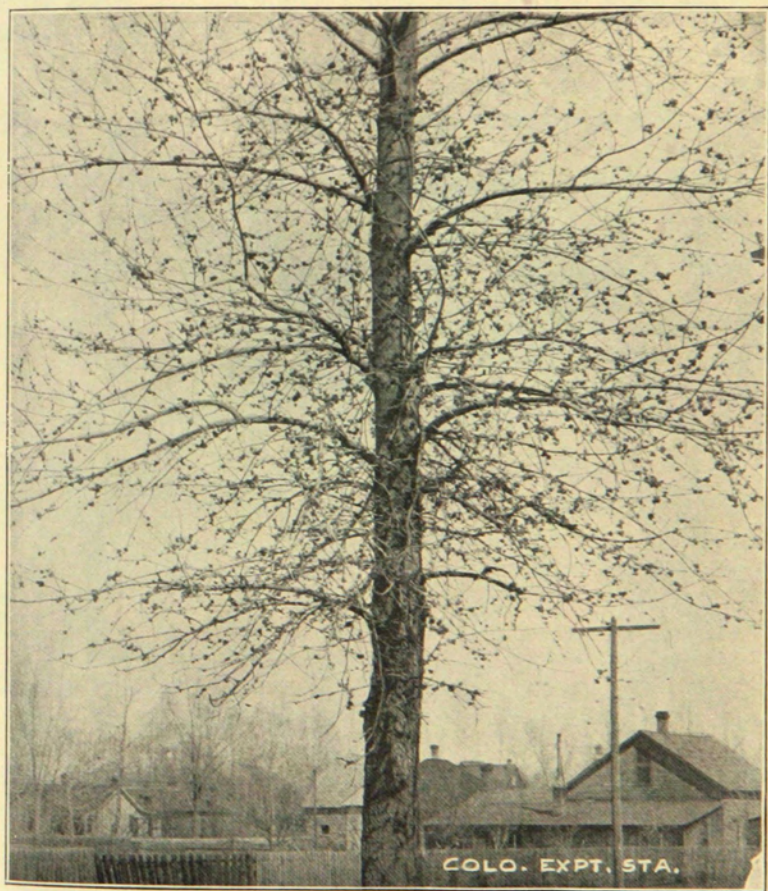


Fig. 9. PLATE III.

Fig. 9. A cottonwood tree showing galls of *Phytoptus* mite on twigs.  
From photo by author.

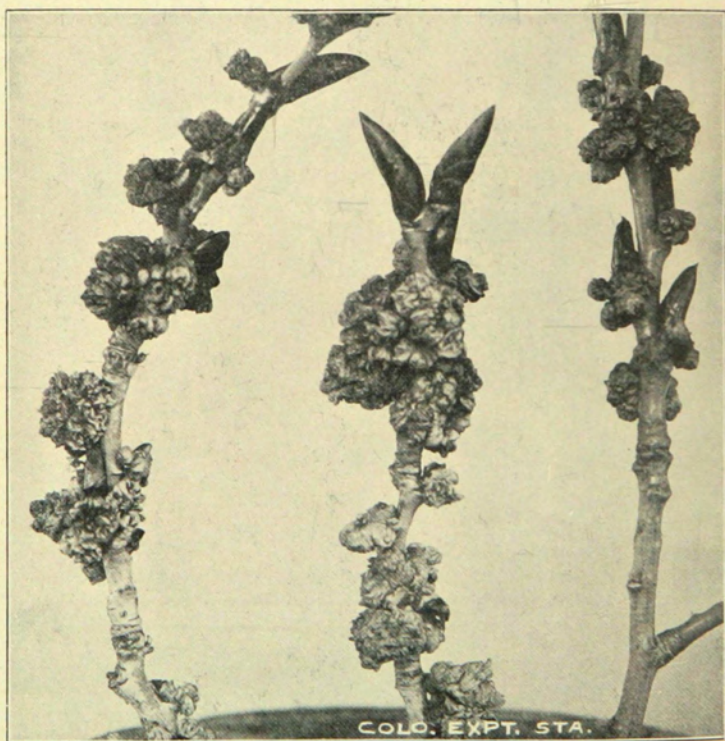


Fig. 10. PLATE IV.

Fig. 10. Life-size galls of *Phytoptus* mite from twigs of cottonwood tree. Some galls may be seen developing from buds, others from the smooth bark of the twigs. From photo by author.

The orchard was examined June 12, at which time the young lice were just beginning to hatch. Pears containing lice were brought to the Station and the young continued to appear till August 20. The newly hatched lice are of the usual yellow color. They locate mostly about the blossom end of the fruit and the first scales are pure white. The older scales become darker and are usually sunken into the fruit. Sometimes there is a reddish discoloration about the scale. On raising a female scale it was often possible to find two or three lice and no eggs, but occasionally an egg or two or perhaps as many as three or four were also present. More often there were no eggs at all. So the lice hatch almost immediately upon the laying of the egg or, perhaps they as often hatch before the egg is laid.

The accompanying cut (Fig. 2) shows the scales, life-size, upon a pear.

The Apple Louse (*Aphis mali*), continues to be a common and often very abundant pest upon the foliage of apple and pear trees after the middle of July or the first of August. During winter and early spring the black shining eggs are often seen in great numbers upon apple twigs. They are shown life-size, in Fig. 3. We have been unable to hatch these eggs when brought into the laboratory. Whether or not they hatch late in the spring upon the trees we have not certainly determined.

Woolly lice on spruce and pine. Two species (possibly one) of Chermes attack the leaves of spruce and pine in northern Colorado. The lice are very dark green in color having the appearance of black specks to the unaided eye. They arrange themselves along the leaves or needles and the females secrete large quantities of white waxy material to cover their bodies and also the clusters of amber colored eggs which they deposit in compact mass behind them. Each egg is attached by a thread. (See Figs. 4 and 5).

I have found kerosene emulsion or whale-oil soap of the ordinary strengths very effectual in killing these lice and their eggs.

The Thistle Butterfly (*Pyrautes cardui*) was unusually abundant in many parts of Colorado last summer and attracted considerable attention from fruit growers, who were afraid it might be some insect injurious to fruit. The butterflies were abundant at blossoms of plum, cherry, apple and other fruit trees on both the eastern and western slopes. This insect is probably more beneficial than injurious as the larvae feed chiefly upon the leaves of thistles and other composite weeds and the butterflies assist in the fertilization of fruit blossoms.

The accompanying cut (Fig. 6, Plate II) shows a butterfly at plum blossoms.

The Cabbage Plutella (*Plutella cruciferarum*). What seems to be a very unusual habit of this insect occurred in Colorado last

summer. Mr. H. E. Mathews, horticultural inspector for Delta county, sent me a quantity of peach leaves partly eaten and having attached to them large numbers of little white cocoons. Mr. Mathews stated that a portion of a young peach orchard had been very badly defoliated by this insect. In a few days the moths of the above named insect appeared from the cocoons and I was greatly surprised to find this eater of cruciferous plants attacking the peach. On visiting Mr. Mathews later I learned the particulars of the case which are as follows: The year previous a large amount of wild mustard had been allowed to grow in the orchard as a weed. Last summer clean cultivation was practiced and the moths of this insect, not finding the mustard upon which to deposit their eggs, turned to the only available plants, the peach trees. The accompanying cut shows the cocoons life-size, on a peach leaf and also a cocoon enlarged so as to show its gauzy structure. (Fig. 7, Plate II).

The Plum Gouger (*Coccotorus prunicida*) is abundant every year on the eastern slope where it is a very serious pest injuring the fruit of the red or Americana plums. The punctured plums are deformed, and gummy exudations appear on the wounds made by the beetle for the purpose of egg-laying or taking food. The wounds made by the beetle and the exudations are shown in Fig. 8.

If all growers of plums in a considerable area would agree on a year when they would all remove every stung plum from their trees between the middle and the last of July, they could in this manner almost exterminate the pest for a number of years.

I have found no signs of this insect on the west slope and it does no appreciable harm to European varieties of the plum.

*Phytoptus Gall on Cottonwoods.* Since coming to Colorado, some ten years ago, I have noticed the gradual increase in numbers of a small gall upon the twigs of the cottonwood. While the gall occurs generally over the State, it seems most abundant in the northern portion. Many cottonwoods in Fort Collins have these galls upon nearly every twig. They may form upon buds or upon the smooth bark as shown in the accompanying illustration. It is not uncommon to find trees as badly infested as the one shown in Fig. 9. Fig. 10 shows the galls life-size.

It will be difficult to apply remedies as the mites live over winter in recesses in the galls. The mites are reddish in color during winter and if galls are cut into at this season the mites may be found in great numbers in clusters. The galls do not have the effect to kill the trees as yet, and few limbs seem to have died from their attacks but they cause an unsightly appearance of the trees when the foliage is off.

C. P. GILLETTE.

REPORT OF THE CHEMICAL SECTION.

---

*To The Director of the Experiment Station:*

I herewith transmit my annual report regarding the work carried on by this Section of the Experiment Station.

No new work has been undertaken. The work set forth in the outline discussed at the January meeting of the Station Council has been prosecuted to the exclusion of all other work, no deviation having been made from the original plan.

There is at the present time a large mass of results which have not yet been published, but which are now in the course of preparation for publication.

The digestion experiments mentioned in the outline as having been at that time, namely, in January, far advanced, have had to be repeated and will probably be completed early in the fall, as will also the work on beeswax, which will be carried on by Mr. F. C. Alford.

There are no new needs of this Section which I shall present at the present time, as I believe you are fully conversant with the status of the section and its equipment.

Respectfully submitted,

WM. P. HEADDEN.

REPORT OF THE AGRICULTURIST.

---

The Experiment Station work in the Department of Agriculture has been somewhat varied during the year. Something has been done on each of the lines of work as planned at the beginning of the season of 1901. One bulletin, No. 66, on Tuberculosis, jointly written with the Veterinarian, Dr. G. H. Glover, has been published, and considerable material is on hand for other Station bulletins. It being the first year of the writer's work in this Station we have preferred to corroborate many of the notes before publishing them. Material is on hand for a bulletin on feeding Belgian hares, and some interesting results were obtained in feeding sheep and swine.

A large amount of data is accumulating from investigations with wheat and oats, especially with that part of the work which is being carried on at Monte Vista and at the College to compare the raising of grain at high and low altitudes. Published with the report is an account of our first year's work with macaroni wheats. We believe this variety of wheat will be quite valuable, especially in those portions of the State where irrigation water is either very scarce or wanting, and agriculture is carried on under scanty supply of rainfall. A number of varieties of macaroni wheat have been introduced from Russia by the U. S. Department of Agriculture which are being grown here in co-operation with the Department. Some of these varieties were collected on the high, dry steppes of Russia where they were raised without irrigation.

One of the most important lines of investigation which we have attempted is the work with grasses in co-operation with the Division of Agrostology. We publish herewith a detailed report of what was done the first year with a large number of varieties both in the grass garden and in a field which could be pastured. There is so much demand for information in regard to grasses which will either improve our ranges or be suitable for the making of pastures which can be irrigated, that we consider this line of work very important, and desire to give it much attention during the coming season.

The crop plats established last year gave some interesting results. Wheat which had been grown for a number of years at altitudes of 7,000 feet, shows a remarkable deterioration when planted here. The result was the same with a large number of varieties and it is interesting to know whether grain raised at high



altitudes is always apt to deteriorate sufficiently to produce very small crops when grown at low altitudes. On the other hand varieties of wheat obtained from Wm. Farrar, the great breeder of new wheats in Australia, did remarkably well, ripening a week or more earlier than the varieties which had been grown at home.

Two new brewing barleys, seed of which was furnished us by the U. S. Department, produced large crops here last season, and Russian spelt, so-called, really a variety of emmer was grown in sufficient quantity to supply grain for some feeding experiments which are now being carried on.

Although so much has been done by the Station with sugar beets during the past twelve years, we are now face to face with this new industry and should like to keep in touch with the commercial side of the question so far as our experimental work will be of value to farmers who are raising beets for the factories. The past season we raised sugar beets from which are to be selected mother beets for the production of seed. There is much demand also for information in regard to sugar beets for stock feed, so it is expected that beets will figure in the rations we adopt for experimental work in stock feeding, until we are fairly well acquainted with their effect when given in addition to other foods. A field experiment on the College farm was carried out with potatoes, the results of which are reported herewith in detail.

The Director distributed a large number of samples of sugar beet seed to farmers last spring. This seed was furnished by the U. S. Department for distribution. Very few of the farmers have reported the results obtained with the beets raised from this seed.

In addition to our work at home with feeding and cropping we have been able to accumulate some information from outside sources which will be of considerable value. Col. J. A. Lockhart, of Rockyford, who is feeding about 3,700 head of cattle, and is using beet pulp and beet molasses in great quantities, has agreed to furnish us his data for publication. The records are being kept in such a way that this material will be of great value. We visited Rockyford on two occasions and have obtained some photographs of the feeding plant and of the cattle which are being fed for market.

We have taken a series of photographs in many of the experiments carried out and consider them a very valuable part of our Station records as well as serving a most useful purpose for illustrating when we have data of sufficient value for publication.

My Experiment Station Assistant, Mr. A. H. Danielson, is thoroughly efficient. He has made his records very accurate and valuable, and his work in photography is of such a character that it is almost indispensable. Mr. Danielson has furnished the detailed reports of experiments with wheats, grasses and potatoes published herewith.

While not an employe of the Station, Mr. C. J. Griffith, who is assisting with the live stock work, is also a careful investigator and through his efforts we are able to publish material of value with regard to feeding live stock, and have accumulated data which will be useful for Station publications in the future.

#### FIELD EXPERIMENT WITH POTATOES.

In recent years it has not been possible to raise remunerative crops of potatoes in the vicinity of Fort Collins, and we carried on a field experiment to throw light on the difficulty if possible. While this experiment has been under way the Horticultural Section has also been working on the problem, and their discovery of the effects of a new disease on potatoes indicates, we believe definitely, the cause of our potato failures. It will probably not be advisable for us to continue the field experiments until such time as the Professor of Horticulture and his assistants have completed their work. Their investigations indicate that our soils have become so full of the fungus that causes the trouble, that it will be necessary to discover some general treatment which will destroy the disease producing spores, or to grow varieties of potatoes which will resist their attacks, or be immune.

Our field trial of last season is of interest, however, as it indicates that different varieties are affected in different degree. One of the objects of the experiment was defeated by accidentally getting the potatoes for seed which we had obtained from different localities mixed. We wished to compare seed raised at an altitude of about 9,000 feet in the mountains with seed of the same variety grown on the plains, but the two lots were not kept separate before planting so we are unable to report this comparison.

We purchased red and white potatoes in the market. The reds were probably Early Rose, and the white ones Mammoth Pearl, though the dealers could not give us the variety names. These were divided into separate lots. A part were treated and a part planted without treating, and parts were planted with and without fertilizers. The treatments given were with corrosive sublimate and formalin for scab, and the fertilizers used were raw bone meal and nitrate of soda. None of the potatoes produced large yields, but the red variety gave much better yields under the different treatments than was obtained with the white variety. The largest yield was  $49\frac{1}{4}$  sacks per acre of marketable tubers, or a little less than  $72\frac{1}{2}$  sacks of large and small tubers.

The yields vary somewhat but it cannot be said that the fertilizers produced any increase. The treatment of seed with corrosive sublimate seemed to give a slight increase in yield of marketable potatoes, though the difference is small. The results of the experiment are given in the following table. The potatoes were

planted late, June 17, and harvested October 14. Lot No. 13 in the table was selected as free from disease. Lot No. 14 was affected with a dry rot (*Fusarium*) and was not treated. Lot No. 15 was affected seed with the injurious fungus (*Rhizoctonia*) but not treated. Lot No. 16 was affected seed treated with corrosive sublimate, and Lot No. 17 was affected seed treated with formalin.

It will be noted that the selected clean seed not treated, gave the largest yield of marketable potatoes. The diseased seed produced a poor stand of potatoes, or rather, many of the plants died from the disease after they came up, cutting down the yield.

Lot No.	Pounds Per Acre Planted	Variety Treatment Corrosive Sublimate	Pounds Fertilizer Per Acre	Market-able Per Acre	Not Mar-ketable Per Acre	Total Per Acre	Weight of 10 Largest Pounds	REMARKS
1	932	Red, Not Treated	None	2381	3075	5456	6.3	Decidedly Scabby
2	1207	Red, Not Treated	761 Bone Meal	2520	4360	6880	6.1	30% Scabby, balance free
3	941	Red, Not Treated	286 Nitrate of Soda	2130	3700	5830	7.2	Fair amount of scab
4	832	Red, Treated	None	4525	2835	7360	8.0	Free from scab
5	762	Red, Treated	477 Bone Meal	4925	2320	7245	7.25	Free from scab
6	754	Red, Treated	220 Nitrate of Soda	4615	2115	6730	7.00	Free from scab
7	814	White, Not Treated	None	2440	2460	4900	6.2	No Scab. Crackling of Skin
8	786	White, Not Treated	599.3 Bone Meal	2380	2190	4570	6.0	Free from scab
9	833	White, Not Treated	317 Nitrate of Soda	2360	2170	4530	6.2	Free from scab
10	878	White, Treated	None	2320	1915	4235	5.75	No scab. Few crackled
11	867	White, Treated	771 Bone Meal	2085	1965	4050	5.5	Free from scab
12	877	White, Treated	505 Nitrate of Soda	2380	1690	4070	5.75	Free from scab

Lot No.	Pounds Per Acre Planted		Market-able Per Acre	Not Mar-ketable Per Acre	Total Per Acre	Weight of Largest 10 Pounds	REMARKS
13	1019	Clean Seed, Not Treated	3733	2322	6055	10.5	Free from scab. No crackling skin. Outer skin peeling off.
14	641	Not Treated	1017	962	1979	6.00	Poor stand. Small potatoes.
15	1086	Not Treated	3666	2304	5970	9.00	Free from scab.
16	979	Corrosive Sublimate	2685	2540	5234	8.2	Free from scab, or small traces.
17	987	Formulose	2915	1889	4804	8.00	No scab. Less smooth than preceding.

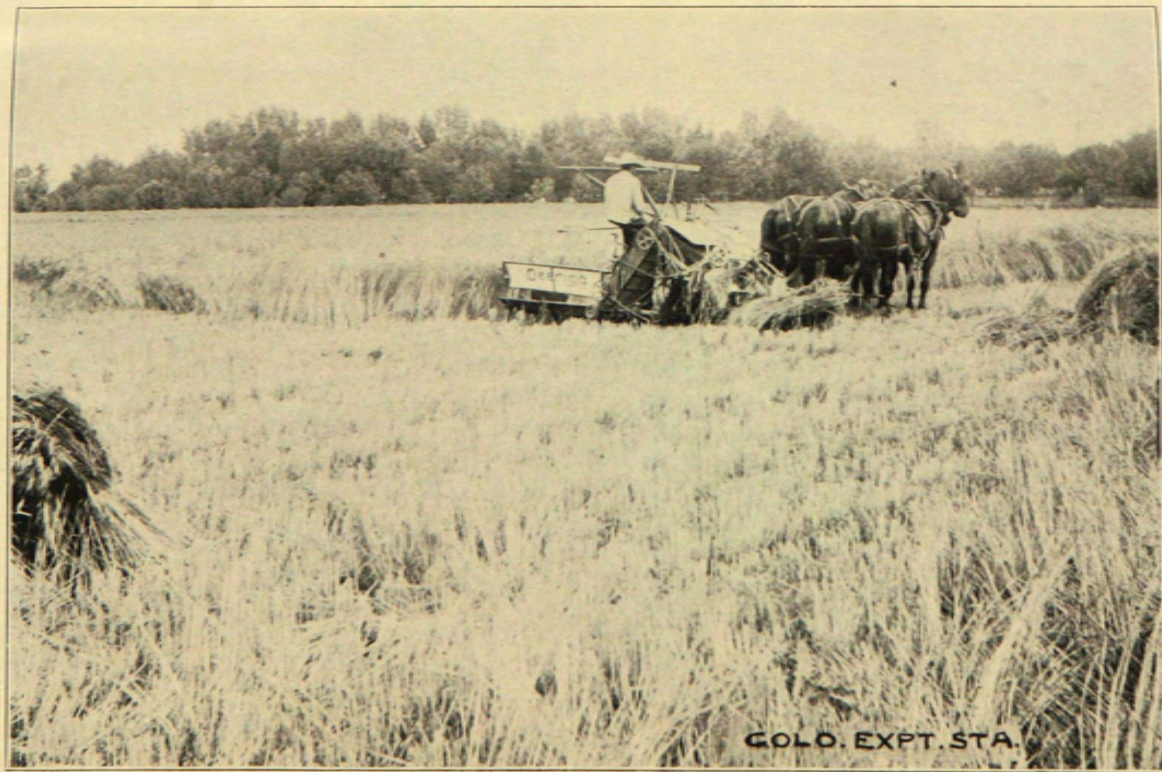


PLATE V.

SHRINKAGE OF POTATOES.

Some of the red and white potatoes from the field experiment were stored in a root cellar, careful weights being recorded to determine the amount of shrinkage. There were two sacks of white potatoes and six sacks of a red variety placed on an old door which was used as a platform to keep them dry. The white potatoes were a late variety and having been planted so late, June 17, did not ripen. They were bruised and peeled badly from handling. They were weighed and placed in the cellar October 18, and were subsequently weighed December 14, and March 8 approximately two, and four and one-half months after storing.

The following table gives the results. The lot numbers given in the first column correspond to the same numbers given in the table reporting the field experiment and are a key to the kind of seed, treatment and fertilizers used. It will be noted that the greatest loss of weight occurred during the first two months, the average loss being 5.5 per cent. for that period, while it is only 7 per cent. for the whole time.

As would be expected the loss of the white potatoes which were green when harvested, was greater than the average. There is some variation in the shrinkage from the individual lots of red potatoes, but we would probably not be justified in stating that this difference is due to previous treatment of the seed from which the potatoes were grown, or to the fertilizers used.

SHRINKAGE OF POTATOES STORED IN SACKS.

Lot No.	Variety	WEIGHT				Per cent. Shrinkage in 4½ months
		Oct. 18 lbs.	Dec. 14 lbs.	March 8 lbs.	Total Loss lbs.	
13	Red	101	96	94.2	6.8	6.7
15	"	100	95.5	94	6.0	6.0
16	"	106	102	100.5	5.5	5.2
17	"	117	109	107	10.0	8.5
1	"	119	111.2	109.7	9.3	7.7
6	"	87	83	82	5.0	5.7
11	White	85.5	80.5	78.5	7.0	8.2
12	"	88.5	83	81.5	7.0	7.9
Total.....		804	759.2	747.4	56.6	7.0

MACARONI WHEATS.

A Brief Report of the Varieties as Tested at the Experiment Station, Fort Collins, Colorado, 1901.

Through the importation and distribution of macaroni wheats by the U. S. Department of Agriculture, considerable interest has

been awakened in this class of grain. Macaroni wheats are considered drouth resistant varieties, and while there is objection in many parts of Colorado to any grain which produces beards, the macaroni varieties of wheat will undoubtedly take an important place in our agriculture, more especially so, perhaps, in the eastern part of the State where crops are raised without irrigation.

The varieties obtained from the U. S. Department were planted with a grain drill in plats 1-20 acre in size, using at the rate of 90 pounds of seed per acre. After harvest each plat was carefully measured and the yield per acre calculated. The stubble left on the field had an average height of 0.2 metres or 8 inches. The land used had been in grain the year before. The plats received one thorough irrigation June 26-27, and the precipitation for the growing season amounted to 10.53 inches, there being 7.47 inches in May, 2.35 inches in June and 0.71 inches in July. The weight per bushel of the grain harvested in nearly every case exceeded that of the seed planted. The table herewith gives the variety, the yield of straw and grain per acre, weight per bushel of that grown on the Station ground and of the seed received, and seasonal notes.

A report of these grains was made to M. A. Carlton, Cerealist of the U. S. Department of Agriculture. He writes as follows: "It is of particular interest to note how the weight of the grain which you have grown varies from the weight of the original seed, being in nearly every case greater than that of the original seed planted. The results as to yield per acre are considerably different in this case from what they have been in other states where trials have been made. In other cases the Kubanka has usually turned out the best, while in this case it stands only about fifth in the order of yield. The Gharnovka, however, which stands at the head in yield in this case is considered also a very good variety in south Russia."

The following additional notes not given in the table were taken of each variety:

No. 4277, Nicaragua. ("Triticum durum. This seed was obtained in Texas where the variety has been grown for a number of years. From its name it probably came originally from Nicaragua"). Was at about the right stage of maturity when harvested. Straw rather short. Grain of fair quality with somewhat smaller kernels than the others; small yield.

No. 5639, Kubanka ("Triticum durum, from Uralsk Territory, Russia. One of the best varieties of macaroni wheats in Russia"). This variety germinated and was above ground ahead of all others. A long strawed variety. The grain harvested was of less weight per bushel than the seed planted, lighter colored, longer kernels, harder and of greater vitreous luster. By grading

the grain threshed into two equal parts the heavier weighed 64 pounds per bushel.

No. 5642, Yellow Gharnovka. ("Triticum durum, from Ambrocievka, twenty miles northeast of Taganrog in Don Territory, Russia"). On July 9 considerable smut was noticed in this variety. The awns or beards were long and abundant. Grain darker colored, more plump, or not quite so shrunken, and of much greater vitreous luster than the original seed planted.

No. 5643, Gharnovka. ("Triticum durum, from the same place as the preceding number"). When harvested the awns stood at right angles to the heads making the grain somewhat disagreeable to handle. The grain is of the same color and luster as the original planted, but the kernels were decidedly smaller, with an increase in weight per bushel.

No. 5644, Velvet Don. ("Triticum durum, Chernouska of some reports, from the same locality as the above"). Heads with velvet chaff. Grain was lighter colored, of greater vitreous luster and longer kernels than the original planted.

No. 5645, Black Don. ("Triticum durum, Chernokoloska of some reports, from the same locality as the above"). Awns or beards were partly black. Grain much lighter colored, more plump and of greater luster than the original planted. After the threshed grain had been graded into two equal parts the heavier grain weighed 65 pounds per bushel.

No. 5646, Gharnovka, from Taganrog. ("Triticum durum, from Taganrog, Don Territory, Russia"). On July 9 a few heads of smut were noticed. The threshed grain of this variety is practically of the same appearance in every respect as the original planted, unless it be lighter in color.



TABLE OF COMPARATIVE YIELDS.

Number and Name	Grain	Straw	Weight	Weight	Average	Date of	Date	Date of	Date of
	Per Acre.	Per Acre.				Per Bushel	Per Bushel	Height of	Planting.
	Pounds	Pounds.	Per Bushel	of Seed	Plants.	April	Ground.	July	August
		Stubble		Planted	Metres.		May		
		0.2m High							
4277 Nicaragua .....	1078	3380	62.5	..	1.07	27	7	10	5
5639 Kukanka .....	1855	6133	62	64	1.57	26	4	2	5
5642 Yellow Gharnovka .....	1640	4980	63	60	1.44	26	8	5	5
5643 Gharnovka .....	1860	5730	63	62	1.37	27	8	5	5
5644 Velvet Don .....	1893	6476	63.5	63	1.47	27	6	3	5
5645 Black Don .....	1984	5930	64	63	1.40	27	5	3	5
5646 Gharnovka .....	1907	....	64	63	1.37	27	5	2	5

## EXPERIMENTAL GRAIN PLATS.

Seven varieties of barley were grown in small plats of approximately one-tenth acre each, and one of these, the Hanna, was grown in a larger field trial of one-half acre. The results on the small plats are reported in the accompanying table.

The Bohemian and Hanna barleys were grown from seed furnished by the U. S. Department of Agriculture. The Bohemian came from Schurazenburg, Bavaria, and the Hanna from Kwassitz, Moravia, Hungaria. We could detect no varietal difference between these varieties. Both have the same season, and yielding power, and both show a tendency to drop the awns or beards at maturity which makes them less disagreeable to handle.

The Hanna is a famous European brewing barley. In a larger field trial of one-half acre it was drilled about three inches deep on April 22, using at the rate of 80 pounds seeds per acre. It received one irrigation on June 24, and was harvested July 25. The yield per acre was 1892 pounds, or at standard weight of 48 pounds per bushel, 39.4 bushels per acre. Our first season's trial indicates that this variety is well adapted to Colorado conditions.

The other varieties given in the table were from seed which had been previously grown at the College.

The oat crops are of some interest. Three new varieties are reported in the table. The varieties from Finland were a little earlier than the others, and one of them produced a large yield. There is a strong prejudice against black oats on the part of our farmers because the wild oats have become such a troublesome weed, and the seed mixed with other grain makes it less valuable. However, the black cultivated oat need not be mistaken for the wild variety, and while it might not pay to raise black oats for our markets, there is no good reason why a farmer should not raise them for his own use if he can obtain a superior yielding sort. The black oats raised from Colorado seed produced a much larger yield than any of the others which were raised under the same conditions, giving 71 bushels per acre, while the yield of the North Finnish variety was 60.5 bushels, and of our best white variety, the Silesian, was 52.4 bushels per acre. However, the Silesian oats planted on a larger area of alfalfa land, gave a fine crop. There was about eight acres in a field which yielded 497.5 bushels, or an average of 62.2 bushels per acre machine measure, and the oats weighed 37 pounds per bushel. On a selected and measured acre in this field the yield was 82 bushels by measure and 87 bushels by weight.

The Russian speltz reported in the table was grown from seed furnished by the U. S. Department. We also purchased 300

pounds of seed which was raised by William Lindenmeier near Fort Collins, and planted three acres of land with it. This field was irrigated June 24, and harvested July 27, yielding 181 bushels, machine measure. The crop weighed 5,386 pounds, which would make the weight per bushel 30 pounds, as it came from the machine only partially cleaned.

#### BROADCASTING VS. DRILLING GRAIN.

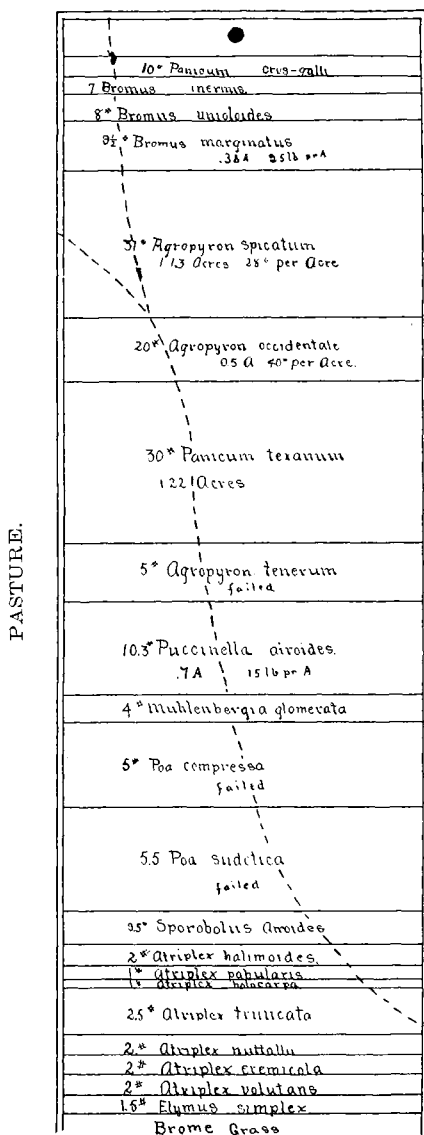
An interesting case of the relative effects of broadcasting and drilling the seed was noted on the experiment plats in 1901. On the plats where the effects of differing amounts of Nitrate of soda upon wheat and oats was being studied, the seed was broadcasted and harrowed instead of being sown with the grain drill.

The seed began to germinate fully a month after planting and then only a small per cent. came up. The plants which came up late did not have time to form sufficient root system to resist the dry weather which followed, and part of the oat plants dried up without maturing. On account of the late germination of the seed, the weeds got ahead of the grain and helped smother the plants coming up. This resulted in a total failure of the crop. Those plants which came to maturity showed absolutely no difference in growth on the fertilized and unfertilized plats.

B. C. BUFFUM,  
Agriculturist.

SOME OF THE EXPERIMENTAL GRAINS—1901.

	Weight of Grain per Acre. Pounds.	Wgt. of Grain & Straw per Acre. Pounds.	Length of Heads. Metres.	Height of Straw. Metres.	Length of Stubble. Metres.	Amount of Seed Planted per Acre. Pounds.	Date of Planting. April	Date Above Ground. May	Date of Heading. June.	Date of Harvesting. July	REMARKS
Barley, Beardless.....	1344	2088	.09	1.05	.17	95	27	5	25	26	Heavy heads; best hulls barley in the plots.
" Dakota Silver.....	1791	3582	.08	1.13	.19	95	27	5	25	26	More tall than preceding.
" Black.....	1009	3188	.08	.85	.17	95	27	5	25	26	Bearded; Very short straw.
" Giant White—Salzer.....	1872	3828	.07	.97	.18	95	27	5	July 2	26	A late, tall, beardless, small-headed variety.
" Mansbury.....	2081	4951	.07	1.14	.18	95	27	5	June 25	26	A very handsome barley, tall and erect, bearded, six-rowed.
" Bohemian, from Schurzenburg.....	2294	5028	.12	1.06	.18	103	27	6	25	26	A two-rowed, bearded, brewing variety.
" Hanna, No. 5793.....	2286	4957	.11	1.03	.18	106	27	5	25	26	Similar to preceding, long heads.
Oats, Russian, No. 2800.....	1289	4602	...	1.43	.18	108	27	7	July 9	31	Straw matures late.
" Black (Colorado Seed).....	2272	6448	...	1.36	...	59	27	4	9	31	A late variety, slender straw.
" North Finnish, Black, No. 5739.....	1986	5808	.85	1.43	.25	77	27	6	2	26	An earlier variety; very coarse straw.
" Forno, Finnish, Black No. 5513.....	1450	3819	.34	1.40	.25	92	27	6	2	26	Much earlier than Solesian; some rust.
" Solesian.....	1677	4595	...	1.44	...	...	27	4	5	31	Sixty per cent. of heads ripe when harvested.
Spolka, Russian, No. 2959.....	661	3934	.03	1.30	.22	85	27	6	5	26	Straw matures from base; in the dough when harvested.
Rye, Prolific Spring.....	1570	4710	.11	1.36	.27	85	27	6	June 21	26	Heads well filled; fine straw!



PASTURE.

PLATE VI.

Dotted line represents an Alkali Slough.



PLATE VII.

Plat No. 99. *Eragrostis neomexica* (Mexican Crab Grass). August 22, 1901.



PLATE VIII.

Plat No. 92. *Euchlaena Luxurians* Teosinte. August 31, 1901.

A REPORT OF THE CO-OPERATIVE GRASS AND FOR-  
AGE PLANTS EXPERIMENTS WITH THE U. S.  
DEPARTMENT OF AGRICULTURE AT THE  
COLORADO AGRICULTURAL EXPERI-  
MENT STATION, IN 1901.

BY A. H. DANIELSON.  
Assistant Agriculturist.

In the spring of 1901 a great number of species of grass seeds were received from Prof. A. S. Hitchcock of the U. S. Department of Agriculture, to determine their adaptability to Colorado. Of these grass seeds, the larger quantities were planted in an eight acre field, in the middle of May, as field trial, and a small quantity of each was also planted in small plats in the grass garden about the first of June. In spite of the frequent rains during May and June very few made any sort of stand, and a great many did not germinate at all.

THE GRASS GARDEN.

A plat of ground was divided into small plats 8x10 feet, with 2-foot alleys between them. The ground had been in Brome grass for three years, and after the grass was started in the spring, was plowed deeply and again cross plowed. The plowed soil was then disc-harrowed again and again; harrowed with a common harrow several times and all the Brome grass roots dug and removed by hand. A heavy rain amounting to half a foot on May 20-23 was followed by several light showers until after another soaking rain the soil was well saturated, when on the 1st of June the seed was sown by scattering over the plats and raking it in well. During June frequent rains kept the surface moist, making unusually favorable conditions for the seed to germinate. The weeds of course proved to be more ambitious than the grasses planted, so beginning with July 1 the plats were weeded by hand and all weeds and plants except the variety planted removed. Part of the garden was watered with hose and sprinkler occasionally throughout the month.

It appears that slight differences in soil and method of planting have great influence on the germination and growth of grass seeds. The same seed which made good plants in the field failed to germinate at all in the grass garden. Different methods of planting, and early, late and fall planting will be tried, however, until we discover the right way, for we are determined to get a good stand with all the grasses and forage plants possible.

For convenience it has been thought best to divide the species



growing in the grass garden into classes: Those that made a good growth, a moderate growth, and those that made little growth or died out, and those which never germinated.

#### THE FOLLOWING SPECIES GREW WELL.

Plat No. 53. *Panicum crus-galli*—Japanese Barnyard Grass. Seed from Amherst, Mass., planted very thickly. July 10, up; July 22, one of the most luxuriant plants in the plats, entire plat covered and 20 inches high. Sept. 28, harvested; seed ripe and saved. Weight of cured hay from 80 square feet, 31.6 pounds, or at the rate of  $8\frac{1}{2}$  tons per acre. Weight of seed 2.5 pounds.

Plat No. 99. *Eragrostis neomexica*—New Mexico Crab Grass, an annual. Seed from Metcalfe, N. M. July 1, up. July 22, fine stand and very thick, 12 inches high. Aug. 31, the finest appearing grass in the plats; slender stems clothed with abundant foliage, has been heading for two weeks but seed is not yet ripe. Average height 36 inches, tallest plant 51 inches high. Oct. 4, yet unaffected by frost, seed ripe and shelling out. Oct. 19, harvested, weight green 22.9 pounds, seed threshed out 0.8 pounds. The seed does not ripen all at once and there is a great deal left on the stems which may ripen later when dry. (Shown in Plate VII).

Plat No. 92. *Euchlaena luxurians*—Teosinte. Seed from Texas Seed & Floral Co. June 14, well up. July 22, very thrifty, 16 inches high. Aug. 31, growing well, good stand, leaves resemble those of corn. Average height 30 inches, highest 47 inches. Seems very hardy, not injured by frost at all by Oct. 4. By Oct. 19 totally killed by frost and dry; harvested. (Shown in Plate VIII).

Plat No. 50. *Bromus secalinus*—(Cheat) (G. & L. Mont.) June 10, up. July 22, very good stand and thrifty, 4 to 12 inches high. Aug. 22, thrifty, close tufted mat, height 4-8 inches. Aug. 31, tops eaten and damaged somewhat by grasshoppers.

Plat. No. 68. *Elymus Canadensis*—Canadian Rye Grass from Shear, Colorado. July 2, up fairly well. July 22, fairly good stand, looks promising; 4-8 inches high. Sept. 15, a few heads have produced seed. March 11, 1902, the fall planting is coming up thickly, 1-1 $\frac{1}{2}$  inches high.

Plat No. 56. *Panicum milliaceum*—Broom Corn Millet, from Potomac Flats, D. C. June 10, up. July 22, full stand, 8-4 inches high, just heading. Aug. 22, seed fully ripe and plants drying up, average height 17 inches. Sept. 21, harvested and seed saved. Weight of dry hay 1.6 pounds. Seed 0.7 pound.

Plat No. 88. *Elyusine coracana*—African Millet, from A. B. Leckenby, Washington State. June 14, up. July 22, very good stand and thrifty. 12 inches high. Aug. 31, has been heading for the past two weeks but seed is not yet ripe; claw shaped heads on end of scape. Average height 16 inches, highest 24 inches. Sept. 28, harvested, seed has been ripe for some time. Weight of partly cured hay 17.4 pounds, seed 2.5 pounds.

Plat No. 59. *Sporobolus cryptandrus*—Drop Seed from Shear, Colorado. July 22, just coming through the ground very thickly. Sept. 28, a good stand but very short. Forms a sod, very caespitose.

Plat No. 54. *Panicum texanum*—Colorado Grass, Texas Millet, from H. L. Bentley, Texas. July 6, up. July 22, good stand at one end of plat. Better success in field plat.

Plat No. 51. *Bromus unioloides*, from M. W. Johnson Seed Co., Atlanta, Ga. June 14, up. July 22, good stand at one end of plat. Beginning to head, 8 to 12 inches high. Aug. 22, seed ripe, falling off; plants 15 inches high.

#### THE SPECIES WHICH MADE ONLY A MODERATE GROWTH.

Plat No. 70. *Elymus ambiguus*—July 2, above ground. July 22, up fairly well, 4-8 inches high.

Plat No. 60. *Sporobolus wrightii*—Saccaton, from Griffiths, Arizona. July 6, up. Sept. 28, a few good plants about 8-12 inches high.

Plat No. 55. *Panicum bulbosum*—Alkali Saccaton, from Potomac Flats, Washington, D. C. July 5, up. July 22, a few scattered plants but the greater part just coming up. Oct. 19, damaged considerably by grasshoppers.

THE FOLLOWING MADE LITTLE GROWTH OR DIED OUT AFTER COMING UP.

Plat No. 100. *Cynocurus cristatus*—Crested Dogs Tail, from I. W. Woods & Son, Virginia. July 1, up; died out later.

Plat No. 95. *Boutelona oligostachya*—Blue Grama, from Griffiths, Cochise, Arizona. Oct. 15, a few plants in evidence.

Plat No. 96. *Calamovilfa longifolia*—From Grand Haven, Mich. July 1, up; died out.

Plat No. 90. *Agrostis stolonifera*—Creeping Bent Grass, from Wood, Stubbs & Co., Kentucky. July 1, up.

Plat No. 85. *Festuca arundinacea*—Red Festuca, from A. B. Leckenby, Walla Walla, Washington. June 14, up. Oct. 15, a number of plants, species uncertain.

Plat No. 84. *Festuca rubra*—Red fescue, from Peter Henderson, New York, July 1, up.

Plat No. 80. *Festuca durinacula*—Hard fescue, from Peter Henderson, New York. July 1, up.

Plat No. 76. *Poa nevadensis*—Nevada Blue Grass, from A. B. Leckenby, Walla Walla, Washington. July 1, up.

Plat No. 75. *Poa laevialmia*—From A. B. Leckenby, Washington. July 1, up.

Plat No. 74. *Poa trivialis*—From Peter Henderson, N. Y. July 1, up.

Plat No. 69. *Elymus glaucus*—(G. & L. Mont.) July 2, up.

Plat No. 65. *Elymus glabrifolius*—Smooth leaved rye grass, from Texas. July 2, up.

Plat No. 64. *Elymus virginicus submuticus*—Short-awned rye grass, from A. B. Leckenby, Washington. July 2, up.

Plat No. 63. *Agropyron spicatum*—From A. B. Leckenby, Utah. July 2, up. (This species did much better under field culture.)

Plat No. 62. *Agropyron occidentale*—From Elias Nelson, collected near Wymore's ranch on the Big Laramie River, Wyoming, Aug. 24, 1900. July 2, up. (Under field culture this species made a good stand in places.)

Plat No. 49. *Bromus richardsoni*—Richardson's Brome Grass (G. & L. Mont.) June 14, up.

Plat No. 48. *Bromus richardsoni pallidus*—Richardson's Brome Grass, (G. & L. Mont.)

THE FOLLOWING SPECIES DID NOT GERMINATE.

Plat No. 98. *Deschampsia caespitosa*—Tufted Hair Grass. (E. Nelson, Wyoming.)

Plat No. 97. *Dactyloctenium australensis*—Button Grass, from Potomac Flats, D. C.

Plat No. 94. *Ammophila arenaria*—Beach Grass, from Provincetown, Massachusetts.

Plat No. 93. *Calamagrostis canadensis acuminata*—From E. Nelson, Wyoming.

Plat No. 91. *Alopecurus pratensis*—Meadow Foxtail—From Wood & Son, Richmond, Virginia.

Plat No. 89. *Beckmania erucaeformis*—Slough Grass. (Griffith & Lange, Mont.)

Plat No. 87. *Puccinellia airoides*—From E. Nelson, Wyo. (This species made a fair growth under field culture.)

Plat No. 86. *Festuca ovina*—Sheep Fescue, from Nongesser & Co., New York.

Plat No. 83. *Festuca kingii*—King's Fescue, from A. B. Leckenby, Walla Walla, Washington.

Plat No. 82. *Festuca heterophylla*—Various leaved fescue, from D. Leudreth, Philadelphia.

- Plat No. 81. *Festuca thurberi*—Thurber's fescue, from Shear, Colo.  
 Plat No. 79. *Poa macrantha*—Seaside Blue Grass, from A. B. Leckenby, Wash.  
 Plat No. 78. *Poa wheeleri*.  
 Plat No. 77. *Poa lucida*—Shining Blue Grass, from A. B. Leckenby, Wash.  
 Plat No. 73. *Poa compressa*—Canadian Blue Grass, from I. W. Woods & Son, Va. (This seed did not germinate either in field or grass garden.)  
 Plat No. 72. *Poa sudetica*—From Paris, France. No. 4334. (Not a seed of this lot germinated either in field or garden.)  
 Plat No. 71. *Elymus condensatus*—Giant Rye Grass. (G. & L. Mont.)  
 Plat No. 67. *Elymus simplex*—Alkali Rye Grass, from E. Nelson, Wyo.  
 Plat No. 66. *Elymus macounii*—Macon's Rye Grass, from E. Nelson, Wyo.  
 Plat No. 61. *Agropyron tenerum*—Slender Wheat Grass, from K. M. Iver, Canada.  
 Plat No. 58. *Agrostis canina*—Rhode Island Bent, from Peter Henderson, New York.  
 Plat No. 57. *Agrostis alba*—Red Top, from Nongesser & Co., New York.  
 Plat No. 52. *Panicularia americana*—American Manna, from E. Nelson, Wyoming.

A number of plats were planted with some commercial seed bought in the open market some years ago. Among these the following made fair success, particularly sand or hairy vetch (*Vicia villosa*):

Orchard Grass, French Rye Grass, Italian Rye Grass, Common Crimson clover, Sand Lucerne, Bee clover, Sand or Hairy Vetch, Velvet Bean, Idaho Coffee Berry or French Pease, etc., European Flax, Johnson Grass.

In the fall of 1901 the grass plats were replanted by opening shallow furrows every six inches, leaving the ground between intact. This is to determine whether freezing the seed during the winter will cause it to germinate more satisfactorily. Early in the spring of 1902 the grass plats were again being replanted by opening furrows across those previously made. This is to see whether early planting is not more successful than late. We are determined to have a representation of all the species possible.

#### THE GRASSES AND FORAGE PLANTS UNDER FIELD CULTURE.

A field of over eight acres was planted to many species by drilling or broadcasting, to determine what the grasses would do under ordinary farm methods. A depression runs across the land through which runs the seepage from the fields above during the irrigating season. In course of time the soil in this depression has become strongly charged with alkali. The grass seeds were so planted that part of each plat was wet during the season while the balance was on high ground, not capable of being irrigated.

The seeds of the salt bush, (*Atriplex*) were planted in every possible manner on both wet, alkaline and dry land, but none germinated, at least this season. A wild millet (*Panicum* sp.)

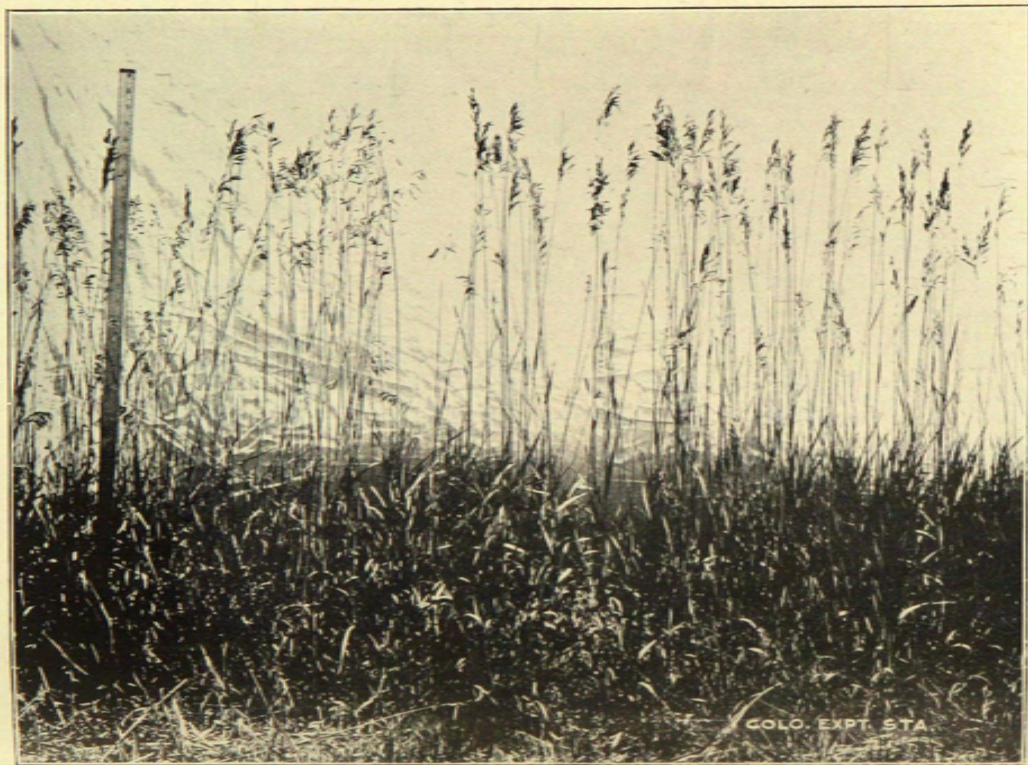


PLATE IX.  
*Eromus Inermis* (Prome Grass).

and a salt sage grows naturally in abundance on this land besides other weeds common on irrigated lands.

The land, which had previously been in a thin stand of Brome grass (*B. Inermis*), was first disc-harrowed and then thoroughly harrowed with a common harrow. The seed was planted between May 10th and 14th by drilling it in with a common grain drill with grass seed attachment where the shape of the seed permitted, or broadcasted by first harrowing with the drill, sowing the seed and again covering by running over the ground with a drill. When all the seeds had been planted the surface of the soil was thoroughly compacted by running over it with a heavy iron roller. Very heavy rains between May 20 and 22, washed the land quite badly. Frequent rains the following month gave the grass seed a good chance to germinate—also the weeds. The latter became so thick by the middle of summer that the entire field had to be gone over with the mowing machine. In the latter part of summer the field was pastured by cattle.

No definite conclusions can, of course, be drawn from a single season's test, but we have received some valuable hints of promising species. The cultivated barnyard grass (*P. crus-galli*) is eaten greedily by cattle (it was almost dug out by the roots by them) and two species of Brome grass (*B. marginatus* and *B. unioloides*) seem to do better the first year even than (*B. inermis*).

*Panicum crus-galli*—Japanese Barnyard Grass. Seed from Amherst, Mass. Sown very thick on 0.16 acre with grain drill at the rate of 64 pounds per acre, May 14. May 25, up. June 12, about 2-4 inches high. July 2, very good stand, 4 to 10 inches high. When pastured by cattle later in the summer it was very readily eaten by them.

*Bromus inermis*—Planted May 14 on 0.15 acre at the rate of 48 pounds per acre by broadcasting and drilling; drilled twice and broadcasted between the two drillings. June 12, about 1½ inches high; fairly good stand. July 2, very good stand in places.

*Bromus unioloides*—Rescue Grass, an annual, from M. W. Johnson Seed Co., Atlanta Ga. Seed planted May 14 by drill; drilled one-half of the land twice. July 2, fair stand in spots. July 18, heading or going to seed in places; 4-8 inches high.

*Bromus marginatus*—Shortawned Brome Grass. (Nees.) Sown May 13, by broadcasting; land harrowed with drill before and after sowing on 0.38 acre at the rate of 25 pounds per acre. June 12, fairly good stand, 1-2 inches high. July 2, very good stand in places, about 4 inches high. This species has made much better growth all around than *B. Inermis*.

*Agropyron spicatum*—From A. B. Leckenby, Utah. Sown by broadcasting on 1.13 acres at the rate of 27 pounds per acre; land harrowed before and after sowing. May 13, planted; June 12, very fair stand, 1-2 inches high. July 2, good stand in spots.

*Agropyron occidentale*—Collected near Wymore's ranch on the Big Laramie, Wyo., Aug. 24, 1900, by Elias Nelson. Sown by broadcasting on 0.5 acre at the rate of 40 pounds per acre, May 13. July 2, good stand in places, very slow to germinate and plants very scattered.

*Panicum texanum*—Texas Millet, Colorado Grass, from H. L. Bentley, Texas. Sown May 13 by broadcasting on 1.2 acres at the rate of 24 pounds per acre. June 12, just beginning to show above ground. July 2, fine stand in places. Oct. 23, has made considerable growth this summer and quite matted along the drill rows; plants average about 3 inches apart.

*Puccinella airoides*—From Elias Nelson, Wyoming. Seed broadcasted on May 11, on 0.7 acre at the rate of 15 pounds per acre. Seed very fine and small; screened twice but too full of straw to be drilled with grass attachment. Managed to drill a small part of the land. July 2, growing well in spots but there are large bare places. July 18, heading or going to seed; 8 inches high. Aug. 22, making fine growth in spots at north end; low densely tufted basal leaves; very slender fine culms.

*Muhlenbergia glomerata*—From A. B. Leckenby, Walla Walla, Wash. Broadcasted seed on 0.2 acre at the rate of 20 pounds per acre on May 11. June 12, coming up fairly well. July 2, very promising stand, about the best in the field.

*Sporobolus airoides*—Alkali Fine Top. Two lots of seed, from E. Nelson, Wyoming, and G. & C. Mont. Broadcasted May 10, harrowed with drill before and after sowing. July 2, making thrifty tufts of grass in places.

*Agropyron tenerum*—Slender Wheat Grass, from K. M. Iver, Canada. Seed like small oats. Planted with drill May 11. Total failure; never germinated.

*Poa compressa*—Canadian Blue Grass, from L. W. Woods & Son, Virginia. Sown with drill at different depths using small seed attachment, May 11. Did not germinate.

*Poa sudetica*—From Paris, France. No. 4334. Planted with drill, covering lightly, using grass seed attachment. Not a seed germinated.

*Elymus simplex*—Alkali Rye Grass, from E. Nelson, Wyoming. Planted May 10. Did not germinate.

#### ATRIPLEXES.

None of the following saltbushes germinated this year. They were planted with the drill where the seed permitted or otherwise broadcasted. They were planted by dropping the seed in a shallow furrow, by covering lightly and again deeply; they were planted on wet alkali soil, moist soil free from alkali and on dry land but none germinated.

*Atriplex halimoides*—Gray Saltbush, from Potomac Flats, Washington, D. C.

*Atriplex holocarpa*—Annual Saltbush, from Potomac Flats, Washington, D. C.

*Atriplex pabularis*—Forage Saltbush, from Elias Nelson, Wyoming.

*Atriplex eruncata*—Utah Saltbush, from E. Nelson, Wyoming.

*Atriplex nuttallii*—Nuttall's Saltbush, from E. Nelson, Wyoming.

*Atriplex eremicola*—Desert Saltbush from E. Nelson, Wyoming.

*Atriplex volutans*—Tumbling Saltbush, from E. Nelson, Wyoming.

REPORT OF THE METEOROLOGIST AND IRRIGATION  
ENGINEER.

---

The work of this Section of the Experiment Station has been very largely the development of plans that have guided the work for a number of years.

The plans of work originally included a study of irrigation conditions of the whole State, or what was planned to be an irrigation survey. In connection with this an examination was to be made of the various valleys of the State, and the conditions especially regarding water and the use of water leading to a description of the valleys in detail.

The means at the command of the Section have been small so that the general purpose has been very much affected, and it has been necessary to take up some phases which would make no demand for funds. This originally led to the seepage measurements on the streams, and these have been made during the past season, and carried on over hundreds of miles of streams. These particular investigations have made but small demands for funds, especially as aid has been given by the ditch companies in the different parts of the State, and others interested in the irrigation development. Other investigations which would require funds in addition to our equipment have had to be very largely set aside.

Meteorological observations have been continued. They are becoming of increasing importance. The object kept in view has been a study of the agricultural meteorology of the State, with each year's addition it becomes increasingly valuable.

These records are extensive and cover all phases, especially of the meteorology relating to moisture.

Respectfully submitted,

L. G. CARPENTER.

## REPORT OF THE HORTICULTURIST AND BOTANIST

---

I have the honor to submit the following report of the Section of Horticulture and Botany of the Agricultural Experiment Station for the year 1901.

The work of the Department has followed along the lines laid down in the schedule, as closely as the available time would permit. Mr. Rolfs was detailed to investigate the cause of potato failures and he has devoted a large share of his time to this work. A number of preliminary experiments in treating seed potatoes before planting and of spraying the vines were undertaken. The results of these experiments together with field observations and laboratory studies prove that the failure of this crop in many portions of the State is due to root diseases; the one that is most destructive being a species of *Rhizoctonia*.

Potato plants affected with *Rhizoctonia* present different characteristics according to the nature of the soil, soil conditions and the extent of injury done to the plant by the fungus. Some of the conditions that are familiar to potato growers are, very large vines which may produce either no tubers, a few tubers, or an abnormal number of small tubers. In other instances the potato plant may be killed, thus reducing the stand materially.

A number of important facts new to science have been established and the experiments give promise of practical methods of overcoming these troubles.

The cultivation of potatoes on a large scale in Colorado is restricted to a comparatively few favored localities, which is no doubt largely due to the ravages of fungi. A practical method of combating these plant diseases will mean the saving annually of many thousands of dollars to the farmers of the State.

A report of progress on this work will be published in the near future in bulletin form. The work, however, is far from completion, consequently it will form one of our more important lines of investigation in the future.

The pea disease at Longmont was not as much in evidence this season as last, though it destroyed several fields. Our investigations show that the disease is caused by attacks of a root fungus, *Rhizoctonia* species, which if not the same is closely allied to the one that is so destructive to potatoes. The fungus is present in the soil when the pea seed is sown and there is no practical method of determining its presence except by its effect on the pea plants.



Now that we know what the cause of the disease is, experiments are to be undertaken the coming season to see if it can be successfully controlled or overcome.

Two trips were made during the summer to Delta county, to investigate a disease of apple trees which had attracted considerable attention in one locality. This condition was found to be due to soil conditions and water supply rather than to the attacks of fungi.

A good deal of attention has also been given to root rot of fruit trees that is present in orchards in many parts of the State. The investigation of this trouble will form a prominent feature in our future work.

A bulletin has been prepared on the subject of "Plant Diseases" which is soon to be published. This will contain a resume of the more important diseases of the year, and directions for treatment will be given where possible.

The investigation of the apple industry of the State has proceeded slowly, owing to the lack of time. However, some data has been secured which will be added to as time and opportunity permit.

The condition of celery, mentioned in my former report, known as pithy or hollow stem, was not as prevalent this year as last. Self fertilized seed from both sound and pithy stemmed plants was secured this fall. Should plants from either lot of seed show a difference in either direction, an effort will be made to improve the variety by selection and thus produce a strain of celery that will produce a large per cent. of sound plants.

Arrangements were made with the authorities of the New York Botanical Garden to work over the material in the College herbarium and classify the plants according to the present system of nomenclature. Accordingly the herbarium has been shipped to New York and an expert is now at work on it. It is gratifying to know that this work is now to be completed and that the Flora of the State is to be published in the near future.

Respectfully submitted,

W. PADDOCK.

## REPORT OF THE ARKANSAS VALLEY SUBSTATION, ROCKYFORD.

---

Herewith is presented a summary of the work performed in the Arkansas Valley the past season:

The lines of investigation have dealt principally with the sugar beet, the cantaloupe and the tomato.

Leguminous crops have been tested for green fertilizing and forage and grasses for pasture purposes. The experimental orchard has been given due attention.

More than half of the time of the agent has been occupied in taking observations upon questions relating to the agriculture of the Valley, most of which had a bearing on the lines of work above enumerated. This part of the work has been less extended than it would have been were better transportation facilities at hand. For this reason most of the work has been restricted to the vicinity of Rockyford.

The Station land, with the exception of about 15 acres has been under lease to different parties.

The following embraces the lines of investigation with the sugar beet:

1. Means of securing a stand.
2. Success attained at different dates of planting.
3. What effect irrigation, applied at different times and in different ways, has upon the growth, yield and sugar content.
4. The use of green fertilizers, yard manures and nitrate of soda as fertilizers for the beet.
5. Note the growth of beets on alkali soil.
6. General and specific observations upon the depth of planting to secure best results.
7. Effect of hail upon the growth and maturity.
8. Observations upon insects and remedies and upon fungus diseases.

The following embraces the work with the cantaloupe:

1. Treatment of seed for blight.
2. The number of sprayings and the best time to spray for blight.
3. A verification of the work of former years.
4. Note the distribution and extent of the disease, also of insect pests.
5. Time of planting to get earliest maturity.

The following points have been studied with the tomato:

1. Propagation of the plants—what effect the use of different classes of plants may have upon maturity and production.
2. The effect of time of planting upon maturity and production.
3. The effect of fertilizers upon maturity, growth and production.
4. Test of varieties.
5. Pruning and training.

Many specimens of injurious insects have been sent to the

Entomological Department, and the Botanical Department has been advised of any fungus troubles.

Some general notes have been taken upon the spraying and irrigation of orchards and also upon the adaptation of fruits.

Full and complete record was kept of the lambs fed upon pulp for market.

The usual meteorological observations were taken and monthly reports forwarded.

Respectfully submitted,

H. H. GRIFFIN,

Rockyford, Colo., Nov. 1, 1901.

Field Agent.

REPORT OF THE PLAINS FIELD AGENT, CHEYENNE  
WELLS.

I herewith present the following report of work done at the Plains Substation and of the work done as field agent during the past year.

*The Weather.* A record of temperature, wind, rainfall and relative humidity of the air was kept until September 1, when the record of relative humidity ceased on account of the psychrometer being broken. I also acted as volunteer weather observer for the United States Weather Bureau until October 1, 1901. The usual April storm occurred causing serious losses to stockmen between the 1st and 12th of April. After the cold rains during the first part of April very little rain fell until the last of July. Several extensive prairie fires occurred during July. After rains began again there was plenty to keep the grass and crops in good condition until frost. June 11 to 15 was a period noted for storms all over the Plains of eastern Colorado. At Eads a regular tornado occurred; a saloon and school house were destroyed and several other buildings were damaged. The same day a windmill of A. Froelich, sixteen miles southwest of Kit Carson was wrecked by a storm, and the corral and stables of Mrs. A. Hinckley eight miles west of Kit Carson were destroyed by what was reported to be a cyclone.

About June 13, a sever hail storm visited the Vernon Divide, causing much damage to crops and to stock. I saw a frame house which had fourteen holes in the weatherboarding on the west side all made by hail stones during one storm. Some stones went through both weatherboarding and plastering. Animals happening to be exposed were killed.

Hot winds were quite common during June and July.

## WORK AT THE PLAINS SUBSTATION.

*Horticulture.* The fruit trees made a good growth. The effect of the storm water upon the trees shows quite plainly even now. The trees nearest the place where the water comes into the orchard are much larger than those at the opposite corner. The storm water is carried to the orchard by means of furrows, and comes only at times of very rapid rainfall.

*Apples.* Two Duchess of Oldenburg bore about one-fourth bushel of fine fruit. We gathered from later varieties: Ben

Davis, one-half bushel; Winesap, one bushel; Utter's Red, thirteen fine specimens; Jeniton, seven specimens; Romanite, one-fourth bushel; Missouri Pippin, two and one-half bushels. The Missouri Pippin tree received some waste water from the house on account of having its leaves eaten off by grasshoppers. No wormy apples have been found among the specimens produced.

*Plums.* Six varieties fruited. The American Eagle plums were specially fine. The Weaver, Minor, Wolf, Cheney and Rolling-Stone were medium sized with fine flavor. From one Weaver plum tree we picked one-half bushel of fruit.

*Cherries.* Dry weather caused the cherry crop to mature imperfectly. About as many specimens were set as in 1900, but the fruits did not grow so large. Many developed only on one side of the stone. One English Morello tree bore heavily in 1900 and then died to the ground. It threw up a vigorous sprout this year which is believed to be above the bud. All standard varieties of cherries seem to do equally well.

*Gooseberries.* Both Downing and Houghton bore good crops. A few bushes died, apparently from some root disease. I find that nearly all who are raising gooseberries lose some bushes from this cause. Some distance below the crown the root turns black, while between the black part and the crown, the roots do not die for some time after the top has withered.

*Apricots.* Twelve Russian apricots set in 1899 are all vigorous. One fruit was set but was eaten by grasshoppers. It has been almost the uniform experience with the apricot on the Plains that it makes a pretty tree but produces but little fruit.

*Peach Trees.* Nearly all the peach trees survived the winter of 1901, and made a fairly good growth during the summer. They have not yet reached the bearing age.

*Dewberries.* All the plants reported last year are alive, but none bore fruit this year.

*Crab Apples.* Nine of the ten crab apples set in 1899 are still vigorous, but none bore fruit.

*Pears.* Six trees set in 1899 are still alive. One of the trees blossomed but failed to set fruit.

*Forest Trees.* Of the forest trees reported in 1900, very few have been lost. All made a fair growth in 1901. We have grubbed out all but two rows of the Russian mulberries planted in the main field. These should be taken out next season.

*Flowers.* The Giant Cosmos showed a repetition of their growth and productivity of 1900. They did not produce a flower until after October 1. After that they flowered profusely until a hard frost. Ordinary frosts do not affect them.

## FIELD CROPS.

*Bromus Inermis.* This grass grew well in the early spring, where it was not thickly set. During the summer dry spell it dried up entirely. It would have burnt at any time between June 20 and July 25. But when the rains came, it again revived and made a good growth. When last seen, October 25, it was still green.

*Hagi.* The plants grown in 1900 lived over winter and grew to be twelve to eighteen inches high this year. These are so thin on the ground that the plants are quite woody.

*Sorghum.* Only two varieties of the several planted were harvested. These were Early Amber and Early Orange. The other varieties were planted later, after most of the moisture which fell in April had evaporated, so that none grew large enough to cut. Most of the seeds merely germinated.

It was the plan to do the work this year on a practical scale so as to make an estimate of the cost of production. Seven and one-half acres of Early Orange cane were planted, and twenty-nine and one-half acres were planted in Early Amber. On the plats receiving the same treatment very little difference could be noticed in the yield. It happened that the Early Orange was planted first and given one more cultivation than the Early Amber. The yields were as follows: Early Orange, 3,125 pounds fodder per acre; and the Early Amber, 1,470 pounds per acre. The cost per ton is about \$2.20, or slightly less than \$2 per acre for the sorghum fodder in the shock.

Different parts of the field furnished valuable object lessons on the value of culture at the proper time. But notwithstanding the losses from inability to cultivate at the proper time, the results show that fodder was put in the shock at a very low cost. Work done on this field is up to the average of the country. Hundreds of men lost entire crops by giving up and letting the weeds take their fields when a little labor spent in killing weeds during the dry time would have made them good crops.

*Alfalfa.* About three-fourths of the alfalfa sown in 1897 is dead. This did not produce enough to pay for cutting. Of that sown in 1899 only a little patch growing in a low place was cut.

## INVESTIGATIONS OF EASTERN COLORADO.

The work done in 1901 was a continuation of the work of 1900 with the exception that less time was spent in collecting crop statistics. The greater portion of the time was given to looking for facts which would tend to explain the variation in results obtained in different localities by men of practically the same amount and quality of industry and intelligence.

A map accompanying this report shows the route traveled. 1,800 miles were traveled with a team over a territory approximately 96 to 144 miles. The territory studies include the three valleys of the Republican, the valleys of the Big Sandy, Rush Creek, Horse Creek, and Adobe Creek, and the drainage basins of all these streams.

The location of irrigation plants was noted and enough information concerning each was recorded so that we can get exact data later by correspondence in cases where it would have been expensive to get such information by personal observation. The leading interest of each locality visited was recorded, and men sought out from whom we might gain reliable information by correspondence.

*Grain Farming.* Concerning grain farming, but little can be added to the report of 1900. This is confined, with a few minor exceptions, to the divide between the South Fork of the Republican and the Arickaree, and that part of the divide between the Arickaree and the North Fork of the Republican lying east of the Sandhills. To these settlements with a few individuals near Thurman, Yale, Wallet, are confined the trials of grain raising now carried on in the territory studied. Outside of the two large districts the number who depend upon grain raising is becoming rapidly less each year. In those districts stock raising is becoming more prominent. A partial failure of wheat in 1901 caused many to feel like trying something else. Wheat was not more than a half crop, but corn on sandy land made a good crop wherever thoroughly cultivated. This was one of the years when careful, hopeful and industrious men were paid for their work and pains. A few who experimented were located and their results will be noted later.

#### STOCK.

*Small Herds.* By small herds we mean small bunches of cattle cared for by the owner or his family. The size of these herds ranges from a few head to four hundred head. As a rule feed is produced by the owner to feed the weak cattle through the winter and the whole herd through the stormy periods. Eastern Cheyenne, Eastern Kiowa, Northern Lincoln, Eastern Arapahoe, all of Kit Carson, Yuma and Washington counties are included in this, except the river valleys where larger bunches are kept. In this whole territory fodder consisting of sorghum, millet, milo maize or corn were produced. The variety of fodder raised seems to depend more upon the prejudice of the producer than upon the locality, as they are all grown more or less in each neighborhood. Sweet sorghum is becoming standard forage. It can be produced and put into shocks at a cost of about \$2 per ton by

using ordinary machinery. It is likely that the cost can be materially reduced when the use of up-to-date machinery becomes more general. Even fodder production has not been found profitable upon adobe soil without irrigation.

*Large Herds.* These are found on land where crop raising has proved a failure, or in the hands of old time stockmen who are prejudiced against using the country except as a cattle range. The western part of Cheyenne and Kiowa, the southern part of Lincoln, and the northern part of Otero and Bent, and the valleys of the South Fork of the Republican and the Arickaree are, as a rule, occupied by large herds. The owners of large herds do not generally believe in feeding, and expect their cattle to hustle their feed in winter and summer. Severe losses during hard winters compel the belief that the time is coming when it will pay to feed cattle. This is especially true where the settlement has encroached upon the open range until it is all occupied to the point of being over-stocked. The time was when the valleys were left for the production of hay, but shortage of grass in the summer of 1901 compelled many rich meadows to be used as pasture. Old time cattlemen believe it is more profitable to ship in grain for use of their stock during storms than to attempt to raise fodder or grain by farming. I have been told by some of these stockmen that a man should be fined heavily if he should attempt to put a plow in the ground.

*Improved Methods of Handling Stock.* As the range becomes crowded, men must choose between feeding during the winter, going out of the business, getting absolute control of certain land, stocking it to its capacity, and then increasing the value of their stock, not by numbers, but by improvement in quality. As yet we have met only one man who is trying this plan. His young stock is now the third cross toward purebred and it is easy to recognize them when they become mixed with his neighbors' cattle.

*Ranges.* Losses incurred by stockmen in recent years make prominent the fact that we have some ranges that are fit for use the year round, and some which are safe only as summer ranges. The sandy loam soils and also the ordinary clay loam soils seem to be safe for use at all times of the year, but the adobe land has proven to be unsafe as winter range. In April, 1900, one cattle company lost fifty per cent. of the cattle put on a range where adobe soil predominated. Old stockmen claimed that the character of the soil was responsible for the loss. When the rain came the soil became a mass of very sticky mud, so that when the cattle walked each foot would soon become loaded with from ten to fifty pounds of mud. One of the riders who worked there told me that the course of the drifting herd could be easily traced by



the dead animals. The adobe country is excellent summer range, and large sections are used exclusively in that way, the cattle being taken either to the valleys and fed alfalfa during the winter or to other ranges which are safe.

#### MISCELLANEOUS OBSERVATIONS.

*Fruit.* Evidence has accumulated showing that plums, cherries and gooseberries can be grown without irrigation by carefully cultivating the soil.

A. E. Tabor, living ten miles southeast of Wray, has produced gooseberries on a commercial scale. His soil is a dark sandy soil. He cultivates carefully; but the efforts at the production of apples, peaches, pears, apricots and grapes without some means of supplying extra water during severe droughts are generally met with failure. However, fine fruits of all kinds have been raised during favorable seasons. For example, the Plains Substation produced some fine apples this year, but the rains happened to come just at the right time to save the fruit. An August drought would probably have caused most of the apples to drop.

The few orchards that are irrigated prove that there is nothing in the climate to prevent success if plenty of water is available when needed for the use of the trees. The places of John Rose, near Seibert; James Howell, near Flagler; John Speirs, near Robb; all show what can be done by irrigation. When I saw the places of Messrs. Rose and Howell, last August, the trees had been recently damaged by a severe hail storm. There were several bushels of fruit on the ground at that time, and what fruit remained on the trees was much damaged. Both these places showed fine fruit in 1900. At Mr. Speirs' last August, his grape vines were heavily loaded with fruit. He is raising considerable small fruit for home use. Peter Eckert, near Thurman, also had a fairly good crop of plums, grapes and cherries this year. Hail is the main source of loss when the trees can be irrigated.

*Timber Claims.* There is nothing to add to the report of 1900, as we have seen very few well kept timber claims this year. Those of Kursidim and Morris (photos of which are shown in bulletin No. 59) are the best that I have seen. These show signs of neglect this year.

*Native Salt Weed.* (*Artiplex Argentea.*) In the annual report of 1900, I recommended that the native salt weed found near the head of the South Fork of the Republican river, be tested as to feeding value and its distribution determined. Then I suggested that if it seemed to be a valuable forage plant, it should be distributed as widely as our means would permit. Three hundred pounds of the salt weed hay were sent to the Station Chemist, Dr. Headden, to be used in the feeding experiment. He reports that

sheep fed the salt weed hay all lost in weight during the test. A full report of the test will be published by the Chemical Department in the near future. In my travels during 1901, I found specimens of salt weed growing in nearly every locality in which adobe soil predominates. Especially if it is alkali soil. Recently I found a specimen near an alkali lagoon two miles south of Fort Collins.

*Australian Salt Bush.* During the year 1900, some plants of Australian Salt Bush were carefully cultivated in a protected corner of a town lot in Burlington, by Hon. T. G. Price. When I looked for them last summer, Mr. Price told me that they had all "winter-killed" during the previous winter. Dr. Headden informs me that Australian salt bush has proved to be an annual in Colorado, although it is a perennial in California.

*Russian Thistles.* I find quite a variety of opinion existing as to the value of Russian thistles as a winter forage for stock. Some claim that thistles are as good as alfalfa for forage, others contend that they are worthless. One man said he liked them for feeding during storms, because as soon as the storm was over the cattle would immediately leave the corrals and hustle for grass; while if millet, corn fodder or cane was fed, the stock would hang around the corral a day or two looking for feed. My own experience indicates that the last mentioned opinion strikes the happy medium and is probably an index to the true value of Russian thistles as forage plants.

*Irrigation.* Only a small part of the region studied this year is irrigated, and from the limited water supply now known, but little can ever be irrigated. No stream flowing through the territory furnishes enough water to make a large ditch pay, or for taking the water up on the divides, where the best water is usually found. Then, where there are good locations for irrigation on a small scale, it is so far from markets that most of the land must be used for raising cheap crops like alfalfa. The best possible use to which such locations can be put at present is as winter quarters for cattle which graze on the uplands during the summer. Most of the irrigated patches are now used in this way. A few use irrigation for making pleasant homes and supplying the family with fresh fruit and vegetables. On the divide it is possible to irrigate small gardens by means of windmills, and this is done by many.

*Windmill Irrigation.* The men who began with a small herd of cattle some twenty years ago, at first had too much water for their stock and so learned to irrigate a small garden. Later, when the herd increased so that it took the water as fast as the windmill would pump it, the gardens ceased to flourish. One calf was said to be equal in value to all the vegetables that could be grown

on a little garden patch. Many are now returning to the plan of raising a small irrigated garden. They say that the garden does not pay, but it is one of the luxuries which their present prosperity warrants.

*Irrigation From Underflow Streams.* Nearly all irrigation along the Big Sandy is by means of underflow. Tiling is used for getting the water out of the sand. Between two and three hundred acres are irrigated from the Big Sandy. We have records of many plants showing location, amount of land irrigated and kinds of crops raised.

*Irrigation From Surface Streams.* Nearly all the irrigation in the valley of the South Fork of the Republican is with water from the South Fork of the Republican river. Charles Milleson has forty acres which is sub-irrigated, and there are a few patches near him which are also sub-irrigated. There are fully three hundred acres irrigated in the valley of the South Fork. The Arickaree and its tributaries furnish water for the irrigation of nearly four hundred acres. There are about four hundred acres irrigated in the valley of the North Fork of the Republican river. The valley of Rush creek has about eighty-five acres irrigated. Horse creek and tributaries furnish water for the irrigation of about one hundred and sixty acres. Much of the irrigation water in the southern part of Lincoln county is secured from springs. The underflow of the Plains seems to come to the surface in many places along the head of Rush, Horse, Little Horse, Steels Fork and other creeks in that region. At one place I saw water flowing from a spring at the top of a hill. This spring furnished water for the irrigation of ten acres, and it looked possible to develop still more water from this source.

*Storm Water.* Nearly all the schemes for the use of storm water in irrigation have failed. However, there are a few people who depended on storm water and have succeeded in utilizing it. The Rosenkrantz ranch, where two hundred and fifty acres are irrigated from Dry Willow creek, a tributary to the Arickaree near the Kansas line, is one of the most successful which depends mainly on storm water. The reservoir was broken by a cloudburst in 1900, but it can be replaced at a small cost. James Howell's small plant near Flagler is a success. W. V. Erickson's plant was not yet at work when I saw it this year, as no heavy rains fell last spring to fill the reservoir. The future must test its value.

Men are going into irrigation at the points of the least resistance. Storage of storm water is a problem of the near future. As necessities arise for the use of storm water, it is likely that means will be found for retaining it on its watershed. This will be done in time wherever it will pay.

*Loco.* From March 20 to September 20, I took pains to col-

lect whatever information I could on the subject of loco. Map No. 1 shows the relative distribution of loco plants and is a part of this report. The evidence of stock men was unsatisfactory. The main points of agreement was that cattle, horses and sheep, become either crazy or stupid or both at times, and the witnesses think that eating some species of astragalus, oxytropus, sage or other plants common to the range cause the effects named. In all the region studied we found specimens of loco plants, but in some localities they were much more numerous than in others. There is some evidence showing that families of animals may be addicted to the loco habit; as a cow and all her calves, or a mare and all her colts. The evidence shows that loco plants can be killed by cutting them off below the crown. As the plants produce much seed this course must be persistently followed for a number of years, and thus eradicate them from the pasture. On open range which belongs to everybody, eradication of plants of loco is not a possible solution of the problem, as no one will work when reward is not sure. The subject must be given long and careful study before we shall be justified in giving an opinion upon it. We need accurate records of cases from beginning to end. Most of the evidence begins in the middle of the case with no available history of the animal affected before it was found sick.

*Soil.* During the year 1900 I took very few samples of soil, but observed the soil over which I traveled with a view of selecting samples later. In 1901 I made the taking of soil samples a part of my business. I took forty-five soil samples during the summer, making forty-nine samples in all. These are now stored for use whenever needed. Map No. 1, which is a part of this report, shows approximately the localities from which the samples were taken.

*Soil Influence on Crop Production.* One of the best illustrations of this is found when comparing Eads and Galatea. Near Eads is a small area upon which good crops of fodder are raised every year. At Galatea only 16 miles west of Eads, nearly all efforts at production of forage have proven failures. Eads and Galatea are located in small areas which are bountifully supplied with well water, but are surrounded by a country in which water is not easily found by digging. All the difference which can be seen is in the kind of soil used in trials at crop production. The soil near Eads is a dark sandy soil, while that near Galatea is a very stiff clay, and may be classed as adobe.

Careful, industrious men have worked faithfully at Galatea, but failures compel them either to turn to stock raising or leave the country. Around the sand hills there is usually to be found a strip of dark sandy land where moderate crops of feed are raised every year while often the clay lands have been abandoned.

*Difference in Climate.* Examine the map and note the small

territory near Vernon between the North Fork of the Republican and the Arickaree which is east of the sand hills. This is the field of the most successful attempts at farming which have been made in the whole region of study. Crops average better there than on the divide between the Arickaree and the South Fork of the Republican. The soil certainly does not increase uniformly in fertility as we get further north. The people are of the same class. Rainfall as determined by local observers, is essentially the same. These three factors being so nearly equal, we must look outside the localities for an explanation of the differences. Note that north of the North Fork of the Republican river is a sand hill region about 20 miles wide. West of the Vernon neighborhood is another group of sand hills about 20 miles square. West of both groups, which almost join each other, near the source of the North Fork of the Republican river, is a region fully as large as the two sand hill regions which drains into the sand hills. Water is found in apparently inexhaustable quantities at a depth of 100 to 125 feet in the farming districts. I have noticed that heavy dews are frequent near Vernon in summer, and that hot winds are infrequent when compared to the Plains 100 miles south. Dews occur frequently on the next divide south of the Vernon Divide, but they seldom occur at Burlington and Cheyenne Wells. These facts indicate that it is possible that the success of the farmer on the Vernon Divide is due to the influence of the sand hills on the climate near them.

#### PROBLEMS WHICH CONFRONT THE SETTLER.

1. Means of combating insects, especially grasshoppers and potato beetles.
2. Garden irrigation.
3. Water supply and means of raising water from great depths.
4. Forage plants suitable for different localities and methods of producing them cheaply.
5. Destruction of prairie dogs on the public range.
6. Improvement, or introduction of small grain. (For a small district.)
7. The stock industry.
  - (a.) Diseases affecting stock on the range and means of prevention and cure.
  - (b.) Methods of handling stock suitable under new conditions.

Respectfully submitted,

J. E. PAYNE.

Field Agent.