Twentieth Annual Report

OF

The State Board of Agriculture

AND

The State Agricultural College

INCLUDING

The Eleventh Annual Report

OF

The Agricultural Experiment Station

Fort Collins, Colorado

1898

DENVER, COLORADO
THE SMITH-BROOKS PRINTING CO., STATE PRINTERS
1899

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Letter of Transmittal.

HON. ALVA ADAMS,
Governor of Colorado.

Sir—Agreeably to statutory provision, we herewith present the Twentieth Annual Report of The State Board of Agriculture under whose direction the various forms of educational and experimental work in progress at The State Agricultural College are planned and conducted. The financial condition of the College, as represented by the annual receipts and expenditures, is set forth in the statements contained in the report of the Secretary of the Board; some of its educational features, including certain principles of administration that are held to be fundamental, are clearly presented in the comprehensive report of the President of the Faculty. The College, in all its departments, is in a prosperous condition. Its educational work is made to touch closely and practically some of the most important of the material interests of the State. That work is, also, of high intellectual and moral value, made so by the system of instruction and discipline now operative.

Respectfully submitted,

A. L. KELLOGG,
President of The State Board of Agriculture.

J. E. DuBOIS,
Secretary of the Board and Faculty.

ALSTON ELLIS,
President of the College.

Secretary's
Statement of Receipts and Expenditures

Connected with the "General Fund," for the Fiscal Year Begun December 1, 1897, and Closed November 30, 1898.

GENERAL FUND.

Receipts:

Land Income Fund (Congressional Act of 1862 for the Endowment of an Agricultural College in Colorado)	$ 8,849.83*	
Tax Fund (State one-fifth mill levy)	40,907.63	
Annie Jones Library Fund	31.00	
Special Fund	146.09	
Total Receipts		$49,934.55

Disbursements:

Salaries	$10,824.72
Secretary's Office	98.33
Library	325.15
Military Department	60.30
Horticultural Department	1,653.04
Farm Department	3,708.47
Chemical Department	263.48
Mechanical Engineering Department	2,088.97
Department of Zoölogy and Entomology	152.40
Department of Domestic Science	84.78
Commercial Department	967.98

*The amount of this fund varies from year to year. The average yearly income from this source, based upon the receipts for five years is $5,526.66.

Department of English and Philosophy	16.70	
Department of Irrigation Engineering	222.74	
President's Office	267.46	
Advertising	774.55	
Printing Catalogue	325.00	
Farmers' Institutes	104.35	
Text-book Account	2,255.59	
Student Labor	1,029.41	
Furniture	318.72	
Current Expenses	1,718.81	
General Repairs	671.44	
Freight (coal) and Express	1,964.93	
Fuel and Light	1,641.87	
State Board of Agriculture	1,155.90	
Insurance	1,259.50	
Chemical Laboratory	15,979.96	
Total Disbursements		$49,934.55

UNITED STATES OR "MORRILL FUND OF 1890."

For the Government Fiscal Year begun July 1, 1897 and ended June 30, 1898.

Receipts:

Balance, July 1, 1897	$ 83.29	
United States Draft	23,000.00	
Total Receipts		$23,083.29

Disbursements:

Salaries	$18,740.32	
Department of Mechanical Engineering	1,433.31	
Chemical Department	2,191.74	
Department of Irrigation Engineering	707.92	
Balance, July 1, 1898	10.00	
Total Disbursements		$23,083.29

President's Report.

June 1, 1898.

TO THE STATE BOARD OF AGRICULTURE:

Gentlemen—The college-year, one term of which had passed prior to the annual meeting of the Board in December last, will close with the exercises of Commencement Day, Thursday, June 2d. The scholastic year includes thirty-nine weeks divided into three terms of equal length. Under our scheme of instruction, the division of the college-year proves very satisfactory. It enables the Faculty committee on student classification to perform its work more thoroughly, thereby increasing the opportunities for effective class-room and laboratory work.

The annual catalogue of the College was received from the printers before the first of May. Since that date about two thousand copies—one-half of the total number printed—have been judiciously distributed. This publication is of creditable appearance and contains information upon all phases of educational work for which the College makes provision.

The number of students reported at the close of the Fall term has been increased by twenty-eight.

In this connection is presented the summaries of student enrollment and classification for the two years just closed.

SUMMARY FOR 1896-'7.

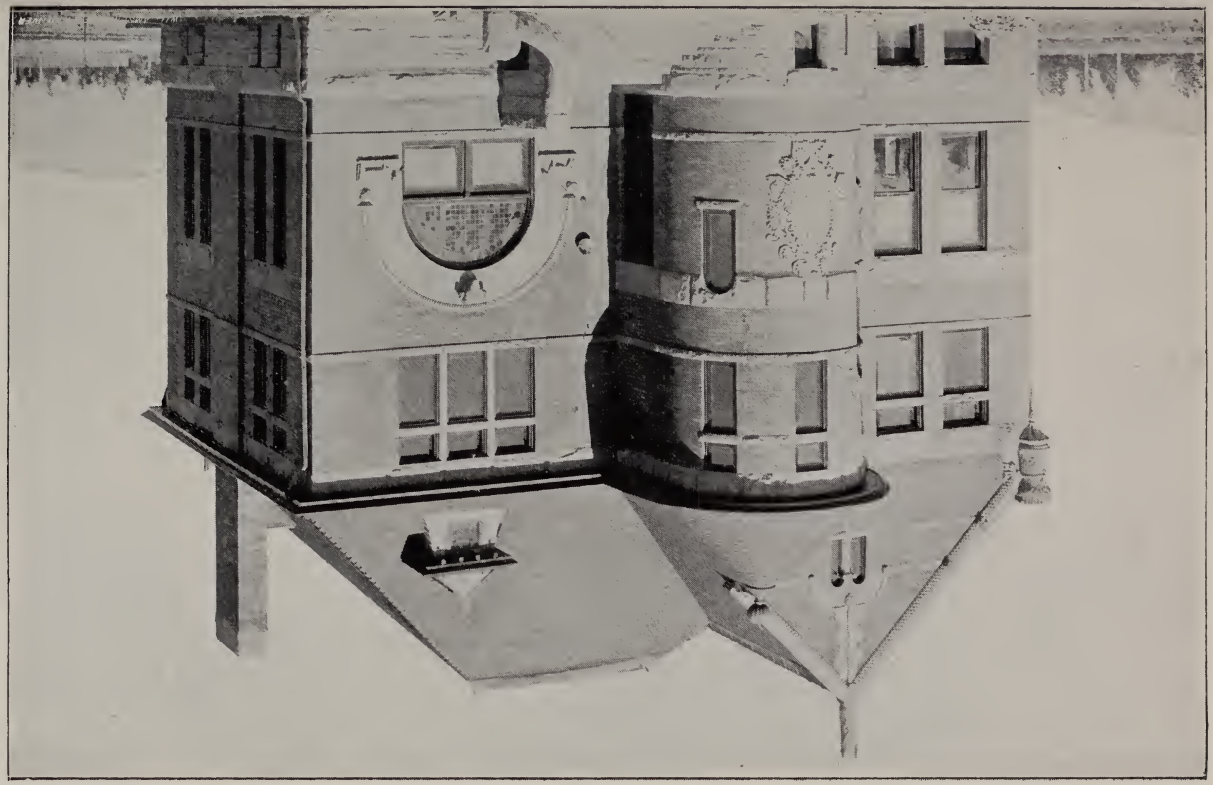
	Male.	*Female.*	*Total.*
Post-Graduates	6	1	7
Seniors	7	5	12
Juniors	21	6	27
Sophomores	34	10	44
Freshmen	33	33	66
Sub-Freshmen	41	22	63
Preparatory Class	17	6	23
Commercial Course	61	20	81
Irregulars	3	9	12
Total	223	112	335

The students represented fourteen states and one territory, as follows: California, 4; Colorado, 307; Illinois, 2; Indiana, 1; Iowa, 1; Kansas, 2; Missouri, 3; New Mexico, 2; New York, 2; North Carolina, 1; Ohio, 1; South Dakota, 1; Washington, 1; Wisconsin, 2; and Wyoming, 5. Total, 335.

The Colorado students represented twenty-seven counties, as follows: Arapahoe, 14; Boulder, 13; Clear Creek, 3; Chaffee, 11; Conejos, 3; Delta, 8; Dolores, 1; Douglas, 1; Eagle, 6; Elbert, 2; El Paso, 2; Fremont, 10; Garfield, 2; Grand, 3; Gunnison, 3; Huerfano, 3; Larimer, 188; Las Animas, 3; Logan, 1; Mesa, 1; Montrose, 1; Otero, 4; Ouray, 1; Park, 2; Routt, 2; Saguache, 1; and Weld, 18. Total, 307.

SUMMARY FOR 1897-'8.

	Male.	*Female.*	*Total.*
Post-Graduates	6	1	7
Seniors	12	1	13
Juniors	24	1	25
Sophomores	33	15	48
Freshmen	45	16	61
Sub-Freshmen	38	19	57
Preparatory Class	28	17	45
Commercial Course—Seniors	6	3	9
Commercial Course—Juniors	51	19	70
Special Class Students	2	7	9
Total	245	99	344



The students represented twelve states and two territories, as follows: Colorado, 314; Illinois, 1; Iowa, 2; Kansas, 3; Kentucky, 1; Michigan, 1; Missouri, 3; Nebraska, 1; Ohio, 2; South Dakota, 1; Tennessee, 1; Wyoming, 8; Arizona, 1; and New Mexico, 5. Total, 344.

The Colorado students represented thirty-three counties, as follows: Arapahoe, 12; Boulder, 17; Clear Creek, 6; Chaffee, 5; Conejos, 2; Delta, 9; Dolores, 1; Douglas, 1; Eagle, 7; El Paso, 8; Fremont, 3; Garfield, 1; Gilpin, 1; Grand, 4; Gunnison, 3; Huerfano, 3; Jefferson, 1; La Plata, 1; Larimer, 190; Las Animas, 1; Mesa, 2; Morgan, 1; Otero, 1; Park, 1; Phillips, 3; Pitkin, 2; Pueblo, 1; Rio Blanco, 2; Rio Grande, 3; Routt, 2; Summit, 1; Weld, 18; and Yuma, 1. Total, 314. Since the publication of the last catalogue, three students, two males and one female, have been registered.

The fact that so large a number of our students come from Larimer, Weld, and Boulder counties has evoked some unfavorable comment in certain quarters. If this is a matter for criticism, there is not an educational institution in Colorado—state or church—that can claim exemption from censure. All educational institutions, and particularly those in a sparsely-settled country, draw largely upon the population in their immediately vicinity for patronage. That condition of affairs existed at the university from which I graduated thirty-one years ago; and it exists in as marked degree to-day. It does not seem just that the College should bear wholly the brunt of a criticism which, if at all deserved, is forceful against every educational institution in the State. The truth is, the criticism is not just whether it be applied to the College or any other institution of learning. It is but natural for sensible people to avail themselves of the superior educational advantages found at their doors. It would evidence disloyalty to home enterprise and a lack of business sense for them to do otherwise. People are beginning to seek homes in Fort Collins and vicinity, to the end that the superior educational advantages offered by the College

in its five distinct courses of study may be enjoyed by their children. Again, the College is located in one of the most prosperous agricultural sections of Colorado, and the well-to-do farmers who have homes therein have the means to give their children higher educational advantages than their district schools afford and have enough intelligence and foresight to avail themselves of educational facilities both wide-reaching and inexpensive. It ought not to be forgotten that the College now enrolls more students from counties of the State outside of Larimer than the total number of students registered a few years ago; also, that our present enrollment of students from other states is more than forty per cent. of the whole number of students registered in 1890. Our students now represent three-fifths of all the counties in the State. Every year brings the College to the favorable attention of a larger number of people interested in the kind of work for which it provides. That the College is liberally supported by people living in its vicinity, is strong evidence that it is worthy of the rapidly increasing patronage from abroad that it is now receiving.

In the catalogue for the present college-year appear the revised courses of study approved by the Board at the last annual meeting. A comparison of present requirements for graduation with those of the past will show a substantial uplift in the standard of scholarship. The new scheme of instruction recognizes the necessity for preparatory work and makes adequate provision for it. Entrance to the lowest class, in either of the regular courses of study, requires a higher degree of scholastic preparation than formerly. The State law, governing the admission of students to the College, reads as follows:—

"No student shall be admitted to the institution who is not fifteen years of age and who does not pass a satisfactory examination in arithmetic, geography, grammar, reading, spelling, and penmanship."

The statute states the minimum age and fixes an indefinite standard of scholarship in certain studies clearly recognized as rudimentary and forming a part of the course of study pursued in every common school in the land. Another section of the law refers to the College as "a high seminary of learning" to which the graduates of the common schools, of both sexes, shall be admitted. It would be possible for our Faculty committee to make the entrance examination in the common-school branches, named in the law, so severe that few could successfully undergo the ordeal. Thus the standard of scholarship on the part of admitted students could be raised. Possibly, the law having with some degree of definiteness fixed a *minimum* of attainment to be possessed by the applicant for admission to the College, it is left to Faculty discretion to establish any standard of a *higher* character. If this interpretation of the law will hold, it is clearly desirable to cut off at the lower end of the course and to make additions to the upper. In the not distant future, I hope to see a regular course in the College represent an amount of work and training fully equal to the best that lies between the completed course of a good high-school and that of one of our best universities—it being understood that the work of the College is always to be a clear-cut differentiation from that of either of the educational agencies named.

So long as the high-school courses are made to prepare those who pass through them for admission to the classical college and the university, there can not be a very close articulation of their work with that of institutions whose prominent features are of scientific and technical trend.

The public-school pupil who comes to the College with the preparation acquired by the proper completion of the work of the eighth-year grade can reasonably expect, by faithful effort, to complete any one of the four regular courses in five years or the commercial course in three. I favor the gradual elevation of the present

standard until a diploma will represent still another year's training.

The College is preëminently a scientific and technical institution and there is no thought, in any quarter, of making it anything else. It has ever been my strong desire to see our scientific and technical work made just as thorough, practical, and far-reaching as possible. Facilities for the more successful prosecution of this work have been greatly increased within the last few years. The appropriations for the equipment of the scientific and technical departments of the College have been generous. In fact, they have practically taken all the money available for adding to departmental equipments. The best and most expensive buildings on the college grounds are those in which class-room and laboratory work in irrigation, agriculture, horticulture, chemistry, and mechanics is carried on. Within the last six years, a sum not much below $70,000 has been expended in buildings for these departments of college work. Four rooms of the Main College Building are given up for instruction and work in zoölogy and entomology. The work in domestic science is carried on in a building which, while not of great cost, is well-planned and serviceable in all its parts. The equipment of this building represents an expenditure of nearly $1,000.

"To promote the liberal and practical education of the industrial classes in the several pursuits and professions of life," it was thought advisable, two years ago, to make more adequate provision for instruction in those branches that prepare for a "business life,"—commercial arithmetic, penmanship, bookkeeping, business correspondence, commercial law, stenography, typewriting, etc.,—and since that time more than $1,500 has been spent in securing the necessary equipment for prosecuting the work.

A largely increased attendance of students has made necessary the employment of additional instructors, by far the larger number of whom are now connected with the scientific and technical departments of the College.

In the face of facts like these it would be amusing, were it not so annoying, to hear fears expressed that the College, in its instruction and work, is being rapidly pushed away from its only safe anchorage and forced into active and unprofitable competition with the literary and classical institutions of which, it is thought, there is already an overplus. If there is any failure in our scientific and technical work I, both as President of the College and member of the Board, do not hold myself in any wise responsible therefor; for at all times I have been a consistent and persistent advocate of every plan and expenditure that gave any promise of making our scientific and technical work more efficient and far-reaching. As Chairman of the Purchasing Committee, I have gone to the limit of the college revenue in authorizing the purchase of equipments and supplies for the scientific departments of the College; and, to-day, as a result of a liberal policy towards them, they are well furnished for the special work for the promotion of which they were established.

In my last report, as Director of the Experiment Station, I showed clearly that our scientific workers were giving a constantly increasing portion of their time to special investigations connected with scheduled station work. This brings a necessity for putting more and more of class instruction under direction of assistants, whose number has been much increased of late years.

Increase the number of students and classes must be increased in proportion; then, necessarily, comes the need for an increase in the teaching force. The unmistakable tendency is for the head of a scientific department to devote himself more and more to special scientific research and more and more to place the work of class instruction and the student laboratory practice under the control of his assistants. From different parts of the State come demands upon the time and knowledge of the scientific expert. These, if met, force a certain neglect even of the *supervision* of the work of instruction going on in the classes of the department. The stu-

dents suffer loss in knowledge and training, that some scientific work of questionable utility may be prosecuted by the professor under whom they are placed for instruction. It is not a wise thought, or one in accord with the plain, unmistakable intent of the various acts —Congressional and Legislative—under which the College is operated, that our scientific workers should be relieved from teaching work and be permitted to give their whole time to such scientific investigations as would show desirable results in the better and swifter advancement of the agricultural interests of certain localities within the State. The ultimate interests of the State, even along lines regarded as intensely practical and beneficial in advancing our material prosperity, will be best promoted by our scientific specialists if their class-room and laboratory instruction is fruitful in sending forth from college halls an earnest body of intelligent workers well-equipped, by reason of their special scientific training, for the successful prosecution of just that practical work which, it is now thought, none but the college specialist in science can profitably undertake.

I look with disfavor and misgiving upon the pronounced tendency to relegate college instruction to inexperienced assistants, even though they be scholarly and ambitious. The student who is induced to go to college by catalogue statements of wisely-planned courses of study, great facilities for scientific work in the way of laboratory equipment, and the naming of distinguished specialists that form the teaching body, have some right to expect, when they enter upon their collegiate work, the best service the college, through its teaching agencies, can furnish. To place them in charge of timidity and inexperience is to do them a grievous wrong and to deprive them of just that experienced and scholarly oversight in class-room and laboratory the expectation of which was their chief inducement to enter upon a course in college. Edward Everett Hale, whose language I quote from "School Economy," voices my sentiments upon the question now under treatment. He

says: "It is an open secret, perhaps, among the presidents and trustees of colleges that it is very hard to make the best teachers take up 'freshman work.' Yet freshman work is the most difficult and the most important. What follows is that the freshman, perhaps eager to take up the full advantage of college life, passes from the high-school or the academy to his first recitation or lecture, to find himself given over to the oversight of some young fellow only four or five years older than himself, who has recently been named as tutor or instructor. The pupil has perhaps just left the personal class of a first-rate educator,—a man of experience, enthusiasm, and genius,—and he finds himself under the tuition of a frightened young graduate, afraid of his class, new to the subject, who is trying his experiments in education."

The matter of discipline, not wholly in the mental field but in the just understanding and observance of wholesome college regulations, is of prime importance as a part of the legitimate end of college training. The mind untaught to look on the right side of things, the will under no judicious control but left to the sway of passion and unworthy impulses, give indications of nothing worthy in life. Our students are, many of them, young and stand much in need of wise instruction by *experienced* teachers, upon many subjects which no course of study can definitely outline. Wholesome college discipline is assured only when there is a proper *esprit de corps* animating the larger part of the student body. Here is where the real professional power of every head of a college department, as a teacher, can make itself discreetly felt. A weakling in charge of a class can do much to demoralize its membership. This is but an instance where prevention of disease is better than the application of many remedial agents after it has become deep-seated and, perhaps, chronic. Heretofore, I have had occasion to commend in strong terms the general orderly conduct of our students. Efforts at securing right conduct on their part were not strained nor was there oc-

casion for the display of much governing power to secure their uninterrupted attention to their work. This general good order was in marked contrast with the senseless, disorderly, lawless conduct which marred the college life of some students in other institutions. Our students have access to the publications of sister institutions in which are often chronicled in glowing, enthusiastic terms the foolish pranks of students. Some newspapers give special prominence, in their columns, to glowing descriptions of every student escapade that smacks of idiocy, insubordination, and rebellion. The surest way of patting insubordination on the back and giving a semblance of heroism to its promoters, is to print a picture of the ringleader of rebellion and publish in connection therewith a glowing tribute to the manly, independent qualities that brought him into "irrepressible conflict" with the college authorities.

It is a marked characteristic of our people that they are restless under any restraint however judicious and wholesome. They are so tenacious of what they conceive to be their own rights and privileges that they sometimes become blind to what is due from them to other people. It is imperative that college authorities give the matter of college discipline well-considered attention. Ignorance and vice have already strongly recruited the ranks of the idlers and law-breakers. The feeling has been that the education of our youth in school and college was a sure means of weakening the ranks of those disorganized forces that threaten the well-being of society and the perpetuity of good government. Recent multiplying manifestations of what is inaptly called "college spirit" and "class spirit," in some of the leading educational institutions of the country, suggest the speedy and judicious exertion of faculty energy in the way of compressing student activities within the limits of order, decency, and law. "Without above himself he can erect himself, how poor a thing is man," is the thought of an ancient writer. To distinguish between freedom and license, to claim for ourselves only that which we are willing to

grant to others, and to place the general good above the realization of merely selfish ends mark the just man and the good citizen. A mind whetted to keenness by a college training can make a perverted conscience a deadly weapon with which deeply to wound society and the state. Respect for law and obedience to its commands are not so common as they should be. One generally lays claim to great forbearance if he yields even tardy obedience to a law which operates, if enforced, to interfere with the accomplishment of some of his selfish aims.

The discipline of the college should not be needlessly strict nor enforced with undue severity. A college regulation that does not look to the promotion of the general good through the individual welfare of the students is unworthy of a place on the faculty record. Rules few in number, wisely ordered in view of exigencies arising in college life, and, while impartial in their *general* application, enforced with a discrimination necessary for *special* cases, suggest a use of college authority efficient, promotive of right relations between faculty and students, and rightly educating in its operation.

The system of text-book supply is proving satisfactory. The general plan is to secure the necessary text-books for students at wholesale rates. There is no loss to the college treasury by reason of these book purchases. When purchases and sales are compared, at the close of any given year, it will be found that the college treasury is the gainer by a small amount. Since the last report, books and supplies representing $935.32 have been sold. The books and supplies on hand are inventoried at $1,846.33.

In view of the appropriations required for the completion of the Chemical Laboratory, there has not been the usual sum expended in the purchase of equipments and supplies for the various departments. The Purchasing Committee has used its best judgment in curtailing expenses. It is believed that no department of college work has been seriously hampered by this enforced economy. The value of additional equipment is recognized

but it is not possible to secure it at this time with the means at our disposal. The new building is completed and some of its necessary equipment is provided for. There are expenses ahead that can not be avoided. They can be met only by the most rigid economy in the use of the college revenue. It is well-nigh impossible to impress this fact upon the minds of some having to do with college expenditures. Thus the duty of the Purchasing Committee is made unnecessarily irksome. A responsibility rests upon the members of that committee that will be met with as little friction as possible.

A new boiler in the Mechanical Engineering building is a necessity. The greatest care has been necessary to make the old boiler serve the required purpose to the close of the present year. Its longer use is out of the question. It stands condemned by the State Boiler Inspector and must go. A new boiler, with proper housing, will not cost less than $2,500. It is possible by giving the boiler a temporary setting to lessen the cost nealy a half, but that course will prove expensive in the end.

The removal of the Department of Chemistry to the new building leaves the one formerly used by it vacant. Under better financial conditions, it would be good policy to tear down the old building and thus remove from the college campus what all regard as something of an eye-sore; but the need of room is so pressing and the means of furnishing it so meager, that the destruction of the old building can not be recommended at this time. There is service in that old, time-worn structure yet, and necessity forces us to secure it. Careful computation of cost has not been made, but it is believed that the proper expenditure of $500 will put the building in condition for accommodating the varied work now in progress in the Commercial Department.

Few additions have been made to the College Library within the year. The money for the purchase of new books was not available. The list of periodicals was revised and reduced, a measure forced by lack of funds.

One piece of property belonging to the "Annie Jones Library Bequest" remains to be sold. The proceeds of such sale, when made, will become immediately available for the purchase of new books. The sale of the property is not forced because there is no demand for it at present and because there is no room for the proper care of the books which the money realized from such sale would secure. The need of more enlarged quarters for the Library is apparent to every one who visits the rooms where the books are now shelved.

Another need which, though pressing, can not be supplied, and for that reason is merely mentioned, is a building that will furnish at least four additional classrooms. Present conditions bring a time-wasting change of instructors from building to building at each signal that marks the close of a recitation period.

In connection with this report, is presented the usual statements of the heads of departments; also a petition from certain Faculty members praying for an increase in their salaries—all of which is presented without recommendation as each will, no doubt, have its reference to the proper Board committee for report.

In conclusion, it is a pleasure to report my conviction that the College is becoming more widely and more favorably known each year. The people of our State are having a juster conception of the work which it is the special province of the land-grant college to promote and, as a consequence of this more enlightened and rational view, criticism when offered is more just and complaint when heard less bitter. With few and unimportant exceptions, the papers of the State have for the College and its work nothing but words of encouragement and commendation. Public sentiment at the open doors of the College is strongly concurrent in its favor. The College merits and is receiving the warmest support of the outside world most nearly in touch with it and most conversant with what is in progress within its walls. This loyal support from those near by is very gratifying to all engaged in college work. I need not refer to the pleas-

ant relations that exist between the members of the Board before which this report is read. At no time since my connection with the College, have those relations been so considerate, so unselfish, and so courteous as now. To say that to work under such direction is to render service under pleasant, helpful, and encouraging conditions is but to repeat what I have had occasion many times to say to others within the last year.

Respectfully submitted,

Alston Ellis

President.

President's Report.

December 14, 1898.

TO THE STATE BOARD OF AGRICULTURE:

Gentlemen—Six months ago, at the semi-annual meeting of your Honorable Body, I presented a brief report making some statements and setting forth some facts relating to the work of the college-year then closing. Should the publication of a report embodying financial statements, enrollment statistics, and the like be authorized at this time, I would suggest that the written report presented by me for your consideration last June form a part thereof.

The two years that have passed since the last publication of a report have brought continued prosperity to the Institution. At no time in its history has it been so well-equipped for the prosecution of its various forms of educational work as it is now. It is not too much to say that, in the educational field, it is doing a work of the highest importance to the State—a work which no other institution of learning, within our borders, can do or ought to do. It is the definite aim of the authorities of the College—an aim never lost to view—to differentiate its work from that of every other educational institution in the clearest manner possible. There is a general area of educational work that all institutions of learning may properly cultivate. All the courses of study, now in successful operation in the College, make pretty full provision for the *general education* of the students who enter upon them. After a desirable general culture is acquired by the student, the next aim is to

bring him in theoretical and practical contact with "such branches of learning as are related to agriculture and the mechanic arts." In the latter work, the scientific and technical departments of the College, well-manned and well-equipped as they are, show their wide-reaching influence. It is the pride of those connected with the College that all its scientific and technical work is so well ordered and successfully prosecuted. The College, by reason of its persistent efforts to strengthen its work along practical lines, is becoming one of the best scientific and technical schools in the country. Its work in most departments of science, in civil, irrigation, and mechanical engineering, in domestic economy—all that vitally touches the home life of the people—and in all the subjects taught in the comprehensive course of the business college, is of high grade and of that character best to fit students for a life of practical, remunerative service after their college days have closed. No attempt is made to force those who leave the College, either before or after graduation, to become *farmers;* but the opportunities for such instruction as will the better fit students for intelligent and profitable work on a farm are never lacking. If a student who elects to follow any of the prescribed courses, mapped out by college authority, passes over it without gaining inclination and power to do something useful and of a living-making nature, he is the exception to the well-nigh universal rule.

ENROLLMENT STATISTICS.

But little is to be reported under this caption. Only one term—thirteen weeks—of active college work has passed since the presentation of the last report. There is an increase in student enrollment, though not a marked one. The close of the Fall term, December 2, 1898, found the names of 324 students registered.

These students represent two foreign countries, thirteen states, and one territory, as follows: Mexico, 1; Turkey, 1; Arkansas, 1; Colorado, 283; Illinois, 2;

Iowa, 2; Kansas, 2; Massachusetts, 2; Minnesota, 1; Missouri, 1; Nebraska, 5; New York, 1; New Mexico, 7; Ohio, 1; South Dakota, 1; and Wyoming, 13. Total, 324.

The students from Colorado represent thirty-eight counties, as herewith shown: Arapahoe, 14; Boulder, 13; Chaffee, 3; Clear Creek, 3; Conejos, 1; Costilla, 4; Delta, 5; Dolores, 2; Douglas, 1; Eagle, 4; El Paso, 6; Elbert, 1; Fremont, 8; Garfield, 1; Gilpin, 1; Grand, 2; Gunnison, 7; Huerfano, 4; Lake, 5; La Plata, 4; Larimer, 152; Las Animas, 1; Logan, 2; Mesa, 1; Mineral, 1; Montrose, 2; Morgan, 2; Otero, 1; Ouray, 3; Phillips, 1; Pueblo, 3; Park, 1; Rio Grande, 2; Routt, 1; Saguache, 1; Summit, 2; Weld, 16; and Yuma, 2. Total, 283.

The enrollment for the Fall term of the college-year, 1898-1899, as before shown, is classified as follows:

Preparatory Class	29
Sub-Freshman Class	65
Students classified as Irregulars	30
Students in Commercial College	61
Freshman Class	50
Sophomore Class	36
Junior Class	30
Senior Class	19
Post-Graduates	4
Total	324

Herewith are given the figures that represent the student registration of the first term of the college-year for a number of years:—

Year.	Males	Females.	Total.
1892	127	36	163
1893	93	37	130
1894	148	57	205
1895	144	62	206
1896	202	88	290
1897	225	91	316
1898	239	85	324

The enrollment statistics of late years show that the College is drawing patronage from an area that is constantly widening. The Institution has always drawn largely upon Fort Collins and vicinity for students for reasons that are obvious upon second, if not upon first thought. The College has not existed a score of years. Its location, while highly desirable in many important respects, places it beyond easy and inexpensive reach of many portions of the State. Its name, too, has given many of our own people a wrong understanding of the extent and nature of the educational field in which its scholastic effort is put forth. All institutions of a like character, in new states especially, show a local patronage widely out of proportion to that contributed by the state at large. It is a most encouraging fact that the College is making larger and larger drafts upon all sections of Colorado for students. It is not chance that brings us students from Nebraska, Wyoming, and New Mexico. Students from abroad come to us because we offer them educational advantages, in the fields of intellectual and industrial activity, which they can not better, or so well, secure elsewhere. As the work of the College, in all its many phases, becomes better known its popularity will correspondingly increase and its attendance of students will be more representative of the people of the State. Each college-year closes with the exercises of "Commencement Day" in June. The enrollment of students and the number of graduates for each year since the opening of the College is shown in the following table:—

HORTICULTURAL BUILDING.

Year.	Males.	Females.	Total.	Graduates.
1880	14	11	25	0
1881	35	22	57	0
1882	49	32	81	0
1883	50	31	81	0
1884	40	37	77	3
1885	50	46	96	6
1886	45	42	87	1
1887	63	42	105	4
1888	71	38	109	4
1889	73	34	107	2
1890	56	18	74	9
1891	77	29	106	3
1892	101	45	146	9
1893	135	44	179	7
1894	142	56	198	7
1895	164	66	230	13
1896	161	71	232	12
1897	223	112	335	11
1898	245	99	344	22**
1898*	239	85	324	...

The graduates from the College who completed one of its regular courses now number one hundred and thirteen. The first class to graduate from the Commercial Department was that of 1898. The positions in the working world held by these representatives of the College testify to what it is doing in giving the industrial classes that liberal and practical education that will best fit them for the several pursuits and professions of life.

COURSES OF STUDY.

The courses of study are four, each requiring four years in addition to two years of preparatory work, and each leading to the degree of B. S.: The agricultural

*Fall term ending December 2, 1898.

**Including nine graduates from the Commercial Department.

course, the mechanical engineering course, the civil and irrigation engineering course, and the ladies' course. Provision is made for post-graduate work. The degrees of C. E. and M. E. are conferred on those worthy of holding them, by faculty action approved by the governing board. A commercial course, covering a period of two years, is established, entrance to which, requires the same qualifications as for admission to the Freshman class; no degree is given.

NAMES OF INSTRUCTORS AND REGULAR EMPLOYES WITH THEIR ANNUAL SALARIES; ALSO A STATEMENT OF THE FUND OR FUNDS WHENCE SUCH SALARIES ARE DRAWN.

Faculty—	*College Fund.*	*Station Fund.*
ALSTON ELLIS, A. M., Ph. D., LL. D., President, and Professor of Logic and Political Economy	$ 4,500.00	$ 900.00
JAMES W. LAWRENCE, B. S., Professor of Mechanical Engineering and Drawing	1,800.00	.....
LOUIS G. CARPENTER, M. S., Professor of Civil and Irrigation Engineering	1,300.00	500.00
CHARLES S. CRANDALL, M. S., Professor of Botany and Horticulture	1,300.00	500.00
CLARENCE P. GILLETTE, M. S., Professor Zoölogy and Entomology	1,300.00	500.00
WELLS W. COOKE, B. S., A. M., Professor of Agriculture	1,300.00	500.00
WILLIAM P. HEADDEN, A. M., Ph. D., Professor of Chemistry and Geology	1,300.00	500.00
THEODOSIA G. AMMONS, Professor of Domestic Science	1,200.00	.....
JACOB A. CHRISTMAN, Principal Commercial Department	1,200.00	.....

	College Fund.	Station Fund.
Faculty—		
EDWARD B. HOUSE, B. S., E. E., Professor of Mathematics	1,200.00	.....
JAMES E. DuBOIS, Secretary of the Faculty	1,000.00	500.00
EDWARD M. TRABER, A. B., Professor of English and Philosophy	1,200.00	.....
JENNIE E. McLAIN, B. S., Professor of History and Literature	1,200.00	.....
WILLIAM C. DAVIS, 1st LIEUT. 5th ARTILLERY, U. S. A., Professor of Military Science and Tactics	.....	.....
Stenographer—		
FRANK H. THOMPSON, B. S	840.00	.....
Librarian—		
MARGUERITE E. STRATTON, B. S	650.00	.....
Principal Preparatory School—		
MARY E. GILL	650.00	.....
Assistants—		
JAY. D. STANNARD, B. S., Physics and Civil Engineering	1,000.00	.....
ROBERT E. TRIMBLE, B. S., Meteorology and Irrigation Engineering	.....	900.00
L. D. CRAIN, B. M. E., Mechanical Engineering and Drawing	1,000.00	.....
ALLEN P. GREENACRE, B. S., Forge-Room Work and Drawing	600.00	.....
WILLIAM F. GARBE, Foundry Practice	540.00	.....
FRANK L. WATROUS, Agriculture	.....	1,000.00

Assistants—	*College Fund.*	*Station Fund.*
EDWARD S. G. TITUS,		
Dairy, (Student help)	150.00	.....
CARL H. POTTER, B. S.,		
Botany and Horticulture	.....	700.00
CHARLES F. MERGELMAN,		
Floriculture and Landscape Gardening	800.00	.....
LOUIS A. TEST, B. M. E., A. C.,		
Chemistry	.....	900.00
FRED ALFORD, B. S.,		
Chemistry	.....	540.00
JOHN E. KITELEY, B. S.,		
Chemistry	.....	540.00
ELMER D. BALL, B. S.,		
Zoölogy and Entomology	.....	900.00
LATHROP M. TAYLOR, B. S.,		
Stenography and Typewriting	1,000.00	.....
CHARLES GOLDING-DWYRE, Jr.,		
Bookkeeping and Penmanship	500.00	.....
JOHN W. NEWMAN, B. S.,		
Mathematics	500.00	.....
Sub-Station Superintendents—		
HARVEY H. GRIFFIN, B. S.,		
Arkansas Valley, Rocky Ford, Colo	.....	900.00
J. E. PAYNE, M. S.,		
Rainbelt, Cheyenne Wells, Colorado	.....	800.00
Engineers and Janitors—		
William Kelly	780.00	.....
John H. Cameron, Sr	540.00	.....
James L. Veazey	540.00	.....
A. M. Wilkin	540.00	.....
Isaac N. Chatfield	540.00	.....

Laborers Regularly Employed—	*College Fund.*	*Station Fund.*
J. H. Cameron, Jr.	540.00	.....
Alvin Fry	540.00	.....
Frank Matthews	540.00	.....
N. G. Strayer	540.00	.....
Robert Cameron	480.00	.....
J. W. Coffman	480.00	.....
Total	$34,090.00	$11,080.00
General—		
Station Labor	.....	2,489.20
College Labor	500.00	.....
Student Labor	900.00	.....
Total	$ 1,400.00	$ 2,489.20

SUMMARY.

Salaries	$34,090.00	$11,080.00
Labor	1,400.00	2,489.20
Grand Total	$35,490.00	$13,569.20

SUMMARY OF COLLEGE INVENTORIES.

NOVEMBER 30, 1898.

LANDS AND ADJUNCTS:—

Two hundred and forty (240) acres of land at an average value of $100 per acre	$ 24,000.00	
Trunk sewer to the Poudre river	6,000.00	
Pipe-line for water supply	2,900.00	$ 32,900.00*

* This estimate includes numerous sewer laterals and water connections; a reservoir for storage of water; all other improvements of the College grounds; and ditch stock, worth $2,000.00.

BUILDINGS, INCLUDING PERMANENT FIXTURES:—

Main College Building	$ 36,000.00	
Mechanical Engineering Building	21,000.00	
Agricultural Building and Creamery	10,500.00	
Horticultural Building	15,100.00	
Civil Engineering Building	9,000.00	
Commercial College Building	6,000.00	
Chemical Laboratory	27,000.00	
Building for Department Domestic Science	4,650.00	
Greenhouses ($3,000) and Forcinghouse ($1,500)	4,500.00	
Barns, Toolhouse, and Shed on Horticultural Grounds	1,425.00	
Barn on College Farm	4,000.00	
Sheep Barn and Paddocks ($600); Implement House and Shed ($450); Pig-pens ($300); Other Stock-pens ($350); Root-cellar and Silo ($250); Fencing ($1,450) on College Farm	3,400.00	
Farm Dwelling House	2,700.00	
Depot, Hose-house, and Apiary	700.00	145,975.00
Grand Total		$178,875.00

DEPARTMENT INVENTORIES:—

History and Literature	$ 400.00	
English and Philosophy	189.17	
Mathematics	572.85	
Military Science and Tactics	7,338.05	
Zoölogy and Entomology	4,953.85	
Mechanical Engineering and Drawing	14,306.95	
Agriculture	6,072.00	
Botany and Horticulture	6,573.93	
Civil and Irrigation Engineering	10,227.63	
Chemistry	2,870.65	
Domestic Science	870.68	
Commercial Department	1,793.24	$ 56,169.00

MISCELLANEOUS—

President's Office No. 1	$ 3,878.17	
President's Office No. 2	2,254.50	
Secretary's Office	494.28	
Director's Office	865.50	
Library	10,752.28	$ 18,244.73
Grand Total for College		$253,288.73

SUMMARIES:—

Total value of College property, 1891	$144,568.98
Total value of College property, 1892	176,600.26
Total value of College property, 1893	187,847.53
Total value of College property, 1894	197,633.76
Total value of College property, 1895	207,411.83
Total value of College property, 1896	212,699.52
Total value of College property, 1897	232,667.62
Total value of College property, 1898	253,288.73

EXPERIMENT STATION INVENTORIES.

NOVEMBER 30, 1898.

AGRICULTURAL SECTION, FORT COLLINS:—

Farm Implements	$ 103.00	
Dairy Supplies	350.00	
Office Fixtures	374.00	$ 827.00

HORTICULTURAL SECTION, FORT COLLINS:—

Instruments and Supplies	634.59	634.59

SECTION OF METEOROLOGY AND IRRIGATION ENGINEERING, FORT COLLINS:—

Meteorological Instruments	383.40	
Irrigation Apparatus	376.28	
Hydraulic Apparatus	166.95	
Stationery and Office Supplies	142.31	1,068.94

ENTOMOLOGICAL SECTION, FORT COLLINS:—

Laboratory Supplies	78.45	
Entomological Supplies	84.65	
Insecticides and Apparatus	101.00	
Apiary Supplies	162.95	
Microscopical Apparatus in Charge	335.00	762.05
Total for Home Station Property		$ 3,292.58

ARKANSAS VALLEY STATION, ROCKY FORD:—

Two hundred (200) acres of land	$ 9,800.00	
Water Rights and Apparatus	1,858.00	
Buildings and Fencing	2,372.80	
Live-Stock	166.00	
Farm Implements	553.75	
Farm Products on Hand	711.90	15,491.20

RAINBELT STATION, CHEYENNE WELLS:—

One hundred and sixty (160) acres of land	200.00	
House, Barn, Fencing, etc	1,265.00	
Farm Products and Supplies on Hand	91.05	
Live-Stock and Implements	348.85	1,904.90

SAN LUIS VALLEY STATION, MONTE VISTA:—

One hundred and sixty (160) acres of land	2,110.00	
Twenty (20) inches of water in the Rio Grande Canal	300.00	
Buildings, Fencing, and Well	1,497.00	
Horses, Wagon, and Harness	177.00	
Farm Implements, etc	54.90	4,138.90

DIVIDE STATION, MONUMENT:—

Forty (40) acres of land	200.00	
Buildings	600.00	800.00
Total Sub-Station Property		$22,335.00

SUMMARIES:—

Grand Total Experiment Station Property, 1898	$25,627.58
Grand Total Experiment Station Property, 1897	25,643.54
Grand Total Experiment Station Property, 1896	25,289.62
Grand Total Experiment Station Property, 1895	27,086.78
Grand Total Experiment Station Property, 1894	29,797.18
Grand Total Experiment Station Property, 1893	25,037.12

GROUNDS AND BUILDINGS; NEED OF A NEW BUILDING.

The college land touches the City of Fort Collins on the south. In the north-east corner of the grounds are to be found the various college buildings. Most of the 240 acres owned by the State is given up to farm operations, general and experimental. The ground immediately adjacent to the college buildings is made use of by the Horticultural Department in the prosecution of its special lines of work. The lawns about the buildings have an abundance of ornamental shrubbery, with here and there flower-beds upon which the skill of the florist has been exerted with pleasing effect. The drives through the farm are thoroughfares at all times of the year. These drives are kept clean and well-rolled and, being well shaded in summer, are much frequented by those seeking out-of-door recreation by riding or driving.

The college authorities draw a long breath of relief in announcing the completion of the new Chemical Laboratory. Two years ago a legislative appropriation for the completion of this building was asked. It was not granted, and every dollar required for putting this building at the service of the State, both in educational work and in furthering the work of the experiment station, in which our farming communities are so deeply and vitally concerned, was taken from the regular mill-tax fund for the general support of the College. The building stands, to-day, a testimonial of the business capacity of the members of The State Board of Agriculture. Departmental equipments and library additions have suffered by reason of the rigid economy in the handling

of college funds, but it were better thus, possibly, than to face the needed efforts of a new fiscal year with a debt burden to carry.

As soon as the building that had so long served the Department of Chemistry was vacated, plans were suggested for its remodeling to render it suitable for the use of the "Business College." The expenditure of less than one thousand dollars has so changed the building as to make it serviceable in accommodating all the classes of the Commercial Department. The interior now presents a sightly appearance. The removal of partitions and other adjustments of space have given four classrooms and an office. Classes in bookkeeping meet in one room; those in banking practice, in another; those in typewriting and stenography, in another; while the last room—a well arranged general classroom—gives ample quarters for classes in spelling, commercial arithmetic, commercial law, business geography, etc. The building is heated by steam, is well lighted and ventilated, and has every convenience required for the right carrying on of the work of the Department for whose use it has been put in order.

A "Mechanical Department" was created in 1882. Its work was carried on in the basement of the Main Building, immediately beneath the present library room, until the following year when a building better designed for the use of the Department was erected on the northwest corner of the campus. This building has been remodeled and enlarged until now it covers a large area. Here is to be found the machinery and other equipment made of highest utility in prosecuting the well-planned and varied work of the present Department of Mechanical Engineering.

In the summer of 1898, a new 80-horse-power boiler was put in place at a cost of $1,100. The old boiler had outlived effective service and was a menace to life and property. The new one is of approved design and good workmanship and will furnish all the power needed to run the extensive plant.

The need of a building suitable for carrying on laboratory experiments in mechanical engineering has long been felt. Through the generosity of some public-spirited citizens of Fort Collins that need will exist no longer. Voluntary contributions have been made to a fund that is now large enough to insure the speedy completion of a building for special experimental and practical work in advanced mechanics. The purpose of the building and its general appearance, are set forth in an article recently published in "THE ROCKY MOUNTAIN COLLEGIAN," a paper devoted to student interests, from which quotation is made:

"The laboratory idea is one of the strong features of the College. The Mechanical Engineering Department has gradually been brought to a high degree of usefulness, and those who have watched the growth of this branch of the college work have become much interested in it, and it has become a feature which is very attractive to those who visit the Institution. The students who have taken up this line of work have, for the past two or three years, been given considerable advanced work, and original investigations and experiments have been undertaken with the limited accommodations at hand; so valuable to the students has this work proved, and so earnestly have they desired it, that much encouragement was felt still further to furnish the necessary accommodations to do work similar to that of the older and larger institutions of the country."

"The object of the work of the laboratory is to give the advanced students an opportunity to make investigations of the physical properties of materials of construction entering into buildings, machinery, and other structures; and also to make tests and examinations of different kinds of boilers, engines, motors, pumps, and all kinds of mechanical appliances which may be obtained for the use of the department. This opens up a splendid and valuable field to the students of the College, not before available, and the experiences obtained here will be of inestimable value to them. Other institutions of this kind throughout the country are rapidly providing conveniences for this work, and our own institution is to be congratulated for keeping in the van."

"The work does not interfere in the least with that of any other department, and is an added help for the department for which it is designed. Nor does it disarrange the plans of the

Mechanical Department, but enables the work to be extended in a most satisfactory manner. A number of pieces of apparatus had already been given, by generous parties, for carrying on this work before the possibility of a building was known."

"The building will be situated directly south of the present Mechanical Engineering Building and will be known as the Mechanical Engineering Laboratory. It will be 40 feet wide and 60 feet long, and built of brick."

The total value of all state property now under the control of THE STATE BOARD OF AGRICULTURE is nearly $279,000. All this property has been secured from drafts upon the mill-tax fund voted for general college maintenance, save $49,500 voted by the Legislature for the erection of college buildings and for sewer construction, and $2,500 appropriated by the same body for the establishment of an experiment station at Cheyenne Wells in Cheyenne county.

Two years ago, in the annual report prepared just prior to the biennial session of the General Assembly, I outlined with some care the needs that seemed most pressing in the hope that a special legislative appropriation would be made to meet them. A small appropriation—still a very helpful one—would have been secured had not a dead-lock between the branches of the

General Assembly delayed legislative action on a number of appropriation bills until the legal limit of the session had been reached.

The highest legal tribunal of the State has decided that appropriations for improving the grounds belonging to state institutions by drafts upon the Permanent Improvement Fund, and other funds of a like nature, are contrary to law. The general revenue of the State, then, must be looked to for meeting all special legislative appropriations for the use of these institutions. That revenue has been a gradually diminishing quantity of late years by reason of the falling off in the valuation of the property by the general taxation of which —under the constitutional four-mill limit—it is secured. A recognition of the limitations thus placed upon our law-making body in the matter of making appropriations, other than those provided for in former mill-tax enactments, for the state educational institutions, causes hesitation on our part in pressing for any large appropriation for building purposes however urgent the need of such appropriation may appear to us.

Something has been done within the last biennial period to make provision for meeting the needs summarized in the report issued in 1896. The statement of those needs was as follows:—

1. Completion of the new Chemical Laboratory.
2. Better quarters for the Commercial Department.
3. A new Library Building.
4. A Central Heating Plant.
5. An Electric Light Plant.
6. A Dairy-House with all necessary appliances.
7. A new building for the Department of Zoölogy and Entomology, with proper quarters for the College Museum.
8. Rooms for the College Literary Societies.

9. An Assembly Room suitable for Chapel and General Exercises.
10. An Armory, a Drill-Room, and a Gymnasium combined.

The most pressing need has been fully met by the completion and occupancy of the new Chemical Laboratory. The Commercial Department now has ample and desirable quarters in the building formerly occupied by the Department of Chemistry. Thus two of the ten needs specified two years ago have been adequately provided for. The next most evident need is an "Administration Building," as it may not inaptly be called. A new chapel, for assembly and public exercises, is a pressing want. It could find a place in the new building; as could an armory and a gymnasium, quarters for the library, rooms for the literary societies and Christian associations, offices for different persons connected with college administration, study rooms for students, reception rooms, and the like. A building as large as the new Chemical Laboratory, recently completed, would answer the needs of the College, in the matters referred to, for years to come. A state appropriation of $30,000 would suffice for the erection of the building and its equipment for use. The removal of the library and administrative offices from the Main College Building would vacate rooms that could at once be used by the Department of Zoölogy and Entomology. The present crowded condition of the Museum would at the same time be relieved.

The present method of heating and lighting the college buildings is unsatisfactory and expensive. A central heating plant and the means of electric lighting are recommended as necessary both by efficiency of service and economy of effort and money.

When the dairy interests of Colorado is considered, when it is clearly known that it is the work of our Department of Agriculture, in its wide-reaching work, to promote these interests in the most direct way that ex-

perience and experiment may suggest, the need of suitable dairy quarters and appliances stands confessed. Our present dairy plant can hardly be said to be beyond the *infancy* state. Means are not present for the successful prosecution of experimental work of much vital importance to the dairymen of the State. A building, with the requisite equipment, is of prime importance if any further effort to suggest profitable methods of conducting a dairy is to be made.

COLLEGE FINANCES.

The sources of college revenue have been frequently explained. The financial support the college receives from Colorado has been growing less of late years. The mill-tax fund—one-fifth mill on the dollar—for college support is levied upon the assessed value of the taxable property of Colorado. The assessed value has undergone some queer changes in the last seven years as the figures herewith given will show.

Year.	*Assessed Value of Property.*
1892	$236,884,449.48
1893	238,722,417.05
1894	208,905,379.15
1895	201,308,969.10
1896	206,598,561.00
1897	197,276,446.00

The last compilation of assessments, that for 1898, shows the total taxable property of the State assessed, in round numbers, at $187,000,000.00. Within the last five years the assessed valuation of property subject to taxation has fallen off more than *fifty million* dollars. This means an annual loss of state revenue, for college support, of more than $10,000. In June 1892, the total enrollment of students was 146, much less than half that reported in June 1898. Thus while student enrollment is increasing rapidly, the revenue for college main-

tenance is becoming less every year. This loss of revenue would have been a more serious matter for the College had not the income received from the Government endowment funds been somewhat augmented each year.

The first Act of Congress, under which the College now receives an annual income somewhat definite, was passed in 1862. Colorado, under the provisions of that act, received 90,000 acres of land as an endowment of THE STATE AGRICULTURAL COLLEGE. Most of the land has been sold, and the sale proceeds form a permanent endowment fund amounting (Oct. 1, 1898) to $68,612.09. This permanent fund is under the control of the State, and the college revenue therefrom is the *interest* the State pays for its use. From the land unsold, and from interest upon sums due upon lands sold but not yet paid for, the College receives a further revenue amounting to no sum that can be definitely stated.

The Congressional act of 1890, for the further endowment of colleges of agriculture and the mechanic arts, has within the last biennial period given the College $47,000.

A summary of receipts, for college support, within the last two years, is as follows:—

Land Income Fund (Act of Congress, 1862).....	$14,000
Additional Endowment Fund (Act of Congress, 1890).....	47,000
Mill-tax Fund (State).....	70,000
Total for Two Years.....	$131,000

The Government appropriations, under the provisions of the "Hatch Act," 1887, for the exclusive support of the Experiment Station, within the same two-year period have been $30,000. No part of this fund is available for college support.

There is pressing need of such legislative action as will place the handling of all college revenue more directly by the college authorities. At present, the State Treasurer is the custodian of all college money save that

CHEMICAL LABORATORY.

received from the Government for experiment station support. To say that the present plan is not satisfactory, is to put it in mild form. The present plan of permitting the State Treasurer to handle the revenue of the College, as its treasurer, is favored by those who have been taught to believe that a great interest saving to the State results from it. This argument has no just basis in fact. The mill-tax fund, the product of state taxation, is used up about as fast as it comes into the hands of the State Treasurer. Were any accumulation of this fund to be in possession of that official, he could not, by its investment, make an interest-bearing fund of it, because he can not know, with any certainty, when its disbursement in redemption of vouchers of indebtedness duly issued by The State Board of Agriculture, will be necessary. There is no *state* fund of the College that can, with safety, be made interest bearing. There is a fund, however, that can be made to yield an interest, and that is the fund voted by Congress, under the provisions of the "Morrill Bill," 1890, for the further endowment of the College. This annual appropriation, of $24,000 for 1898, comes in the shape of *one* draft annually, upon the Treasurer of the United States. The college drafts upon this fund are made monthly. Being of nearly equal amounts throughout the year, they can be fairly estimated in advance by the custodian of the fund upon which they are drawn. At the time of the writing of this report, the fund referred to has several thousand dollars to its credit. This credit is looked to for the means, in part, of college support up to the close of the next government fiscal year, June 30, 1899. I assert that this is the only college fund that can be made safely available for the production of interest. I assert, further, that if the College has ever received *one cent* of interest revenue from that fund I have been misinformed. The State of Colorado can have no just claim to any interest which the government appropriations for college support may earn. Fair dealing would suggest that all interest earned by such ap-

propriations should be for the sole use of the College. The way to reach an equitable solution of this whole matter is to enact a law empowering The State Board of Agriculture to select its own treasurer—with proper safeguards as to bond, bondsmen, etc.—and to make this official the custodian of *all* college funds just as soon as the same may be available for use.

The plan of having a local *treasurer* to receive and disburse the experiment station fund has ever worked without friction. Not one cent of this fund has ever been misappropriated or lost. The financial statements of this officer have never met with rejection or criticism by the authorities at Washington. There is no reason to fear that the officer who has handled the experiment station revenues so satisfactorily would prove untrustworthy were he made the custodian of other funds, subject as far as their expenditure is concerned, to the control of THE STATE BOARD OF AGRICULTURE.

Much interest naturally attaches to the first Congressional act, that of 1862, making provision for the permanent endowment in each state and territory of at least one land-grant college. Under that act Colorado receives 90,000 acres of land for the permanent endowment of THE STATE AGRICULTURAL COLLEGE. Through the courtesy of Hon. L. C. Paddock, Register of the Colorado Board of Land Commissioners, I am able to present, herewith, tabulated statements showing the location of this land, the disposition made of about one-half of it, and the approximate annual revenue received by the College from the grant.

County.	Acreage Patented to State.	Acreage sold prior to Nov. 1, 1898.	Acreage remaining Nov. 1, 1898.
Baca	635.42	.....	635.42
Bent	1,903.95	386.67	1,517.28
Fremont	9,585.44	4,635.61	4,949.83
Larimer	5,601.50	.....	5,601.50
Las Animas	400.00	.....	400.00
Montezuma	19,121.29	.....	19,121.29
Otero	42,589.61	38,239.72	4,349.89
Pueblo	6,113.83	.....	6,113.83
Routt	1,996.28	.....	1,996.28
Total	87,947.32	43,262.00	44,685.32

The amount of permanent funds invested for the benefit of the College is $52,663.01, which sum is invested in 6% interest-bearing State warrants.

The probable income from certificates of purchase for 1899 is as follows:—

County	Permanent.	Income.
Fremont	$ 14.00	$ 14.28
Otero	5,726.22	4,930.84
Total	$5,740.22	$4,945.12

The following income from leases.

County.	No. of Leases.	Acreage under Lease.	Annual rental.
Pueblo	1	80	$ 10.00
Montezuma	7	720	146.50
Larimer	1	2,578	64.47
Fremont	5	1,240	58.00
Total	14	4,618	$278.97

The total receipts from the land-grant endowment from January 1, 1897, to September 30, 1898—a period of twenty-one months, were as follows:—

Permanent fund	$9,554.97
Income fund	9,009.45

No portion of the permanent fund is available for college support. Any interest return from its investment is, under limitations named in the Congressional act, a source of financial support to the College.

It will be seen that of the 90,000 acres of land to which the College is entitled, there yet remain 2,052.68 acres unpatented. Steps have been taken to locate this land and to secure a patent therefor from the General Government.

In the older and more populous states of the Union, the annual revenue for college support derived from the land-grant endowment of 1862 amounts to many thousand dollars, giving the institution for whose benefit it was established a not inconsiderable part of its total income. In Colorado, the college revenue from this endowment can never reach a sum that will prove any large per cent. of the total sum required for college maintenance. There is need that the lands now unsold, and yet to be patented, be handled with the utmost care that the ultimate permanent endowment of the College may be swelled to the largest possible sum.

The State Treasurer is made the custodian of the permanent fund, the college endowment, the interest income from which is one source of college support. This permanent fund is generally invested in State warrants and is thus made to produce a 6-per cent. revenue for the College. By reference to a preceding paragraph in this report it will be seen that, according to figures given out from the State Auditor's office, the permanent endowment, on October 1, 1898, amounted to $68,612.09. From the statements received from the office of the Register of the State Board of Land Commissioners, under date of November 2, 1898, it is shown that the sum actually invested, and thus made interest-bearing for the College, was only $52,663.01. These figures show that about $16,000, or nearly one-fourth of the whole endowment fund

is unproductive of any college revenue. The annual interest-income thus lost to the College approximates one thousand dollars.

COLLEGE AND EXPERIMENT STATION.

I think it is beyond discussion that the law of Congress contemplates a vital connection between the land-grant college and the experiment station. True, this union is not forced, some discretionary power being lodged with the law-making power of each state, but the evident intent of the law, known as the "Hatch Act," is that the experimental work in each state shall be prosecuted in close contact with the college and under the supervision of its governing board. The wisdom of this working policy has not been gravely questioned. Provision is made in the law, for a division of the experiment station fund between two colleges, if there be such in the same state. Where experiment stations had been established prior to the approval of the Act of 1887, the states wherein they existed were not forced to abandon them in order to share in the distribution of the fund provided by that enactment. A then existing university was entitled to the benefits of the act—by special legislative action—provided there were established in connection with it "a separate agricultural college or school, which shall have connected therewith an experimental farm or station."

When the "Hatch Act" became operative, Colorado was placed in a most favorable position for the utilization of the experiment station fund. There had been established, nearly ten years before, an educational institution, having no educational or governmental union with any other, known as "The State Agricultural College." There was no other educational institution within the state that had a shadow of a just claim to ask any portion of the grants of money authorized by that act. In the legislative act, making acceptance of the provisions of the Congressional act of 1887, is a section that reads as follows:—

"That the State Board of Agriculture shall have the control of the fund appropriated by the said act of Congress and shall disburse the same for the use and benefit of the Agricultural Experiment Station *Department of the State Agricultural College*, and in accordance with the terms and provisions of said act of Congress."

Legislative action, by Colorado, on another matter was not so wisely ordered and was not so fortunate in its issue. A number of sub-stations were established and the college governing board was required to provide for their support out of the station fund received from the United States treasury. In only one instance, in the history of the experiment station of Colorado, has there been a legislative appropriation for station support. This history is, doubtless, repeated in a majority of the states.

While state control of the experiment station work is widely permissible, under the terms of the "Hatch Act," that control does not legally extend to a division of the Government experiment station fund among a number of sub-stations. In most cases these sub-stations are unnecessary and bring about an unprofitable employment of station effort. The Government station fund is rightly used in the support of one station in each state, said station being a department of an agricultural college or school either with a separate organization or in connection with some educational institution under state control. Any other use of this fund is clearly unauthorized by the Congressional action creating it.

In this connection I may record my conviction that there are but few cases where college support is had at the expense of the experiment station fund. The converse is true in the majority of states of whose college and station organization I have knowledge. A not inconsiderable part of the time devoted to station work and much of the equipment employed in its prosecution are paid for by drafts on the college treasury.

There has been some discussion in educational conventions, and elsewhere, as to the closeness of the con-

nection that should exist between the college and the station. The closer and more vital that union the better for both interests, is an opinion I have entertained ever since my attention was given to the question. If the experiment station is to be a department of the college—and that to my mind is the plain intent of the law—its relation to the college should be on the same basis as the relation of any other department thereto. There must be no wheel within a wheel so adjusted as to admit of the possiblility of their attempting to turn in opposite directions. The president of the college is the logical head of the experiment station as he is, unquestionably, that of any other college department. I do not mean that his headship is to be shown by a direct personal supervision of departmental work or even that he is to be learnedly conversant with the details of that work, but that in his executive capacity he is the legitimate head of the whole college system whether of few or many departments. There is nothing inconsistent with a wise ordering of station work by the college executive even though he be no specialist in science and stand confessedly incapable of prosecuting experimental work supposed to be the forerunner of more successful farming. What occupant of the executive chair of an educational institution could undertake, personally, to conduct all phases of class-room and laboratory work with which his executive functions bring him in contact?

The ideal station director, as some attempt to describe him, should be a specialist in every known department of science—a chemist, an entomologist, an agriculturist, a botanist, and so on through the list until the nomenclature of scientific specialists is exhausted. It is not strange that a professor coming to the directorship of the station, with supposedly this amount of scientific qualification tacked to him and properly labeled, should soon come to regard himself as a "bigger man" than the chief executive of the college.

There is no executive function connected with the work of the experiment station that can not be per-

formed by one qualified properly to supervise the general workings of a college. A union of director and president in the same person gives coherency to all the work and is in the interest of economy and harmony. Next to the president, the agriculturist of the college would seem to be the one most naturally eligible to the office of director; but the appointment of the head of one college department to direct work with which other departments are closely connected has its obvious disadvantages.

Another question having connection with others herein suggested is, Shall the heads of college departments to whom teaching hours are assigned, constitute the scientific working force of the station? This is a question about which, as about most others, something sensible can be said on both sides. I believe there is strong reason for saying that the capable *teacher*, possessed of the true scientific spirit, will prove the most serviceable worker in the station; yet few rules are without their exceptions. The professorial duties of the station worker must be so ordered as to give him time to devote to experimental work. Herewith I insert some language found in my last report as director of the experiment station:—

"I think it can be affirmed that most scientific men who give instruction and make investigations at the same time, as do the station and college workers now in mind, have a decided preference for the experimental side of the field upon which they bestow thought and effort. Their reports show a decided inclination, on their part, to emphasize the importance of the scientific and experimental investigations which they have under way and an evident desire to be released as much as possible from the cares and duties of the class-room. The tendency in the direction indicated is too strong to escape notice. It much more than counteracts any loss of experimental attainment by reason of periodic application to the work of instructing classes and supervising laboratory exercises."

"There is a closer connection between the scientific work of an agricultural college and the experimental work of the station connected with it than is usually supposed to exist. The one qualified to conduct experiments in agriculture ought to be

one well fitted to give instruction to a class of students studying the subject. The scientific training that gives the chemist ability to analyze soils, waters, fertilizers, and food products makes him all the more serviceable in the class-room or laboratory in the presence of a body of students. The plan of articulating the work of the college and the station as closely as possible is sound in theory and fairly satisfactory in practice."

President H. C. White, of the Georgia State College of Agriculture and Mechanic Arts, speaks of the union of the school of agriculture and the experiment station with the college proper in the following langauge:—

"The school of agriculture should be the clinic of the college. In a manner, it should bear the same relation to the college that the hospital bears to the college of medicine. It should be primarily designed for those who have already received, or are at the same time receiving, the educative culture of the college proper, and it should not undertake to duplicate, or infringe upon, the pedagogic work of the college. * * * The illustrative work and training of the college farm and its attachments should be distinct from the research work, in its several lines, of the experiment station. It is, unquestionably, eminently advantageous and desirable that the station should be intimately associated with the College, particularly for the sake of the station, but for the sake of the college as well. For that matter, an investigator in one might very well (and preferably) be a teacher in the other, and advanced or graduate students of the college might be admitted to participation in the researches of the station; but the work in each should be distinct, and while they should coöperate and aid each other whenever possible, the distinctive purposes and functions of each should be carefully discriminated."

COLLEGE DISCIPLINE.

Discipline is a term that grates harshly on the ears of many super-sensitive American people. To them it savors of force, oppression, and the restriction of legitimate freedom. There never was a time in the history of our country when parental discipline, school discipline, and college discipline called for wiser ordering than now. Our people seem seized with a spirit of un-

rest that makes them uneasy under restraint however mild and salutary it may be. We boast of our free institutions and almost in the same breath give expression to words that show that liberty and license are not wholly divorced in our minds.

The right handling of college students is no easy matter; and the outcome of college administration, in as far as it affects the future relations of students with the governing agencies of the country, may be of the highest importance. Sowing wild oats in college, as elsewhere, usually brings but one crop. If there is one place above all others where order, sobriety, and decency should hold sway, that place is in an educational institution supported by money taken from the tax-payers' pockets. If educational institutions are not to train for usefulness, for honorable effort, for good citizenship, how strong an argument for their maintenance at general charge is removed. The education of the intellect is well, the culture of the heart is desirable; but, in many respects, the training of the *will* surpasses either in wide-reaching effect. The undisciplined mind is the one where the will runs riot and puts under foot the best suggestions of the intellect and the most generous promptings of the sensibilities. How to reach and develop what is best and noblest in student character, is the burning question of the day. Different conditions will evoke different agencies for the accomplishment of this end. The age and previous preparation of the student for college life have something to do with the kind of college administration proper to bring to bear upon him. The student who has reached man's estate is not properly subject to the closer supervision desirable in the case of the young preparatory student who stands, as to years and development, at the most critical period of character forming.

Shall the student body have a representative voice in college administration? I have never known such a body to which could be safely delegated any controlling voice in the government of the institution with

which it was connected. This statement, if accepted generally, may suggest that college students are not capable of self-government, even in part, and that conclusion is usually the correct one. I would willingly see heralded in a new, a more enlightened era in the management of college students. Gladly would I welcome a condition of affairs that would enable faculty ability to be felt more strongly in class-room and laboratory and less in devising ways and means to secure the orderly deportment of students.

The stumbling-block in the way of a better understanding between faculty and students, in the matter of college discipline, is the traditions of the past and the class spirit—better sometimes called fool spirit—that is made supreme even though it war against the best judgment and impulses of the better class of students. There is a thought that a college without a certain quantum of student deviltry is a back number. Fathers recount to sons, and uncles to nephews, the college diabolism in which they engaged in their student days, and young America is led more than to emulate their example when he enters upon his college career. The highest ideal of college life that can be held up to students by conscientious instructors fails of good effect under such conditions.

What is inaptly termed "class spirit" is a mischievous power that often reduces well-disposed students to a condition of slavery, their better sense all the time protesting against their thraldom. My class, right or wrong! is the shibboleth of every little noisy, turbulent clique of students, the reason for whose presence in college halls is beyond finding out. The influence of a few bold, active spirits in directing student thought and activity is known to all having experience in college administration.

There are too many student organizations connected with modern college life, and the tendency to multiply them is all too apparent. Herein are sown most of the seeds that later germinate into student escapades, col-

lege rowdyism, and a senseless opposition to constituted authority. It has been said that a council of war rarely results in a decision to fight a battle; a council of students, in the shape of a class meeting, is more than likely to bring on disturbances that can only be quelled by the wisest faculty action.

The land-grant institutions have been remarkably free from student outbreaks, manifestations of college spirit as they have been styled. The reason is to be found in such an ordering of college work as to keep students wholesomely employed. Then, until lately, the traditions of the old-time classical institutions had been a sealed book to students seeking an education in the land-grant colleges. The leaven of unrest, of impatience under salutary restraint, is working *upwards*, from the ranks of the idlers and dudes found in the elder institutions of learning, into the student bodies of our scientific and technical schools, as it has already worked *downwards* into higher grades of the public schools with pernicious result.

Self-activity, self-restraint, and self-direction—all are terms freighted with meaning. Good conduct in the presence of a constable or policeman is politic, to say the least, but it does not indicate one's habitual disposition to keep in the right path. The true test comes when good resolutions are sorely beset by covert or open assaults of wrong. Every influence at our command should be wisely employed in making worthy and exemplary men and women of our students. There is much of foolery connected with college life that could be easily suppressed by timely faculty or executive action. A single instance will illustrate. Junior "class-day" is the occasion of exercises that are, in the main, subversive of good discipline and pregnant with malicious mischief. Make the exercises of this day conform to propriety and decency or prohibit them altogether. Class publications are of the same ilk as the class-day exercises. The game secured by firing these explosives is not worth the powder burned. A writer in a recent issue of one of our

educational papers pertinently says: "Year after year there come to us from the colleges the annuals got out by the junior class, representing an enormous expense resulting in what seems to us very little product, and an unbounded attempt at wit resulting in what seems to us usually vulgarity, and always rankling unkindness. * * * We believe there is something wrong in a college course which brings its young men and women to believe that these grinds are permissible."

A common-sense, not a military, discipline is what is needed in our colleges. Respect for law, obedience to rightful authority, is not the characteristic of a slave, as some college students seem to believe, but indicative of elements of character worthy of a true freeman, for "he is a freeman whom the truth makes free and all are slaves besides." Home and school training count for much in the right or wrong preparation for college environment. Hereditary traits, also, can not be eliminated wholly from the equation of college life. There is consolation to instructors in the thought, expressed by an able man, that "you can not by any scheme of education make anything of anyone and obliterate all trace of the natural character."

Abundant evidence is at hand to show the need of speedy and circumspect faculty action in putting wholesome restrain on student lawlessness. The press of the day is full of half-approving reports of the senseless pranks of college students. Recently, there came to my office a copy of The Courier, published in Geneva, New York, in which I read with much interest, a lengthy account of the dedication of a number of new buildings for the use of the New York Agricultural Experiment Station. The front page of the paper fairly overflows with reports of the idiotic doings of Geneva school boys and the wasted energy to be given by the students of Hobart College to a cane rush and football games. Not a word about the scholastic work of school or college can be found in these reports which appear in three separate columns of the page. That college work of any

desirable kind can thrive under such conditions is not in evidence. The air that is most popular with most students just now, and which indicates the direction of most student activity, is, "There'll be a Hot Time in the Old Town To-night."

COLLEGE ATHLETICS.

From what I have said under the head of "College Discipline," it will not be difficult to forestall much that I shall say, and might say, upon this subject.

Against the proper physical culture of college students, I have nothing to say. Most field sports are of value, if not pushed to an extreme. The manifest tendency, however, is to overdo matters and push athletics into the realms of professional sport. Possibly, I favor as strongly as any one the physical development of the race. A sound body is the proper receptacle for a sound mind. Emerson says that health is the best wealth. There is something of truth in the saying that the first thing one should do is to try to be a good animal.

The late war with Spain showed us the need of soldiers trained to great physical activity and inured to hardship. It also showed a need of discipline and an obedience to orders not the outcome of "football ethics." The swaggering air of ill-judged independence, so characteristic of some of our people went with our recruits to camp and battle-field. Undisciplined soldiers with false ideas of personal independence have brought brawl, riot, and bloodshed into some of our military camps.

It is discouraging to see our youth who, under our educational policy, enjoy exceptional opportunities for wisely fitting themselves for usefulness and honor hereafter, waste their time, fritter away their parents' money, weaken their moral growth, and suppress the promptings of their better nature in demoralizing sports, unmanly behavior, open-mouthed defiance of authority, and aping the swaggering habits of toughs and roughs.

In every student body, there are restless, lawless spirits, having the quality of leadership, who act as firebrands to inflame all the idle, vicious propensities of their fellows. Their presence in college halls is not for the purpose of acquiring scholastic training but to find a field for the play of their sporting tastes. The demoralizing influence they exert upon their companions is scarcely to be measured. They organize the forces unfriendly to studious habits; they stand in the forefront of all student escapades that bring just reproach upon our institutions of learning; they stamp the impress of their lawlessness upon the exercises of the athletic association; and there is never a revolt against decorum and decency with which they are not prominently associated.

The close observer of college life is forced to the conviction that the athletic association of every institution is its *storm center*. Many worthy students have membership in this organization, but their influence in its management is not very marked. The ostensible purpose of the association—the physical well-being of its members—is commendable. Most college students, particularly under the old-time idea of college instruction, need some kind of physical exercise to break the monotony of study hours and recitation periods. The value of the exercises of the gymnasium will not be diminished by the elimination of the danger element.

The last football season left a record of five deaths, thirty-three serious injuries, and minor accidents almost beyond computation. A newspaper writer, very friendly to the game, says, "The football season just closed shows more deaths and more serious accidents than any season in the history of the game." To weaken just condemnation of a game attended with such a number of casualties, the writer asserts that 25,000 players participated in the games during the season. Loss of life and permanent injury to body are bad enough, but they disclose but imperfectly the train of ills led by the "great game," as it is called.

I think that no one can make it clear that college athletics, as understood at present, secure any desirable development, physically, of those who take part in them. On the contrary, the strain they put upon the physical energy of the participants is so severe, at times, as to leave the bodily organism permanently impaired. Cases are not infrequent where football contests, on the "gridiron," have resulted in broken bones, over-strained muscles, and incurable bodily injuries.

Athletic contests are generally time-wasting, dangerous to life and limb, promotive of lawlessness, suggestive of brutality, and enervative of correct moral sense. If there is good in them it is deeply buried under the avalanche of bad. To say that good people give them a word of approval and countenance them by becoming their onlookers, is not to say that every rowdy, brutal, immoral, and idle element among the people does not find in them a source of keen, relishing enjoyment—something strongly appealing to that sense of pleasure to which alone their sensibilities are open.

The necessity for bodily exercise, training of the whole physical being systematically and regularly, has been admitted. The youth has animal exuberance that needs outlet. The direction of this virile force is of the utmost importance. The manner of its exercise must not bring undue physical exhaustion or any weakening of moral fiber. The country boy on the farm has about him the means of gaining bodily strength without any loss of intellectual energy or moral power. Work is an old-fashioned way of developing strength of limb and muscle.

There is a happy mean somewhere and college wisdom should seek to find it. The technical school, which has a scheme of instruction in which strength of mind and vigor of body come in daily contact, is one that promises some solution of the question that is prominent in educational circles—the education of the young from *all sides*. Open-air work, shop work, laboratory practice, engineering field work, and, above all, the military drill

CIVIL ENGINEERING BUILDING.

with its strong, quick, graceful, and well-executed movements give the students fresh from scholastic work just what their physical nature craves and what will be of most service in its right development.

It would be well were our news reporters, instead of writing up the senseless and immoral pranks of college students in flippant style, as though right principles and public morals were not concerned in what transpires in school and college, to set forth in earnest words the lack of manliness and honor evinced by such reprehensible conduct. This course is rarely followed; and the failure of sharp newspaper rebuke encourages students of light brain power or those afflicted with "fatty degeneration of the conscience" to imagine that their foolish acts are the open sesame to public approval.

It is discouraging to the student of studious habits and earnest purpose, to see his idle, improvident, and lawless fellows lionized in newspaper paragraphs or pictured for the public eye, while his patient scholarly efforts whose success promises so much to his country, appear unworthy of casual mention. Some of the newspaper pictures of notable football worthies would prove a striking and an appropriate addition to the rogue's gallery. The young, unthinking and inexperienced in the just demands that society will make upon them, are prone to court this newspaper notoriety, seeing in it, under the flashy coloring in which it appears, the avenue to the attention and Godspeed of the public.

The football coach, is, in the false light reflected from college halls seen in gigantic proportions beside the gentlemanly, scholarly student who takes the highest honor of his class.

There will be a public awakening on this subject ere long; and the result will be the kindly, yet firm, repression of the objectionable features now connected with college athletics and an insistence, on the part of the college officials, that the young people under their direction give more wholesome and undivided attention to their legitimate educational work. Hazing, cane-

rushes, oratorical contests of shouts and yells, hand-to-hand conflicts between members of rival classes will be things forgotten or remembered but to flush the cheek with shame that they ever occurred.

MILITARY INSTRUCTION IN LAND-GRANT COLLEGES.

ARMY SERVICE OF COLORADO AGRICULTURAL COLLEGE STUDENTS IN THE WAR WITH SPAIN.

My approval of the military drill is as hearty as my disapproval of football, as played, is sincere. The military drill would be desirable, because beneficial, were wars and rumors of wars to cease. I know of no physical culture, outside of a well-ordered gymnasium, that is comparable with that of the drill exercise. On the drill ground, rather than on the "gridiron," can be found a place for "the cultivation and attainment of the better qualities of personal character such, for example, as courage, obedience, endurance, and regard for personal honor."

An oft-quoted paragraph of the first "Morrill Bill" contains one provision that makes it obligatory upon the authorities of the land-grant colleges to provide for instruction in military science. An amended act of Congress gives the President of the United States power to detail an officer of the Army or Navy to act as professor of military science in certain educational institutions having capacity to educate at the same time not less than one hundred and fifty male students. The number of officers thus detailed must not exceed one hundred and ten and the land-grant colleges are first to be recognized in making the details.

Prior to the war with Spain all the institutions given priority of details, as far as I know, had military exercises supervised by an officer of the Army or Navy. On the declaration of war, this officer was ordered to return to the service of the Government. At present I know not the status of the military work at the institutions affected by the order of recall but suppose

that it does not differ essentially from that existing in the institution I represent. The opening of the present college-year found two hundred and fifty male students, many wholly unfamiliar with any kind of military exercise, on our college grounds, and, in their organization into companies, I had no cadets of higher rank than sergeant available for service.

Lieut. Warren H. Cowles, 16th Infantry, was the first officer detailed by the President for service in The State Agricultural College of Colorado. Lieut. Vasa E. Stolbrand, formerly of the United States Army, preceded Lieut. Cowles as military instructor. Lieut. Cowles was succeeded by Capt. John C. Dent, 20th Infantry; he in turn by Lieut. Harry D. Humphrey, 20th Infantry, and upon the expiration of Lieut. Humphrey's detail, in the summer of 1897, Lieut. William C. Davis, 5th Artillery, became the professor of military science and tactics at the College. When war against Spain was declared, Lieut. Davis was ordered to rejoin his regiment, since which time the College Cadets have maintained their organization without the aid of an officer detailed from the Army.

Recently a circular letter, prepared by the Inspector General of the Army, was sent out, in which request was made for statistical information regarding the military service rendered by students and ex-students, of institutions whence officers had been recalled, in the war with Spain. If conditions generally were such as the Colorado cadets had to face, the history of the services of the students of the land-grant colleges in that war would be like the famous account of the snakes of Ireland—"There are no snakes in Ireland."

A portion of the circular referred to reads as follows:

"In order to determine the practical results of military instruction at the civil institutions of learning and with a view to further stimulate the military work conducted at these institutions, kindly fill up the inclosed blank forms and return one to this office."

"It is desirable that the information requested be given as fully as possible; and any further information or remarks upon the subject will be thankfully received."

The blanks referred to contain a series of ten questions designed to bring out full information regarding the military service of students and ex-students of the College in the late war with Spain.

As a matter worthy of more than a passing interest, I give, herewith, the full text of my reply to the circular letter.

To the Inspector General, United States Army, Washington, D. C.

Sir:—I have before me the blank forms whereon you request me to furnish statistical information regarding the military service rendered by students and ex-students of The State Agricultural College of Colorado in the late war with Spain. I have knowledge of four graduates and seventeen undergraduates and ex-students who were in the army after the war before named began. Herewith I give their names, and present rank and location as fully as information at present available will permit:

GRADUATES.

1. Archie Jesse Harris, (Fort Collins, Colo.) 2nd Lieutenant, 2nd Infantry, U. S. A., now at Montauk Point, New York. This enlistment was a result of the action of the War Department whereby students of meritorious standing in military service in certain institutions of learning were made eligible to a commission in the Regular Army.
2. Edgar Avery Mead, (Greeley, Colo.) Sergeant Co. D, 1st Regiment, Colorado Volunteers, now at Manila.
3. Richard Appleton Maxfield, (Rifle, Colo.) Sergeant Co. I, 2nd Regiment, U. S. Volunteers, Engineer Corps, now at Honolulu.
4. Grafton St. Clair Norman, (Hamilton, Ohio) 2nd Lieutenant Co. K, 8th Infantry, U. S. A., now at Fort Thomas, Newport, Kentucky.

UNDERGRADUATES AND EX-STUDENTS.

1. Frank D. DeVotie, (Greeley, Colo.) Sergeant Co. D, 1st Regiment, Colorado Volunteers, now at Manila.
2. Neil Carmichael Sullivan, Jr., (Longmont, Colo.) Sergeant Co. H, 1st Regiment, Colorado Volunteers, died at San Francisco, California, June 4, 1898.

3. John McMillan, (Fort Collins, Colo.) 7th Infantry, U. S. A., wounded at San Juan.
4. William B. Sexton, (Fort Collins, Colo.) Co. G, 20th Kansas Volunteers, Engineer Corps, now at San Francisco, California.
5. James Pullar, (Fort Collins, Colo.) Co. G, 8th Infantry, U. S. A., service at Santiago; three year term just expired.
6. Simon Moses Marks, (Buena Vista, Colo.) Co. F, 1st Regiment, Colorado Volunteers, now at Manila.
7. Joseph Clinton Holtschneider, (Buena Vista, Colo.) Co. A, 20th Infantry, U. S. A., was at Santiago; is now at home on furlough for sickness.
8. Francis Virgil Leroy McCandless, (Florence, Colo.) Corporal Co. A, 1st Regiment, Colorado Volunteers, now at Manila.
9. Perry Hjalmer Nyberg, (Pueblo, Colo.) Sergeant Co. A, 1st Regiment, Colorado Volunteers, now at Manila.
10. Robert James Potter, (Gunnison, Colo.) Co. F, 1st Regiment, Vermont Volunteers, at present at home on furlough.
11. John Thomas Richards, (Erie, Colo.) Co. F, 1st Regiment, Colorado Volunteers, now at Manila.
12. Benton Sylvester, (Berthoud, Colo.) 2nd U. S. Volunteers, Engineer Corps, now at Honolulu.
13. George Washington Springer, (New Windsor, Colo.) Co. D, 1st Regiment, Colorado Volunteers, now at Manila.
14. Everett Washburn Taylor, (Fort Collins, Colo.) Corporal Co. G, 1st Battalion, Wyoming Volunteers, now at Manila.
15. Fred Montgomery Westlake, (Florence, Colo.) Lieutenant 2nd U. S. Volunteer Engineer Corps, now at Honolulu.
16. Guy Surinus Hooper, (Greeley, Colo.) 2nd U. S. Volunteer Engineer Corps, now at Honolulu.
17. Henry E. Voegeli, (Cincinnati, Ohio) 1st Illinois Infantry, U. S. Volunteers, service at Santiago; now on furlough, Chicago, Ill.

Doubtless there are other ex-students who are enrolled in some branch of the army service, but information at hand does not give their names or location. This may not be regarded as a creditable showing for an institution in which compulsory mili-

tary drill, under an army officer detailed by the War Department of the Government, is required of two hundred and fifty students each day of the college-year. The military drill is an important feature of the work of the land-grant college as outlined by Congressional acts.

The detail of an army officer to fill the post of professor of military science and tactics in such an institution must be accepted as evidence of the importance of the military department therein as seen from the standpoint of the authorities at Washington. The military instruction and drill to which college students are subjected, under present regulations, are not designed, primarily, to foster a warlike spirit, but to afford a wholesome exercise whereby the bodily vigor of the student will be stimulated and conserved. The drill, as conducted, offers the young men of our educational institutions the best possible athletic exercise under conditions favorable to physical upbuilding and suggestive of permanent health. The thought of possible service in the fighting force of the Nation is not absent, but it is not the thought uppermost in the minds of those who conduct, or engage in, the military drill under normal conditions. When the blast of war blows in our ears, then it is natural to look to the young men trained in military science and tactics for loyal, patriotic, efficient service in the armies of the Republic. That such service was not proffered in larger measure by the students and ex-students of our institution is due to no lack of patriotism or courage on their part. These young people, without exception, are intensely loyal to their Government and under proper conditions would be among the first to respond to their country's call in time of war.

I regret to say that these conditions have not existed and do not now exist. At the first call to arms, Lieut. William C. Davis was ordered to return to his regiment and the College Battalion was left without an organizing and a directing head. This was not a move calculated to awaken and stimulate the military ardor of the two hundred and fifty cadets forming the three companies of the Battalion. The boys felt, perhaps without due consideration of all the conditions, that the Government had but little interest in the military work they had done, and were doing, and less call for any service they might feel prompted to offer. Some of them could look back upon five years of faithful service as members of the College Battalion, and at a critical juncture that organization had been practically ignored by the Government. If the late war, although making no great draft upon the

military resources of the country by reason of its short duration and the second-rate war power of the nation with which we were contending, shall better instruct those in authority, with us, how to utilize the military energy and enthusiasm of students whose college course requires attention to military study and the varied exercises of the drill, it will bring about a condition in our college life greatly to be desired. Under the new regime the officers of the War Department will have full power and ample means to put military instructions in our higher institutions of learning on a more efficient and a more enlightened basis. Then it will not be thought best to furnish grudgingly, and under useless and annoying restrictions, the various battalions of college cadets with out-of-date arms and equipments. The field pieces that lumber up our drill room or, when laboriously dragged upon the campus, excite the open-eyed wonder of small boys, will be retired from service and replaced with something less suggestive of Revolutionary days. Few of our cadets have ever seen, much less handled, a Krag-Jorgensen rifle.

The attitude of the War Department toward the college military drill is now one of "masterly inactivity," in which "how-not-to-do-it" is made conspicuously prominent. I have written two letters to the Department requesting information as to when to expect the detail of some officer to organize and direct our military work and have received nothing definite in reply. I have been forced to reorganize our military department with the highest officers available for help ranking as *first sergeant.* There are many retired officers efficiently serviceable for such work as is performed by a professor of military science and tactics in an educational institution, but I am not advised that any official attempt has been made to put them in charge of it. A letter from the Adjutant General's Office, of recent date, suggests that possibly the services of a retired officer could be secured by advertisement in the Army and Navy Journal, New York City, and the Army and Navy Register, Washington, D. C.

I have received information from a source somewhat distant from the War Department offices, that "no details whatever will be made till after the report of the Peace Commissioners." It is thought possible that this report may see the light of day about October 15. How doth hope deferred make the heart sick! The same mail that carried me that promise, whose fulfillment will doubtless project itself well into the future, brought your request for statistical information that will show the service rendered their country in time of war by our students and ex-students. A stream is not likely, by natural means, to rise above its source. I fear it will

be next to impossible to imbue our cadets with much of patriotic war spirit when so little concern for their growth in military experience and knowledge is shown by those to whom they look, with some right, for encouragement and help. I shall welcome the day when the military departments of our educational institutions are made highly efficient by reason of the hearty support and intelligent supervision they receive from the authorities connected with the War Department. Give the cadets every facility in the way of instruction and equipment that military experience can suggest and they will not be without military ardor or the power and will to give their country prompt and effective service in her time of need.

The opening of the late war found our male students prepared and eager for military service, but deprived of the commander who had brought their organization to a high state of efficiency. The Government seemingly had no call for their service as an organization or as a picked part of an organization. The only way open to our students, in their wish to serve their country, was in the complete disbandment of the organization to which some of them had belonged all through their college life and to which they were, with just reason, most strongly attached. If they turned to the state, in some hope that they would receive recognition from that quarter, they were told to wait until the mustering in of all divisions of the National Guard was completed and a place might be found for them in the ranks thereafter to be recruited. Meeting disappointment at every turn, they reluctantly gave over effort to secure recognition as a military organization. Those who enlisted did so on their own account, took pot-luck so to speak, and became tail-enders in some company whose efficiency as a military organization was not comparable with that which they were forced to abandon.

Some may say that patriotism should have prompted the boys to put aside the *esprit de corps* that so warmly attached them to their own organization and made them willing to pass down to the foot of some other one. Possibly had the exigencies of the Government, from the military side, been more pressing and urgent than they were, that course would have been uncomplainingly taken by our students, but the necessity for a disbandment of their organization to swell the membership of some other did not seem present. The officers of our companies had won their way to the front rank among their fellows by years of careful attention to, and pride in, the military drill. They were conversant with the manner and aims of military organization and were able to render what may not inaptly be called *expert*

service. Throw them out of their battalion organization and their military advancement is lost, and they must take places as privates in companies officered by persons of inferior intellectual and military education to themselves. It takes a strong patriotic force to push one out of a well-earned position of command into ranks filled up chiefly with men but little more than raw recruits. The graduate of a college who has won with honor and credit the epaulets of a commissioned officer may well be pardoned for showing some reluctance to entering upon a military life as "high private."

Had there been place for an organized body of our students in the line of troops, that place would have been occupied had it been pushed well up towards the nearest point of hardship and danger. It was not possible for the Agricultural College Cadets *to break into* the Army by all the push, personal, political, and official, they could summon to their aid. The recital of these facts shows why the College, with a large body of students and ex-students available for efficient service in the Army, can report but twenty-one representatives as placed where military service in their country's behalf can be rendered.

In connection with what I have written, I feel disposed warmly to commend that heading in the annual report of the Military Department of the College under which is given the names of three cadets of the graduating class who have shown the most proficiency in the military work. Following this, the recent action of the War Department in giving some thus selected for complimentary mention a chance to show fitness for a commission in the Regular Army, can not but be productive of good result. Now that a permanent increase in our national military force is almost an assured fact, would it not be well to make the selection of a few college cadets, of approved scholarship and proficiency in the military exercises, for suitable positions in the Regular Army a settled policy? Such recognition of deserving cadets, with the desire to follow the life of a soldier, would give an impetus almost beyond measure to interest in every phase of college military instruction. I can not but think that the army organization would be rendered more efficient by such an infusion of young virile force. There are some of our people who profess to see in the increase of our standing army a menace to personal rights and free institutions. This feeling will be materially weakened if people see important posts in that army filled by their sons and their neighbors' sons who have been educated in their home institutions of learning.

I wish not to widen the gap that now exists between the military organizations in our educational institutions and those whose movements are under the immediate direction of the War Department of the Government. On the contrary, I earnestly desire to see the existence of a closer bond of union between them. I would force no graduate or undergraduate into the Army. A craze to enter the Army in ordinary times, would indicate an abnormal, an unhealthy state of student life. There is no just ground to fear that military instruction in college, even on a much more wide-reaching and effective plan than that to which we have been accustomed will engender a blood-thirsty, war-at-any-cost spirit among students. I would not have a student prepared to serve his country in war hampered in his desire to do so by hard conditions and red-tape regulations. The Government provides for the military training, more or less effective, of a large student body. If war comes, and there is no opening in army ranks for these trained and scholarly young men, save in the lines of raw recruits, they may reasonably question the purpose of such prolonged and costly military training. There ought to be a ready place in our war forces for any well organized body of college cadets seeking active service and there ought to be no unnecessary obstacles placed in the way of their enlistment.

Let us have a more thorough management of the military work of the colleges in which military departments exist and a more ready means, in the war emergencies of the Nation, of utilizing the product of this increased efficiency of organization.

Respectfully yours,

ALSTON ELLIS,
President.

Fort Collins, Colorado, October 3, 1898.

When war with Spain was declared, a number of the college cadets, enough to form a single company, made tender of their service, with the single condition that their organization as such be accepted; but their effort to secure recognition was futile. That so many college representatives found active and honorable military service in the various volunteer forces of the country, is a testimonial to the unselfish and patriotic spirit prompted and strengthened by the military discipline and general training of the College.

The General Government has never given enough attention to the military organization at the College. The military authorities of Colorado have never manifested the slightest interest in it. While attempts of a vigorous nature have been made to organize companies of the National Guard in different sections of the State, a military organization large in numbers and suggestive of efficient service in war emergencies has been practically ignored by our state military authorities.

The neglect, to which attention is herein directed, is no matter of necessity; it is the outcome of choice—choice manifestly antagonistic to the spirit, if not the letter, of the law.

The three sections of the act of the General Assembly of Colorado, approved April 9, 1895, read as follows:—

Section 1. That, for the purpose of further carrying out the provisions of the act of Congress approved July 2, 1862, in relation to agricultural colleges, the military body known as the Agricultural College Cadets, of the Colorado Agricultural College, is hereby organized as an auxiliary branch of the Colorado National Guard, placed upon the same footing as regards arms, ammunition, clothing, camp and garrison equipage as the Colorado National Guard.

Section 2. That the proper officers of said Colorado National Guard are hereby authorized and directed to honor the requisitions of the commanding officer of said Agricultural College Cadets, under such rules and regulations as may hereafter be prescribed by the State Military Board and the State Board of Agriculture, when countersigned by the President of said college, for ten rounds of ammunition per year for each member of said military body, and for such camp and garrison equipage as may be necessary for the proper instruction of said body in all that pertains to the practical duties of soldiers in camp.

Section 3. The Cadets of the State Agricultural College shall be attached to the Colorado National Guard, under such rules and regulations as may hereafter be prescribed by the State Military Board and the State Board of Agriculture.

If this law is not intended to secure an intimate connection between the College Cadets and the National

Guard of the State, the reasons for its enactment are not readily apparent. It is desirable that early action to make effective the provisions of the law quoted be taken. A step in the right direction would be the issuing, under state authority, of commissions to the commissioned officers of the College Battalion. Then, such inspection of the military work of this organization, by the proper officers of the Colorado National Guard, as would show interest in its existence and approval of its purpose, should be provided for.

A larger regular army, for the wide-reaching service that lies just before the United States, is now recognized as a necessity. Competent military authorities maintain that the great need in army circles will be an increased body of well-trained, scholarly, serviceable officers. The General Government can widen the work of the National Military Academy and, in time, supply the Army with the required number of trained officers, or it can establish new military schools and thus bring about the same result; but both plans suggest great expense and are wholly unnecessary. By the endowment of the land-grant colleges, by requiring instruction in military science and tactics to form a part of their work, and by the detail of army and navy officers as instructors in them, the Government has placed thousands of its able-bodied young men—picked men as to native and acquired ability—in a position to receive that military and scholastic training that makes the best equipment of an army officer. In every college, in any way subject to the control of the Government, there are a number of lusty, energetic, patriotic, and intellectually-trained young men who have an enthusiastic desire for a military life. This desire on their part is not unnatural, merits no strong repression or stern rebuke from any quarter. All over the country aspiring young men are seeking, with avidity, cadetships at West Point and Annapolis and, in their efforts for such appointments, are receiving the active support of their friends and the hearty approval of the public. The conditions about the land-grant college are

such that the right preparation each year of a limited number of students for commissions in the regular army would bring nothing in the way of extra effort or expense to the institution. The colleges of the United States to which military officers are now detailed, as instructors, can, annually, direct towards the permanent military organization of the country several hundred young men worthy to hold rank as commissioned officers, and that, too, without additional drafts upon either state or national treasury. Were the annual selection of two or three college cadets, of strong inclination and special aptness for military life, as commissioned officers in the Regular Army, made an assured fact by action of the Government, a strong impulse would be given to every phase of our military work. Thus would the military needs of the Army, in the way of well-equipped officers, be easily, inexpensively, and effectually met.

FUNCTIONS OF THE LAND-GRANT COLLEGE.

I purpose under three heads, of which the one found above is the first, to give an exposition, as full as may be presented in the limits of such a report as this, of what a land-grant college is and the kind of educational work it can legitimately undertake.

It would seem, at first view, that there ought to be no difficulty in rightly interpreting the provisions of the Congressional acts of 1862 and 1890. The first includes eight sections and the second, five—none of great length. Look at the names of the institutions that are beneficiaries under said acts, and the conviction is forced upon you that those who control them are far from having a common understanding of the amount and character of the educational work for the promotion of which the "Morrill Bills" were framed. The author of those measures has been called upon time and again for an expression of his purpose in their preparation. He has uniformly asserted that the acts were designed to meet the educational requirements of the millions engaged in industrial pursuits. He has affirmed that the term

"Agricultural College" as applied to the institutions, established under the acts of Congress before referred to, is a misnomer and not suggestive of the *liberal* education of the industrial classes.

The name "College of Agriculture and Mechanic Arts" comes nearer to expressing the purpose of the "Morrill Bills," as far as that purpose can be determined from their wording, than does the term to which Senator Morrill so strongly objects.

There are some points that, to me, seem clearly established. Congressional legislation never contemplated any general duplication of existing institutions. No one can find in any part of the "Morrill Bills" any authority for the establishment and support of schools exclusively for "agriculture" or the "mechanic arts." No narrow, one-sided, technical school is authorized anywhere in the bills to which reference has been made. The teaching of trades, the forcing to farm labor, and the neglect of the cultural in education can find no authorization in the broad and liberal provisions of these enlightened measures.

It is unfortunate, in many ways, that the name "Agricultural College" has been fastened upon so many of the institutions partly endowed by acts of Congress. It may be doubted whether the appellation "Land-Grant College" suggests anything of the nature of the educational work of these institutions. As long as they are called "Agricultural Colleges," "Agricultural and Mechanical Colleges," "Industrial Universities," and names equally significant, it is reasonable to expect the general public to have erroneous ideas of their legitimate work and aims. What more natural than to expect and require an agricultural school to teach *agriculture*, and but little else? If an industrial university is not to teach all the trades—prepare for all the vocations in which physical energy is employed—people are led to say "what's in a name"? The people who have to deal with an "Agricultural College" are not wholly to blame for the persistence with which they hold to the opinion that its mis-

sion, in the educational world, is to give that practical training that will best fit one to become a farmer or a mechanic. In many cases appeal has been made to law-making bodies for financial support with arguments tending rather to strengthen than to weaken this narrow and illiberal view.

The common opinion of what a college founded "for the benefit of agriculture and the mechanic arts" should do is expressed in the questions that come from some self-named practical man who professes to believe that the less education one has the better fitted he is for labor on the farm or in the shop.

The head of an agricultural college is asked how many farmers' sons seek his institution for educational advantages and how many of these, after a period of college training, return to the farm? A few quotations from a reply I once wrote to a series of such questions may find an appropriate place in this connection.

"The writer of the queries forgets, seemingly, as many others forget, that the land-grant institutions are not exclusively agricultural schools, although some of them are operated under the title, 'Agricultural College.' It is well to keep in mind the scope of the Congressional act of 1862, under whose wise and liberal provisions more than sixty scientific and technical schools, 'to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life,' have been established."

"In no part of the various provisions found in the Congressional acts of 1862 and 1890, better known as the 'Morrill Bills,' can the word '*agriculture*' be found out of immediate connection with the terms '*mechanic arts*.' The just conclusion is that the so-called land-grant college is as much an institution for promoting education in the mechanic arts as in agriculture. A clear understanding of this fact will weaken the force of much criticism upon the work and the products thereof, of the land-grant colleges. All these institutions of learning—they are such, not merely little, narrow, one-sided schools of agriculture resting upon a shallow scientific foundation—have, or ought to have, under the requirements of the Congressional acts, courses of study making adequate provision for instruction in 'agriculture and the mechanic arts' and such branches of learning, including the clas-

sics, as are related thereto, and properly suggesting a 'liberal and practical education.' "

"I have not a wide range of statistics at hand to support my opinion that the work of the agricultural college is becoming a strong force to popularize and make more remunerative all phases of labor connected with farm life."

"There are strong influences tending to counteract this good work, and these influences are thrust through college doors into college halls by farmers themselves. Only yesterday, a farmer of more than average thrift and intelligence, brought his seventeen-year-old boy to my office to arrange for his admission to college. In the boy's presence he stated that his purpose to have him enjoy the advantages of the institution was born of a desire to have him get a living by some easier, surer, and swifter process than farming. Are there not many such farmers in the land? I venture to say that the larger number of farm people who send their sons and daughters to the agricultural colleges do so in the hope of freeing them from the necessity of the slave life of labor, as they call it, through which they passed to the creature comforts they now enjoy. These comforts are too plain, too every-day, and too little suggestive of social dissipation to satisfy wants that have grown abnormal under the promptings of the restless, uneasy, dissatisfied spirit all too common among our people. Then, too, people want to get rich fast and are not always choice as to methods. No wonder that under such home influence the boy grows into the belief that an education worth having should bring its owner the maximum of pay with a minimum of effort."

"The college in which science is taught practically, where technical work is wisely planned and made an every-day exercise, is doing more to make toil respected than the farm home presided over by parents who teach their children to look upon an education as the 'open sesame' to a life in which the work grows lighter as the pay becomes greater."

"Even the graduate from the agricultural course of a college is not always to be blamed for not throwing himself with spirit into the usual current of farm life. There may be no farm to which he can profitably return. That of his father, it may be, is under full tribute to support the stay-at-homes. The son with a college training, costing some years of effort and a snug sum of money, naturally rebels against entering into the labor and compensation of the average farm hand of the push-and-pull, fetch-and-carry order. If the possessor of a college diploma can direct, with advantage to all concerned, the operations of an extensive

MECHANICAL ENGINEERING BUILDING.

irrigation system, why ask him to pull on a pair of irrigating boots and irrigate the crops on some land-owner's farm at $25 per month and board? If an education fits one to earn $100 per month, why find cause for criticism because he is unwilling to engage in a more uncongenial labor for much less pay? What kind of service from the agricultural college graduate is it reasonable to demand? The one capable of directing aright the labor energy of a number of employés, in any branch of productive industry, is giving better service than he could render under the condition of the average laborer."

"It is too soon to declare without qualification the success or failure of the agricultural college in industrial fields, be they urban or rural. Some of the operations of this new educational agency are in a tentative state and further data are needed before safe conclusions are reached. I believe it is true that most educational agencies outside of the land-grant colleges and technical schools have little thought about the farmer and the needs of his children as the farm people of the future. The traditions of the old-time college, with its classical course and exaggerated ideas of the value of a professional life, are against any mode of securing a livelihood outside of an office. There is hope for better things under the new educational regime which recognizes the dignity of manual labor and professes to fit for it by special scientific and technical training. The educated man is always best equipped to meet the problems of life."

I have already expressed my belief that the institutions established under the provisions of the "Morrill Bills" should form a distinct link in the educational chain. The author of the law of 1862 has said that when he introduced that measure into Congress, the colleges and universities of the country were giving an education designed exclusively for the so-called learned professions, with nothing to meet the pressing requirements of the members of the great working bodies of the people. Then, in the framing of the law with which his name is so honorably connected, he could not have contemplated an addition, in kind and method, to the very institutions he felt had ignored the educational needs of the industrial classes. The "Morrill Bill" of 1862 was not designed so much to strengthen any existing educa-

tional institutions as to found, and to provide an endowment for, a wholly new one—one that in its work and aims should pretty clearly differentiate itself from colleges and universities as they then existed. It may be admitted that there is argument for teaching almost anything to be found in the latter portion of section four of the Act of 1862. It is hard to believe, however, that the founding of a new college or university along the then established lines, or the financial strengthening of some institution for higher education that had "given little or nothing to the requirements of the millions engaged in industrial pursuits," was the motive that prompted Congress to pass that law. The trouble is that college men interpret the educational clause of that measure to support their own views or to defend the environments wherein their professional efforts are exerted.

When the first "Morrill Bill" became operative, there was hardly a state college or university in the country that did not make effort to secure recognition under its provisions. The fact that such institution, by reason of its lines of study and deep-seated traditions, was almost wholly unprepared for the new work and out of all vital sympathy with it, was no hindrance to effort on the part of its authorities to secure its further endowment at the expense of the fund established for the "liberal education of the industrial classes."

It is worthy of note that the word "*university*" nowhere appears in either of the "Morrill Bills." Wherever the institution to be established, or further endowed, is referred to it is termed a "*college.*" We recognize a clear-cut distinction between the terms, as did, doubtless, the author of those measures and others who supported them. Plainly, in my view, the "Morrill Bills" were designed to establish and endow new institutions whose aims, methods, and activities should be a wide departure from those then in vogue in the colleges and universities of the land. The new institutions, in their work, were to keep prominently in view instruction that

would further the advancement of agriculture and the mechanic arts. Other scientific and classical studies, not closely connected with the *main end* to be advanced, were not necessarily to be excluded from their courses of study, for, with all the special training for definite ends held of first value, the liberal culture of the students was considered desirable. That some associate anything designated *liberal culture* with the study and mastery of the classics—Greek and Latin—is a fact that has no vital connection with the question now under consideration. There are some who are just as pronouncedly of opinion that all we call culture, in the realms of mind and morals, is not reached by winding through the intricacies of Latin construction and delving into the mysteries of Greek roots. Even some of the abstractions and mystifications connected with the study of what is rather indefinitely called, "*philosophy*" might be omitted from the course of the land-grant college without serious loss to the culture and training of its students.

However wide and liberal, in the interpretation of some, may be the provisions of the first "Morrill Bill," there is no mistaking the fact that pretty definite metes and bounds are set to the educational work of the land-grant college by the terms of the second. Herein it is expressly stated that the more complete endowment and support of the college for the benefit of agriculture and the mechanic arts shall "be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to the industries of life." Evidently the thought connected with this language is that a liberal education for the man of affairs has some connection with close, student contact with the lines of study thus specifically stated. Did the period that spanned the dates 1862 and 1890, bring a revolution of opinion as to the work proper for a land-grant college to enter upon, or are we to regard the later

expression of the will of the law-making power but as an interpretation of what went before?

There is a link that binds these two dates and the provisions of the Congressional acts connected with them. The act of 1887, known as the "Hatch Act," connects a department, to be known as an "Agricultural Experiment Station" with each land-grant college, then established as the result of former legislation, under certain minor conditions that state legislative power may impose. The evident intent of the "Hatch Act" is to give stronger and more practical impulse to the agricultural work of the land-grant college.

As a result of some of the facts recited—in view of *all* the legislation of Congress bearing upon the establishment and support of colleges for the "benefit of agriculture and the mechanic arts"—a few conclusions seem warranted:—

1. The state that has established *one* college for the benefit of agriculture, etc., and that wholly disconnected with any other educational institution, has followed closely in the path marked out by Congressional legislation.

2. The course of that college, if it make *prominent* instruction in agriculture and the mechanic arts, is in prime accord with one of the most important provisions in each "Morrill Bill." To profess to teach branches *related* to agriculture without teaching the subject itself is, to me, sheer nonsense.

3. Although special prominence should be given to the subjects before named, other studies designed to broaden and discipline the mind of the student—to fit him for intelligent helpfulness in affairs of society and state—should find a place in the course of study offered by such college. These studies should be such, in the main, as articulate most closely with those already named and engender a trend of thought and effort most in harmony with the ideas underlying the promotion of industrial education generally.

4. A course in domestic science, one for a business department, and under-graduate or post-graduate courses in engineering—civil, mechanical, and electrical—are not out of place in the exercises scheduled for the college.

5. The work of a school of mines has no intimate connection with that of such a college as has been referred to; but inasmuch as its general aim is to make more effective an important phase, in certain sections of the country, of industrial life, its incorporation with that of the land-grant college would not be at variance with the general purport of existing legislation and, in a state where mining is one of the leading occupations of the people, might be strongly in the interest of economy.

6. Instruction in military tactics is a part of the prescribed work of the institution receiving financial support from the General Government. The land-grant colleges are first served in the authorized details of officers from the Army and Navy to serve as professors of military science and tactics in educational institutions. The requirement is recognized by all the colleges affected; but there are different ways of rendering such requirement effective. The letter and spirit of the law ought to be obeyed and all able-bodied male students should be held rigorously to a reasonable amount of military service.

STATE AND COLLEGE.

The relation of the *state* to the land-grant college has not been a subject of much discussion in circles touching the work of the institution. The work of the college will depend almost wholly upon the manner of its organization under state authority and the local interpretation of the provisions of the "Morrill Bills."

The financial provisions of the original act have given some land-grant colleges a permanent endowment from which they now receive a large annual revenue;

others derive but a slender revenue from that act. State equality in sharing in the endowment fund created by the act of 1862 was not secured by reason of the fact that the amount of land apportioned to each state was determined by the number of representatives in Congress to which it was entitled. This worked to the disadvantage of the newer and smaller states. All states are put upon an equal footing, as to government financial support, by the conditions of the act of 1890. No discrimination against a small state is seen in the apportionment of the fund for the support of the experiment stations.

Uniformity in nature and scope of the work of the land-grant colleges is impossible so long as the various state and territorial governments place their own interpretation upon the language of the Congressional acts. One state begins with an agricultural and mechanical college and later on converts it into a state university with courses of study in conformity with the new title. Another finds a full compliance with the acts of Congress in creating a college of agriculture in connection with some existing institution. Some provide one course of study; others a number of courses. Money for the support of all this varied work is taken from both government college-funds, save that language instruction other than English is not paid for from any appropriation authorized by the Act of 1890. In many states, the appropriation from the state treasury for college support exceeds that received by the institution from the United States treasury. The state in such cases, at least, can justly claim a controlling voice in the managerial policy of the institution within its borders. Then, it must not be forgotten, that the purpose of the "Morrill Bills" is not *unduly* to influence action favorable to the development of certain phases of higher education, thought desirable and serviceable, within the states. No state is forced to accept the bounty of the Government whereby the better education of the industrial classes is sought to be conserved. The people of this country have been taught by the logic of events to

look with disfavor upon any governmental policy smacking strongly of paternalism.

The authorities who have the general supervision, in the name of the Government, of the funds set apart for the maintenance of the sixty institutions, or more, founded under the acts herein so frequently named have ever shown a disposition to recognize state control over them as final to the fullest extent consistent with a very liberal interpretation of the law. Commissioner Harris, of the Bureau of Education, states the guiding principle governing the acts of the officials referred to when he says, "This office has no desire to go behind the returns; and, except where it is evident that a misstatement has been made, the reports of the treasurers are accepted as rendered."

When certain lines of study are specified in the Act of 1862, it is at once added that the instruction shall be given "in such manner as the legislatures of the states may respectively prescribe." It is taken for granted that each state will use its own legislative judgment in the matter of founding the college and organizing its work. The action of the legislature of Colorado, in making acceptance of the terms of the Act of 1862, in the name of the State, is, I believe, a type of what is best in this class of legislation. A portion of an act approved January 27, 1879, reads as follows:

> "Whereas, The State of Colorado has constructed and provided for the support and maintenance of an agricultural college within its limits * * * that in conformity with an act of Congress of the United States * * * assent is hereby given to the provisions of said acts and amendments thereto, and the grants mentioned in said act are accepted, with all provisions connected therewith."

After the passage by Congress of the Act of 1890, legislative action in Colorado, making full and complete acceptance of its conditions, was coupled with the following authorization: "That the State Board of Agriculture shall have the control of the fund appropriated

by the said act of Congress, and shall disburse the same for the use and benefit of the State Agricultural College, in accordance with the terms and provisions of said act of Congress."

These acceptances did not terminate legislative action relating to the management and support of the college. A tax of one-fifth mill on the assessed valuation of property within the state was authorized, special appropriations for buildings were voted, and laws creating a governing board and, in general, defining its duties were enacted. In referring to Colorado, in these particulars, I am calling attention to no isolated case. There is not a state in the Union that would not maintain its right to legislate, almost without restriction, upon matters connected with its college "for the benefit of agriculture and the mechanic arts;" and, in so doing, there would be no great likelihood of a misunderstanding or conflict with the Washington officials.

The fact that the state is the active, right-at-hand agency for directing our college work, is a sufficient explanation of the different forms that work assumes and the diverse views sometimes entertained by college representatives regarding it. College men, may consider, discuss, and argue until they reach an agreement—were that possible—as to what the land-grant college should do and should not do, yet that agreement must find expression in the laws of the various states before it can be made forceful in changing, to any great extent, college management. Primarily, the Congressional acts suggest certain lines of work with more or less definiteness; ultimately, legislative enactments in the states close the question against all but local debate. A college preparatory school is a necessity, if the standard of scholarship for entrance to the college is too elementary in consequence of legislative action. Left to act upon my own judgment, I would not make admission to the institution with which I am connected as easy as it is now. I think a pronounced vote of land-grant college men would favor raising the standard of scholarship all

along the lines of educational effort with which they come in touch. Most of them feel, doubtless, that their work suggests specialization of effort on the part of students too soon and that a fairly broad foundation of general scholarship should underlie the attempt at specialized effort in every field of human activity. They may agree upon these things in convention, but unanimity of opinion among them does not change the necessity for obeying the law at home. "Good thoughts, though God accept them, yet toward men are but little better than good dreams unless they be put in act."

PURPORT OF THE CONGRESSIONAL ACTS OF 1862 AND 1890, BETTER KNOWN AS THE "MORRILL BILLS."

QUOTATIONS SHOWING THE BEST INTERPRETATION PLACED UPON THE EDUCATIONAL PROVISIONS OF THOSE ENLIGHTENED MEASURES.

It is now more than thirty-six years since the first bill for establishing and endowing a "college of agriculture and mechanic arts," in the several states and territories of the Union, was enacted into a law by Congress. Since then more than sixty institutions of learning have been established under the liberal provisions of that wise and beneficent measure. These institutions while having a general aim, pretty well defined, vary greatly in the amount and kind of work upon which student activity is exerted. The trend of educational effort in most of these institutions is towards a more liberal culture of students—a higher standard of scholarship —and a training that will later place the student in more helpful contact with the great and diversified industrial interests of the country.

The information, regarding the workings of these new educational agencies, most needed by the people, is that which will bring clearly to their minds the paramount objects for the accomplishment of which these institutions were established and the legitimate means to be employed in the attainment of these aims. As an

interesting and instructive addition to this field of thought and discussion, briefly stated views of some eminent for service in the cause of popular education are herewith given.

In speaking of the educational significance of the movement that resulted in the establishment and endowment of the land-grant colleges, in an address delivered at the Massachusetts Agricultural College in 1887, Charles Kendall Adams said:—

"It opened the whole realm of nature as the legitimate field of investigation and study. Before this time the work of the schools and universities had been confined to developing the minds of the pupil and the teaching of the four learned professions—theology, medicine, law, and pedagogy. Universities had been established in the twelfth, thirteenth, fourteenth, and fifteenth centuries in all parts of Europe, but in no one of them were studies carried on in accordance with the modern investigating spirit."

And, again, in closing his address, he makes use of the following language:—

"These are some of the lessons and some of the necessities that are taught by experience; and yet they are only hints, as it were, designed to show how vast is the domain that invites the careful study of our schools and colleges. It is into this domain that the people were invited by the wise Land Grant of 1862. It is in this domain that the colleges and universities founded on that grant, if they live up to their high behest, will accomplish results that shall be for the helping, if not for the healing of the Nation."

Hon. Justin S. Morrill, whose honored name is inseparably connected with the Act of 1862, the *first* "Morrill Bill," followed President Adams in a striking address from which the following excerpts are taken:—

"The existence of the colleges can alone be vindicated by reason that they are not superfluous but indisputably wanted; and that their work is not Utopian but practically of real service to the country. * * * The importance of long terms of human training for the professions of theology, law, medicine, and peda-

gogy, has for years been held to be indispensable. But these learned professions, important as they are, numerically include only a small fraction, comparatively, of the human race; and, yet, it is hardly too much to say, that our ancient colleges and universities mainly provided instruction originally intended exclusively for those who sought to be equipped for these special classes. The great majority of mankind, therefore, lacking perhaps neither ambition nor native ability, were dependent upon the hap-hazard of self-culture, or upon being taught in some brief way in the district school how to read, write, and cipher. If this uncounted and unrepresented multitude sought to acquire knowledge of more practical value in the voyage of life, they soon found that useful knowledge was often estimated in ancient and richly endowed institutions to mark the humble station of steerage passengers, while the august institutions assumed to provide alone for passengers in the cabin, and, for them—having reluctantly abandoned the discipline of the 'birch'—only an intellectual discipline, the efficacy of which no one disputes, though no less efficacy may be claimed in behalf of studies for scientific use than for classic ostentation. * * * The great army of industrious laborers in the field and workshop, in mines and factories, or on railroads and other business enterprises—ready at any time to give their lives in support of the liberties and union of the Nation—had some right to more of sound and appropriate learning that would elevate and especially profit them in their respective future careers."

"The school age of man is far too brief for the acquirement of all knowledge of philosophy, letters, and science, and where the dead languages have the primacy, there is little chance for the sciences, for modern languages, or even for our native tongue, or, indeed, for much, with scholarly thoroughness, in anything else. A mere smattering of the sciences, or of the ancient languages, is no more to be coveted than even the old absolute *unity* of all college education. The organic law of the land-grant colleges, therefore, made it a leading feature that instruction should be provided, *without ostracising anything*, in branches related to agriculture and the mechanic arts, upon which, as we all know, the greater number of mankind must rely for their subsistence and happiness, as well as for their growth and reputation among men."

In the quotation last given the italics are my own. The words are deeply significant of what was in the

mind of Senator Morrill when he introduced into Congress the first measure that is best known by its author's name. The whole address from which these citations are made is a strong plea for industrial education in which the practical and cultural elements shall be happily blended. There is not a sentence of Senator Morrill's utterances, at the time named, that is not in fullest accord with the opinions expressed in the brief quotations given. Ten years later, 1897, Senator Morrill writing, from the Senate Chamber, Washington, D. C., to Director True, of the Office of Experiment Stations, United States Department of Agriculture, says:—

"I have to say that the Act of 1862 was intended to give those whose lives were to be devoted to agriculture or the mechanic arts, *or other industries*, embracing much the largest part of our population, some chance to obtain a liberal and practical education. The colleges in existence did not pretend to do anything more than to educate young men for the three professions of divinity, law, and medicine and surgery."

Again I take the liberty to italicize three words in the quoted extract.

At one time it was proposed to make the Agricultural College of Massachusetts a "living branch" of Amherst College. The latter institution was, doubtless, in need of a "living branch;" but the state's obligation to the masses of the people, and to the General Government as well, would have been imperfectly fulfilled had the proposed union of the two institutions been consummated. Hon. Charles G. Davis, who gave a masterly historical address on the occasion twice before referred to, had this to say of the proposed connection of the institution authorized by the Act of 1862 with the classical institution at Amherst:—

"I have never been able to see how the state could 'support and maintain' a college if it is made an annex to another college. How can the state send its Board of Agriculture as overseers to another corporation? 'At least one college.' If an agricultural college, so-called, is located in the vicinity of another college, it

still can not be another college, unless it rests upon a separate foundation, with independent and distinct professors throughout; and, if so, there can be no saving of expense by any such conjunction as can be made under the law."

The following tersely expressed opinion of the best reason why the farmer's son should go to the land-grant college, is from the pen of Dr. A. C. True, whose efficient labors have done so much to promote the value of experiment station work in the United States:—

"The boy does not go to an agricultural college to practice the ordinary operations of a farm as a means to provide support for his schooling or simply to learn the art of agriculture. He is to be taught not only how to do things, but why he should do them, and he should be so taught that when his college course is over, he will not be merely familiar with the ordinary routine of farm work, but will be able to plan such work in a progressive way, to take advantage of all that can be learned from the investigations of experiment stations and other scientific institutions working in behalf of agriculture, and to direct the labor of others in the most approved and profitable way. Not only must the agricultural college supply the demand for trained managers of our larger agricultural industries, but it must also train men for positions in our experiment stations, colleges, and in that increasing number of industries related to agriculture where scientific training is necessary to the highest success."

The proceedings of the College Section of the Association of American Agricultural Colleges and Experiment Stations, at the tenth annual convention of that body, held in Washington, D. C., in November, 1896, were marked by the presentation of a number of papers on the question, "What shall be taught in our colleges of agriculture?" G. T. Fairchild, then President of the Kansas Agricultural College, opened the discussion by reading a paper from which a few characteristic extracts are taken:—

"Unless the colleges of agriculture reach a considerable body of farmers with their liberalizing education there is little hope for a scientific agriculture. * * * It is absolutely essential that the way from the farm to the college shall not be interrupted.

The city high schools do not and can not furnish the true line of training for the farm boy whose every sympathy is in the field and forest and farmyard. The trend of secondary schools is almost universally toward the need of the city in merchandise, manufactures, and professions. * * * As fundamental in all study, a thorough training in the English language must stand first. If this is given through a comparison with other tongues I shall not complain, but the result must be English rather than linguistic information or grammatical expertness."

Then in order of importance as he sees it, President Fairchild names "an exacting study of mathematical principles and distinct application of these in quantitive sciences like chemistry and physics," the "descriptive sciences and the philosophies of organic life," the "art of expression," and a "training in manual dexterity."

President H. H. Goodell, of the Massachusetts Agricultural College, spoke, in part, as follows:—

"More mind and less muscle is the watchword of to-day. In preparing the soil, in planting, in cultivating, in haying, in harvesting, in threshing, in the management of the dairy, in fact almost everywhere, intelligence is the principal thing, and mere brute force comparatively worthless. * * * The curriculum naturally divides itself into seven departments—the English, the agricultural, the chemical, the botanical, the mathematical, the zoölogical, and that of languages and social science."

H. J. Waters, Director of the Missouri Experiment Station, followed in the discussion and made the following statements, among others:—

"It is clear that no definite scheme of studies equally applicable to the needs and requirements of all states and to the peculiarities of the public and high-school system of the different states can be laid down. Nor is it, in my judgment, possible, except within very wide and general limits, to say what shall be and what shall not be taught in our agricultural colleges. * * * It appears to me to be a matter for each college to determine for itself whether it will attempt to take cognizance of all the important industrial interests or concentrate its efforts and funds upon a few of the more important ones. As to whether a given college shall offer courses in agriculture, mechanical, mining,

civil, or electrical engineering, and domestic economy, or require all its students to pursue one course embracing the leading educational and industrial features contemplated in the law should be left to the properly constituted authorities of that college to determine. * * * By the letter of the law there is no restriction as to what the cultural subjects shall embrace—whether the classics, modern languages, psychology, or what not. While it is agreed upon every hand that in all cases provisions should be made in all courses for a reasonable amount of instruction that tends toward liberal culture, it is equally clear that the technical, the industrial, the useful instruction (those sciences relating to the several industrial pursuits) shall constitute the majors, in order that the training there imparted may be directed to some practical end."

H. C. White, President of the Georgia College of Agriculture and Mechanic Arts, emphasized much that had already been brought out in the preceding papers, in his address from which quotation is herewith made:—

"Our institutions are to be educational establishments, not professional schools. They are to contribute to the drawing out and direction of the intellectual powers of the youth of the land—particularly of the 'industrial classes'—so that they may be properly fitted by 'liberal and practical' culture to engage in the 'several pursuits and professions of life.' * * * There is no warrant in law, or reason, for the distinctive designation of our colleges as 'agricultural' or 'mechanical.' I think it is a pity that the habit has grown among us. 'Land-grant' or 'State,' or 'Science,' would be more fitting appellations if distinctiveness is desired."

The Act of 1862 "was intended to increase the learning of the youth of the land, to furnish them with intellectual powers and stores of knowledge applicable to industrial pursuits by providing liberally for the education, to that end, in order that, those who might engage in such pursuits should no longer be mere slaves of craft, but freemen in the intelligent prosecution of their chosen handiwork. * * * So far as the letter of the law is concerned, the strictest constructionist could not assert that anything having the faintest shadow of a claim to be considered a branch of education might not be taught in our colleges."

The twelfth annual convention of the Association of American Agricultural Colleges and Experiment Sta-

tions was held in Washington, D. C., November 15, 16, and 17, 1898. The address of the President of the Convention, Henry C. White, Ph. D., of Georgia, contained statements interpretative of the acts of Congress relating to the land-grant colleges. The address was referred to a special committee, composed of George W. Atherton, LL. D., President of the Pennsylvania State College; J. E. Stubbs, LL. D., President of the Nevada State University; R. H. Jesse, LL. D., President of the University of Missouri; Enoch A. Bryan, A. M., President of the Agricultural College and School of Science of the State of Washington; and J. K. Patterson, LL. D., President of the Agricultural and Mechanical College of Kentucky.

In its make-up, the committee represented every phase of educational work operative within the land-grant colleges. Its report, which is an authoritative affirmation of the statements contained in President White's address, is as follows:—

"The brief time which could be given to a proper consideration of the address, in the midst of many pressing engagements, precludes the possibility of doing more than to express a general but unqualified assent to the views so ably set forth by the President of the Association; and the Committee submits to the Association, without argument, the following resolutions as a brief expression of its views and as a platform upon which the institutions here represented may confidently take their stand."

"1st. That the proceeds of the United States Land-Grant Act of 1862 and the annual appropriations provided for by the Acts of Congress of 1887 and 1890 are a National Trust to be administered by the several states in strict accordance with the letter and spirit of the grant."

"2d. That the land-grant colleges, whether organized separately or as branches of state universities, are primarily educational institutions required by law to teach certain branches of learning."

"3d. That these branches of learning are to be taught with special reference to their applications in the industries of life."

"4th. That this requirement involves a thorough fundamental training in the principles of the mathematical, physical and natural sciences, in order that their practical applications may be

DOMESTIC SCIENCE BUILDING.

clearly understood, and forbids that the institutions shall in any way be regarded as *trade schools.*"

"5th. That the land-grant colleges are required by law to provide a *liberal* as well as a *practical* education, and that it is therefore their special duty to study, practice, and develop sound principles of instruction in the teaching of all branches of learning both liberal and technical, to the end that the subjects taught may be made the means and instruments of a true education, as well as a means of acquiring a body of concrete knowledge."

"6th. That the aim of all research shall be to learn the truth, and the aim of all teaching, to teach the truth and nothing but the truth; and that, to this end, freedom of research and freedom of teaching are indispensable."

"7th. That all teaching should accordingly be absolutely free from partisan or sectarian bias, that the institutions should be free from partisan or sectarian control, and that no interference in the administration, or in the teaching, or in the tenure of office should be allowed on partisan or sectarian grounds."

The opinions that the foregoing quotations present vary in degree, but not in kind. The consensus of opinion, regarding the necessity of a broad, generous literary culture, growing out of the instruction and training given the students of the so-called land-grant colleges, is very marked. Conditions in Colorado are very favorable for the realization of all that is best and most progressive in the Congressional legislation, assent to which, coupled with wisely ordered legislative action, has given our state a college that stands well up to the front among the institutions of its class.

CONCLUSION.

I have purposely made this report more comprehensive than usual. In its preparation, I have not hesitated to quote liberally from my recent report to the State Superintendent of Public Instruction and my address, as Chairman of the College Section, delivered before the annual convention of The American Association of Agricultural Colleges and Experiment Stations that met lately in Washington, D. C.

The College is now more deeply imbedded in the regard and good-will of the people of Colorado than ever before in its history. Its progressive course has been watched by them with friendly and deep interest. They have been taught to know how practical and wide-reaching is the educational work that it is doing.

The students who leave the College at once put its instruction and training to practical and effective use and thus give forceful, undoubted testimony to the value of educational processes that train brain and hand to aggressive activity in the industrial world.

I can not close without speaking in terms of strong commendation of the financial management of the College under your painstaking, business-like administration. You have proved wise stewards of the high trust placed in your keeping. You have just rounded out a biennial period of college history with the institution you have so wisely fostered free from debt and in a position that gives promise of its greatly increased usefulness in the near future.

To all who have, in any way, contributed to making college administration effective and successful, I offer thanks and best wishes.

Very respectfully,

Alston Ellis

President.

Eleventh Annual Report

OF

The Agricultural Experiment Station

OF

Colorado

For the Year 1898.

Home Station,
Fort Collins, Colorado,
December 14, 1898.

The Agricultural Experiment Station,

Fort Collins, Colorado.

BOARD OF CONTROL:
The State Board of Agriculture.

EXECUTIVE COMMITTEE IN CHARGE:

A. L. KELLOGG, *Chairman*,
Rocky Ford,

ALSTON ELLIS,
Fort Collins,

JOHN J. RYAN,
Fort Collins,

P. F. SHARP,
Denver,

B. F. ROCKAFELLOW,
Canon City.

STATION COUNCIL.

Alston Ellis, A. M., Ph. D., LL. D.....President and Director.
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C. S. Crandall, M. S.....Horticulturist and Botanist.
W. P. Headden, A. M., Ph. D.....Chemist.
L. G. Carpenter, M. S.....Meteorologist and Irrigation Engineer.
C. P. Gillette, M. S.....Entomologist.
J. E. DuBois.....Secretary.
F. H. Thompson, B. S., Stenographer.

ASSISTANTS.

F. L. Watrous..... .....Agriculturist.
Carl H. Potter, B. S.....Horticulturist.
Louis A. Test, B. M. E., A. C.....Chemist.
Fred Alford, B. S.....Chemist.
John E. Kiteley, B. S.....Chemist.
R. E. Trimble, B. S.....Meteorologist and Irrigation Engineer.
E. D. Ball, B. S.....Entomologist.

SUB-STATIONS.

Harvey H. Griffin, B. S.....Superintendent.
Arkansas Valley Experiment Station, Rocky Ford, Colorado.

J. E. Payne, M. S.....Superintendent.
Rainbelt Experiment Station, Cheyenne Wells, Colorado.

The State Experiment Station.

SECRETARY'S FINANCIAL STATEMENT OF THE EXPERIMENT STATION FUND FOR THE FISCAL YEAR ENDING JUNE 30, 1898.

Receipts—	*United States.*	*College.*	*Total.*
United States Treasurer	$15,000.00	.....	$15,000.00
Balance June 30, 1897	.....	$1,938.89	1,938.89
Farm Products	.....	730.69	730.69
Total	$15,000.00	$2,669.58	$17,669.58

Expenditures—	*United States.*	*College.*	*Total.*
Salaries	$ 9,601.82	$ 562.43	$10,164.25
Labor	2,223.28	265.92	2,489.20
Publications	1,206.45	285.30	1,491.75
Postage and Stationery	77.50	.....	77.50
Freight and Express	24.75	.....	24.75
Heat, Light, and Water	1.25	.....	1.25
Chemical Supplies	.....	.....	.....
Seeds, Plants, and Sundry Supplies	259.41	6.00	265.41
Fertilizers	104.02	2.40	106.42
Feeding Stuffs	76.53	358.65	435.18
Library	.....	.....	.....
Tools, Implements, and Machinery	101.06	.....	101.06
Furniture and Fixtures	.....	.....	.....
Scientific Apparatus	343.41	87.66	431.07
Live-Stock	36.00	.....	36.00
Traveling Expenses	806.40	467.30	1,273.70
Contingent Expenses	10.00	.....	10.00
Buildings and Repairs	128.12	.....	128.12
Balance	.....	633.92	633.92
Total	$15,000.00	$2,669.58	$17,669.58

Letter of Transmittal.

HON. ALVA ADAMS,
Governor of Colorado.

Sir—I have the honor to present herewith the Eleventh Annual Report of the Agricultural Experiment Station which, by the terms of Congressional and State legislation, is one of the departments of THE STATE AGRICULTURAL COLLEGE of Colorado.

Both College and Station are under the direct control of The State Board of Agriculture, some of whose employes give time and effort to both College and Station work.

Two sub-stations are maintained by the use of a part of the Government fund provided for in the "Hatch Act" of 1887. Such use of said fund is unauthorized by the law, but it has been thought best "to stretch the law" a little rather than wholly to abandon the work in which the people in two important districts of the State are so deeply interested. There is faint hope yet that the Legislature, realizing how vitally concerned are our farming communities in sub-station experimentation, will furnish the financial support necessary to render it permanent and of increasing utility.

Irrigation surveys in at least two important valleys of the State and wide-reaching experiments in the growing of sugar-beets, have profitably engaged the time of some of our station workers. All scheduled lines of ex-

perimental work have been followed out with painstaking effort put forth systematically.

Forming interesting and valuable parts of the matter herein presented for your consideration, are the reports of the different members of the Station Council and those of the Superintendents of the Rainbelt Station, at Cheyenne Wells, and the Arkansas Valley Station, at Rocky Ford.

Respectfully submitted,

ALSTON ELLIS,
Director of the Agricultural Experiment Station of Colorado.

Fort Collins, Colorado, December 14, 1898.

Report of the Director.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—Station work has been more successfully prosecuted within the last year than ever before. It is very fortunate for us that changes in the Board of Control and the station working force are not frequent. There has not been a change in the *personnel* of the Station Council for a number of years. Even the labor force has a permanency that adds greatly to the efficiency of the service by which planned work is carried into execution.

A sum in excess of eleven hundred million dollars is expended annually for the support of experiment stations in the United States. About one-fourth of this sum comes from state appropriations; the rest is provided for by drafts upon the Treasury of the Government under the terms of the "Hatch Act" of 1887. It is a significant fact that Colorado has never appropriated any money for experiment station support. The substation at Cheyenne Wells was put in operation by the economic use of a state appropriation of $2,500, but the support of that station, for the four years of its existence, has been at no cost to the State.

Drafts upon the experiment station fund have been made in strict compliance with the letter and spirit of the law. No part of college support is secured at the expense of this fund. All ordinary farm operations, as well as many of a wholly experimental nature, are car-

ried on at college expense. The salaries of employes whose service is in any way connected with both College and Station are so adjusted as financially to strengthen the latter at the expense of the former.

Our principal lines of station work, pursued without material deviation ever since that work was entered upon, are as follows: Chemistry, field experiments, meteorology, botany, horticulture, entomology, and irrigation. About two years ago, garden experiments were discontinued. I hope to see provision made for some garden work in future schedules.

There is a growing demand that our experimentation in the interest of dairying be made more far-reaching. Dairymen have just reason to ask that their interests be not overlooked in the station work paid for out of the government fund. The act creating that fund contains provisions in which experimental work closely connected with the dairy interests of the country is plainly suggested. Original researches on the physiology of animals, the diseases to which they are subject and remedies therefor, are provided for. The experimental work outlined in the "Hatch Act" includes consideration of "the composition and digestibility of the different kinds of food for domestic animals" and "the scientific and economic questions involved in the production of butter and cheese." We have not the *best* conditions for carrying out the investigations referred to in the language quoted. Our present facilities for prosecuting these investigations could be added to at no great expense; and that course is suggested by the rapidly increasing interests that would be favorably affected by its adoption. Some qualified to make suggestion assert that if the conduct of a station be put on a *business basis*, the dairy can be made efficient as an experimental agent and partially self-sustaining at the same time. The dairy interests of Colorado are now large and annually growing in importance. The alfalfa districts of the State, as they may be termed, are peculiarly fitted for the profitable handling of dairy herds. The products of such herds will

find a constantly increasing market-area when their excellent character is more widely advertised. An editorial writer in a recent issue of "The Western Creamery," published in San Francisco, expresses the opinion that "an era of great faith in dairying" is at hand. His description of some conditions favorable to the dairy industry in California might be applied with equal force to those now existing in many parts of Colorado. In referring to the superior dairy products coming from the alfalfa districts of California, he says:—

> "Until 1897 it was commonly believed that alfalfa would not make good butter, but when ten California tubs of butter were sent to the National exhibit at Owatonna and alfalfa secured the highest score of the lot, it dawned upon our people that they might be mistaken. When again, at Topeka, the alfalfa butter secured the highest score of the four tubs sent from California, an impression was made upon the trade and, with the intrinsic merit of such goods to sustain the reputation there gained, alfalfa butter has since stood in the first place in our markets."

The recent action of the Executive Committee in authorizing the feeding of a small "bunch" of yearling calves, at the sub-station at Rocky Ford, is in line with the thought that prompts me to say what I have said on dairying.

Within the last two years appropriations amounting to $1,350 have been made for the prosecution of irrigation surveys in the San Luis and Arkansas valleys. Measurements of the Arkansas river are now in progress. Prof. L. G. Carpenter, Irrigation Engineer, has direction of the work.

Experiments in the growing of sugar-beets have been made in various parts of the State. The plans for this work were perfected by Prof. W. W. Cooke, head of the Agricultural Section, and the Station Chemist, Dr. William P. Headden. All this work was but the continuation of effort begun nearly a dozen years ago. The results, as they are seen at present, may be thus summarized. Under average conditions, from 14 to 16 tons

of sugar-beets can be raised on one acre of land; their sugar content will be from 12 1/2 to 13 per cent.; and their purity will be represented by a per cent. ranging from 75 to 78.

These wide-reaching experiments have entailed upon at least two of our station workers a vast amount of labor and have been prosecuted at no slight expense to the experiment station fund. They were undertaken to show the adaptability of our soil for growing sugar-beets in amount and quality to justify capitalists in building beet-sugar factories in Colorado. The results already secured make it clear that all phases of the sugar-beet industry can be made profitable when labor and capital unite for their development. In view of what has already been accomplished—the facts now pretty definitely established—it may well be considered whether further experimental work, along the lines so well wrought out heretofore, shall be undertaken by the Station in the near future.

The work of the Entomological Section, directed by Prof. C. P. Gillette, has been, principally, an investigation of the value of different methods of destroying the codling moth, an examination of grasshopper depredations in certain localities, and a continuation of apiary investigations. The continuation of a systematic test of varieties of orchard and small fruits, has engaged a large part of the time, available for station work, of Prof. C. S. Crandall, Station Horticulturist.

We are frequently called upon for statements showing in what manner our station investigations have proved of practical benefit to the farmers of the State. Station work in Colorado has been systematically carried on ever since the "Hatch Act" made an experiment station a college department. Even before the provisions of that act were made operative, much experimental work had been intelligently planned and successfully executed. To meet with question regarding the value of the work done in the past, and that planned for the future, is to be expected. A reference to our numerous bul-

letin publications furnishes strong testimony of the far-reaching efficacy of what has been already accomplished by the well-directed efforts of our station workers.

Not long since I received a letter containing a number of inquiries regarding the *practical* results secured by our station workers in the carrying out of their investigations and researches. Some of these queries are worthy of more than a passing notice and, for that reason, are herewith given:—

1. What are the special lines of work which the Colorado station is trying to follow, and what has been the success of the work?

2. What special discoveries, if any, of scientific or practical value have been made by workers of the station?

3. Has the station discovered, or been active in introducing any system, method, process, remedy, variety, or other principle which has been of marked value?

4. Has any publication of the station been of special importance or excited special criticism?

It would require much space and no little thought to give full and satisfactory replies to such inquiries as these. They are not made by an *outsider*, but by one closely and practically identified with station work. They are suggestive of some things that the station employé should keep steadily in mind in the prosecution of his work.

Our station work, in its plan and execution, has met with the *general* approval of the authorities at Washington. In some not essential particulars that work has been criticised, perhaps justly. In so far as criticism is based upon observations made in one hasty station visit, by an official, there is ground for questioning its justness and value. Things are not the same at all times, and broad generalizations are not warranted by one hasty and, necessarily, superficial examination.

In a letter to me, under date of September 27, 1898, Dr. True, of the Government Office of Experiment Stations, writes as follows:—

"In looking over the accounts of the work of your station, during the past year, which have been received here, including the report of Dr. Allen on his visit to the station at Fort Collins and the sub-station at Rocky Ford last spring, I am impressed with the increasing value and importance of the work which your station is doing. I am particularly glad to see that not only the irrigation engineer is making successful studies of the irrigation problems, but that other officers are also beginning studies having vital relation to the successful development of farming in Colorado under irrigation. As you know, I spent some time last summer in the irrigated region west of the Mississippi and I am more than ever convinced that your station, with others, has a great opportunity for work of a high scientific and practical value by devoting itself to studies of problems directly connected with irrigation farming. There is work here for the chemist, botanist, horticulturist, agriculturist, and experts in a number of other different lines as well as for the irrigation engineer. I hope it may be possible for your station to develop this work more largely in the future and that Congress will put this Department in a position to give you financial assistance. Arrangements have already been made to utilize the investigations of your irrigation engineer in connection with the work on irrigation which the Department is attempting this year. It will be our policy to coöperate most largely with those stations which are doing the most to help themselves in this line of work."

The same official, in his annual report for the year ended June 30, 1897, speaks of our station work in the language herewith quoted:—

"The work of the Colorado station is being strengthened and developed along lines of great usefulness to a wide region of the West. The importance and value of thorough experimental inquiries in behalf of agriculture is being more fully appreciated by the managers of the station and by the agricultural public of the State. When once the station is relieved of the expensive and wasteful burden imposed by the sub-stations, it will undoubtedly be able to do still better service through coöperative and other enterprises affecting the vital interests of the agriculture of the entire State."

SOME COLLEGE BUILDINGS—NORTH FRONT, LAUREL STREET.

STATION EMPLOYES, 1898-1899.

HEREWITH ARE GIVEN THE NAMES OF ALL PERSONS REGULARLY CONNECTED WITH STATION WORK, THE POSITIONS FILLED, AND THE SALARIES RECEIVED.

Home Station— Names and Positions.	Annual Salaries from Station Fund.	
Alston Ellis, Director	$ 900.00	
W. W. Cooke, Agriculturist	500.00	
C. S. Crandall, Horticulturist	500.00	
Wm. P. Headden, Chemist	500.00	
C. P. Gillette, Entomologist	500.00	
L. G. Carpenter, Meteorologist and Irrigation Engineer	500.00	
J. E. DuBois, Secretary Executive Committee and Station Council	500.00	
ASSISTANTS.		
Frank L. Watrous, Agriculture	$1,000.00	
Carl H. Potter, Horticulture	700.00	
Louis A. Test, Chemistry	900.00	
Elmer D. Ball, Entomology	900.00	
Robert E. Trimble, Meteorology	900.00	
Fred Alford, Chemistry	540.00	
John E. Kiteley, Chemistry	540.00	
Sub-Station Superintendents—		
Harvey H. Griffin, Rocky Ford	$ 900.00	
J. E. Payne, Cheyenne Wells	800.00	$11,080.00

The yearly expense for labor is about $2,500.00.

OUTLINES OF STATION WORK FOR 1898.

At a meeting of the Station Council, held January 25, the schedules of station work for the year were presented, revised, and adopted. These schedules were subsequently—January 28—adopted at a regular monthly meeting of the Executive Committee. The outlines of

experimental work for the different sections of the Home Station and for the sub-stations, located at Rocky Ford and Cheyenne Wells, are herewith given:—

AGRICULTURAL SECTION.

Spring Lambs:—

A continuation of the third year of the experiment, selling both the lambs and the ewes, closing up the experiment and making a bulletin report to be accompanied by notes on the raising of lambs on alfalfa and pasture, for which purpose twelve ewes were purchased last fall.

Ensilage:—

A continuation of the fourth year of the experiment, closing up the tests to be made with reference to sheep, cattle, and dairy cows, and making bulletin report of the whole subject as related to Colorado conditions.

Sugar Beets:—

The work in this connection to be done in coöperation with the Chemical Section, tests of seed grown in the United States as compared with that grown in Europe, tests of the effect of alkali, early and late thinning, early and late planting, medium and late irrigation, manured and unmanured land, and alfalfa sod; all these tests to be made at Fort Collins and Rocky Ford, and part of them at fourteen other places distributed in the valleys of the Platte, Arkansas, Grand, Gunnison, and on the Divide and in the San Luis Valley.

Bromus Inermis:—

Tests for hay, pasture, and seed, with and without irrigation, especially with reference to fall seeding.

Alfalfa:—

The continuation of the tests of top dressing, with duplicate tests of plowing-in stable manure; duplication of the tests of the past season on the losses of alfalfa in the stack and in the mow, and on the effect of different

times of cutting alfalfa; a test of a new variety of alfalfa as compared with the common variety, to be made at Fort Collins and Rocky Ford, and if possible, at several other places.

Corn:—

A continuation of the second year of a three years' test on the value of seed from different climates.

Winter Wheat:—

A test of its use as fall pasture for sheep when sown after barley.

Gypsum:—

A test as a top dressing on alfalfa, as plowed in for cereals and corn, and as an addition to stable manure, in our third year of the test for the reclamation of "poverty weed" land.

Digestion Experiments:—

In connection with the Chemical Section, it is especially desired to make some digestion experiments with sheep with reference to Dr. Headden's new method for determining the feeding value of fodders by chemical analysis. The animals necessary for the experiments are already on hand. It will probably take about $75.00 to buy the necessary apparatus for performing the experiments and for fixing up the stalls to make them suitable for carrying on these lines of experimentation.

SECTION OF BOTANY AND HORTICULTURE.

I. The study of the Flora of the State, special attention being given to:

1. The weeds of the farm and garden.
2. Grasses, native and introduced.
3. The various species and varieties of the genera Oxytropis and Astragalus.

II. The further introduction to the garden of such wild fruits as can be obtained.

III. Nursery test of orchard fruits with a view to the study of the adaptability of varieties to this climate.

IV. Tests of varieties of small fruits.

V. Coöperative work with the Division of Forestry of the United States Department of Agriculture.

SECTION OF METEOROLOGY AND IRRIGATION ENGINEERING.

I. Meteorology—To continue observations as hitherto. This includes observation and record of the data bearing on agricultural meteorology; average maximum and minimum temperatures; range; solar radiation; terrestrial radiation; rainfall and humidity observations; barometer, wind, amount, direction, etc.; and amount and intensity of sunshine. This also includes observations by various voluntary observers and at the sub-stations. To make these of most value, the stations should be visited to examine the exposure of the meteorological instruments.

II. Evaporation determinations—The continuation of that from waters, and study of evaporation from soils and vegetation.

III. Soil moisture.

*IV. Soil temperatures.

V. Continuation of examination of irrigation questions of the State—The subirrigation question of the San Luis Valley was not completed last year. The correspondence now in progress may enable its completion without taking it up as a topic for the summer. I think it is desirable to enter upon a study of the questions of the Arkansas Valley.

VI. Seepage measurements in the State—On the Arkansas and on some other streams.

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*Note—In some lines there is enough accumulation of data to make it possible to obtain useful results from their careful study. As time permits, it is intended to take up some of these questions.

ENTOMOLOGICAL SECTION.

I. Collecting and rearing insects for the purpose of determining food-habits and life-histories.

II. Experiments for the destruction of insect eggs.

III. The beginning of work looking to an Orthopterological survey of the State.

IV. Testing insecticides.

V. Experiments to determine the value of the bandage system of combatting the Codling Moth.

VI. Experiments for the destruction of miscellaneous insect pests.

VII. Experiments in the Apiary:

1. To determine the value of sugar for winter stores.
2. Testing apiary appliances.
3. Making a collection and list of honey-producing and pollen-producing plants with notes as to their probable value.
4. Experiments to determine the nature of and remedy for the disease known as "Bee Paralysis."

CHEMICAL SECTION.

I. Continuation of the soil study already begun, including a study of the effect of cropping alkali soil to sugar beets, as outlined last year.

II. Coöperation with the Farm Department in the study of the sugar beet problems in Colorado, including the subjects of the influence of the seed upon the date of maturing, effect of manuring, etc.

III. Animal digestion experiments in coöperation with the Farm Department—a continuation of the study

presented in Bulletin No. 39. This will entail an expenditure of about $75.00 by the Department of Chemistry.

Note—The miscellaneous work is not considered in this schedule. This character of work has increased very greatly during the past year.

ARKANSAS VALLEY EXPERIMENT SUB-STATION.

Rocky Ford, Colorado.

CEREALS:—

1. Wheat—A comparative test of varieties begun last season. A half acre plat each to Turkey, Clawson, Red Russian, and one-tenth acre to Canadian Velvet Chaff. One-tenth acre each of six varieties of Russian wheat furnished by the Department of Agriculture, Washington, D. C.

2. Rye—Four acres of Mammoth Spring rye; more clearly, Polish wheat.

3. Corn—(a) Test on culture. Cultivation *versus* irrigation, and how much and when best to apply each. This is the second year of a continuous test begun last season, with a slight change in the original plans, so that those portions of the field which are to receive only one or two irrigations shall not be given any water until the corn shows signs of decided need of moisture.

(b) Corn on alfalfa sod. To show how long the effects of alfalfa will last. This will be the third year of the test. The variety, Golden Beauty, will be used on a plat of four acres.

GRASSES:—

1. The establishing of test grass plats and plats of different kinds of forage crops, with tests of annual forage crops, to take the place of those drowned out the past season; the different grasses, cereals, and forage crops to be sown in single or double rows. The entire area to be limited to one-fourth of an acre.

2. Alfalfa—A test to discover if anything can be gained by planting alfalfa, in such shape as to give light

cultivation and subirrigation, where intended to produce seed; the tests to be made on an area not exceeding one-fourth of an acre.

GARDEN DIVISION.

VEGETABLES:—

A test of varieties with notes on irrigation and cultivation; to be restricted to what is needed for immediate use on the farm and for exhibition purposes.

1. Celery—To experiment with varieties and methods of growing and bleaching, on an area of two square rods.

2. Potatoes—One-half acre devoted to experiments on two varieties on the different methods of planting, culture, and irrigation.

3. Sugar Beets—One-eighth of an acre grown as a duplicate test of the experiments made at the Home Station at Fort Collins.

HORTICULTURAL DIVISION.

OLD ORCHARD:—

Observations on the amount and date of first bloom of varieties, and of the setting of fruit, and of yields. Observations of the blight and its effects on different kinds of apples and pears. The replanting of places where trees have been killed out by blight.

NEW ORCHARD:—

The vacancies in the orchard set out in 1896, caused by the dying of the trees, are to be replaced by new trees of the same varieties, but the live trees to remain in their present places. A few conifers from the Department of Agriculture, at Washington, are to be set in connection with the deciduous trees, as far as it can be done without materially increasing the labor of cultivation. The remaining 4 1-2 acres of the original ten acres set apart for the orchard, are to be set out to new varieties as far as means at hand, at this time, for this purpose, will permit.

FORESTRY AND ORNAMENTAL TREES:—

The planting of elms along one side of the lane which runs through the Station, and the planting of elm. catalpa, locust, ash, and other ornamental and nut trees around the 80 acres devoted to experimental work as far as means may be on hand for this purpose.

ENTOMOLOGICAL DIVISION.

Observations on injurious insects in connection with the Entomological Department of the Home Station. Spraying and other remedies on orchard and garden crops when affected with insects. Special observations and notes on the strawberry leaf-roller.

METEOROLOGICAL DIVISION.

A continuation of the meteorological records that have usually been kept at the Station.

FERTILIZERS.

Experiments with decomposed gypsum as a top dressing on three acres of land which received too much water last season. This land has been covered lately with manure, and the intention is to apply the gypsum at the rate of 500 pounds per acre in strips with alternate spaces left with nothing but the stable manure.

The remainder of the station land, not included in the leased land, to be used in growing such general farm crops as, in the judgment of the Superintendent, will be of most value.

RAINBELT EXPERIMENT SUB-STATION.

Cheyenne Wells, Colorado.

CAMPBELL PROCESS TEST.

I. Spring of 1898—

(a) Potatoes,.....1-2 acre.
(b) Spring wheat,.....1 acre.
(c) Spring rye,.....1 acre.

(d) Oats,.....1 acre.
(e) Barley,.....1 acre.
(f) Corn,.....4 acres.
(g) Sorghum,.....1 1-2 acres.
Total,.....10 acres.

In each case the land is to include the part that is under the Campbell method and the check plats under ordinary cultivation; i. e., the ten acres to be about three quarters Campbell and one quarter common culture.

II. Autumn of 1898—Fall wheat, two acres selected varieties, one-half the land to be by Campbell method and the other half a check by common method.

Variety tests of grasses, cereals, and forage crops to be reduced to double rows and included in the ten acres of the Campbell test.

III. Vegetable tests to be made on a small scale and not included in the ten acres, but as far as possible made by the Campbell methods.

IV. The remainder of the farm to be devoted to forage grains, such as California barley, millet, and bromus inermis, with at least three acres devoted to a test of decomposed gypsum, at the rate of 500 and 1,000 pounds per acre.

V. Scientific work—

(a) Test effect of wind-break on soil moisture at different distances from the wind-break.
(b) Test rate of evaporation from four types of soil found here.
(c) Test evaporation from water surface in shade and sun.
(d) Continued examination of the soil of the Station which was begun in 1896.
(e) Test effect of the Campbell method on soil moisture.
(f) Observations on meteorology to be continued.

STATION PUBLICATIONS.

Within the year covered by this report, nine bulletins have been issued. The total number of bulletins is now forty-nine. A list of these publications is herewith given:—

No.	*Subjects.*	*Authors.*
1.	Reports of Experiments in Irrigation and Meteorology	Elwood Mead
2.	Report of Experiments with Grains, Grasses, and Vegetables on the College Farm	A. E. Blount
3.	Concerning the Duties of the Secretary of The State Board of Agriculture, and Distribution of Seeds	Frank J. Annis
4.	Report of Experiments with Potatoes and Tobacco	James Cassidy
5.	Experiments in the Apiary	C. M. Brose
6.	Notes on Insects and Insecticides	James Cassidy
7.	Potatoes and Sugar Beets	James Cassidy David O'Brine
8.	Alfalfa: Its Growth, Composition, and Digestibility	David O'Brine James Cassidy
9.	Soils and Alkali	David O'Brine
10.	Tobacco	David O'Brine James Cassidy
11.	Sugar Beets	C. L. Ingersoll David O'Brine
12.	Some Colorado Grasses and Their Chemical Analysis	James Cassidy David O'Brine
13.	On the Measurement and Division of Water	L. G. Carpenter
14.	Progress Bulletin on Sugar Beets	David O'Brine
15.	The Codling Moth and the Grape-Vine Leaf-Hopper	C. P. Gillette

No.	*Subjects.*	*Authors.*
16.	The Artesian Wells of Colorado and Their Relation to Irrigation	L. G. Carpenter
17.	A Preliminary Report on the Fruit Interests of the State	C. S. Crandall
18.	Index Bulletin	W. J. Quick
	Special Bulletin "A" Concerning Subjects Investigated by the Experiment Station	
19.	Observations upon Injurious Insects, Season of 1891	C. P. Gillette
20.	I. The Best Milk Tester for the Practical Use of the Farmer and Dairyman	W. J. Quick
	II. The Influence of Food upon the Pure Fat Present in Milk	
21.	I. Sugar Beets II. Irish Potatoes III. Fruit Raising	F. L. Watrous
22.	A Preliminary Report on the Duty of Water	L. G. Carpenter
23.	Colorado Weeds	C. S. Crandall
24.	A Few Common Insect Pests	C. P. Gillette
25.	Progress Bulletin on the Loco and Larkspur	David O'Brine
26.	Garden Notes for 1893	Marion J. Huffington C. S. Crandall
	Farm Notes for 1893	W. W. Cooke Frank L. Watrous
	Seeding, Tillage, and Irrigation	Fred. Huntley
27.	The Measurement and Division of Water. (Third Edition, Revised, of Bulletin No. 13)	L. G. Carpenter
28.	The Russian Thistle	C. S. Crandall
29.	Strawberries and Grapes: Notes on Varieties	Marion J. Huffington

No.	Subjects.	Authors.
30.	I. Farm Notes for 1894	W. W. Cooke, Frank L. Watrous
	II. Notes on Tomatoes	Marion J. Huffington
31.	Hemiptera of Colorado. (Technical Series, No. 1)	C. P. Gillette, Carl F. Baker
32.	Sheep Feeding in Colorado	W. W. Cooke
33.	Seepage or Return Waters from Irrigation	L. G. Carpenter
34.	Cattle Feeding in Colorado	W. W. Cooke
35.	Alfalfa	Wm. P. Headden
36.	Sugar Beets	W. W. Cooke, Wm. P. Headden
37.	The Birds of Colorado. (Technical Series, No. 2)	W. W. Cooke
38.	I. Sheep Scab II. A Few Insect Enemies of the Orchard	C. P. Gillette
39.	A Study of Alfalfa and Some other Hays	Wm. P. Headden
40.	Barley	W. W. Cooke
41.	Blight and Other Plant Diseases	C. S. Crandall
42.	Sugar Beets in Colorado in 1897	W. W. Cooke, Wm. P. Headden
43.	I. Colorado Lepidoptera II. A Few New Species of Deltocephalus and Athysanus from Colorado III. A List of Original Types, etc., in Collection. (Technical Series, No. 3)	C. P. Gillette
44.	Further Notes on the Birds of Colorado. (Technical Series, No. 4)	W. W. Cooke
45.	The Loss of Water from Reservoirs by Seepage and Evaporation	L. G. Carpenter
46.	A Soil Study, Part I. The Crop Grown: Sugar Beets	Wm. P. Headden

47. Colorado's Worst Insect Pests and their Remedies ..... C. P. Gillette

48. Losses from Canals from Filtration or Seepage ..... L. G. Carpenter

49. Meteorology of 1897, with Illustrations ..... L. G. Carpenter, R. E. Trimble

The cost of the station publications issued since the last report is herewith given. The number of copies of each and the pages of matter therein contained are likewise shown.

I.	1,500 copies Tenth Annual Report, 110 pages, with cover.....		$ 119.84
II.	6,000 copies Bulletin No. 41, 22 pages....		77.44
III.	7,000 copies Bulletin No. 42, 64 pages....		286.39
IV.	2,000 copies bulletin No. 43, (Technical Series, No. 3,) 32 pages.....$ 92.50		
	Electrotypes	2.30	94.80
V.	2,000 copies Bulletin No. 44, (Technical Series, No. 4,) 32 pages.....		66.00
VI.	6,000 copies Bulletin No. 45, 32 pages....$132.00		
	Electrotype	1.00	133.00
VII.	6,000 copies Bulletin No. 46, 64 pages....		255.00
VIII.	6,000 copies Bulletin No. 47, 65 pages....$227.50		
	Six (6) pages half-tone work.....	36.00	
	Six (6) pages half-tone cuts.....	21.80	
	Electrotypes	15.64	300.94
IX.	6,000 copies Bulletin No. 48, 36 pages....		161.25
X.	6,000 copies Bulletin No. 49, 72 pages....$252.00		
	Thirty-five (35) pages tables, $2 per page, extra.....	70.00	
	Two (2) pages brevier, extra.....	1.70	
	Electrotypes	3.30	327.00
	Total		$1,821.66

THE SUB-STATIONS.

The condition of sub-station management is that which existed at the time of the last report. The future of these auxiliaries of the Home Station is as unsettled now as it ever was. A modest state appropriation for their maintenance would insure their permanency and usefulness. As long as the burden of their support falls upon the Government fund the question of their continuance is one of anxiety and uncertainty.

In speaking of station work in Colorado, Dr. True, in his annual report, from which quotation has already been made, says:—

"The sub-stations at Cheyenne Wells and Rocky Ford have been continued, but under unsatisfactory conditions. The work at Cheyenne Wells, considered as a temporary enterprise to determine the agricultural possibilities of the locality, may prove of some value, but no good reason has been assigned for a permanent sub-station there. The sub-station at Rocky Ford has suffered the usual vicissitudes attending the prosecution of station work under ill-trained superintendents, and is clearly an expensive venture without important results."

In Dr. True's letter, before referred to, is found the following language:—

"Dr. Allen's inspection of the sub-station at Rocky Ford did not satisfy us that it had been properly managed. While there are good features about the work in progress there, there have been so many changes in the management and the records have been kept in such an incomplete and unintelligible form that it seems to us that the money spent there has been very largely wasted. I hope no effort will be spared to secure state aid to put these sub-stations on a substantial basis and permit the entire withdrawal of the Hatch fund from them. Otherwise I think definite steps should be taken to abandon them. This has been done in nearly all the states where sub-stations existed at the expense of the Hatch fund."

Dr. True's strictures upon the station work at the existing sub-stations, and his suggestions as to their fut-

ure disposition, are, in the main, warranted; but no one with only the knowledge of the conditions under which our sub-station work is conducted secured by hurried visits, few and far between, can be in a position to speak with high authority on the subjects of sub-station efficiency and sub-station continuance.

The Arkansas Valley Experiment Station—Conditions have not been favorable for securing desirable results. Three different persons have been in charge of the work of the station within a year.

W. Frank Crowley was, June 29, 1897, appointed Superintendent of the station and at once entered upon the duties of the position. His work was satisfactory and gave promise of good results. On February 10, 1898, the following communication, from Mr. Crowley, was received by the Executive Committee:—

"Honorable Sirs:—I have to-day telegraphed you my resignation as Superintendent of the Arkansas Valley Station and I further write to explain my action."

"I have resigned the position in order to establish an experimental fruit farm near Holly, Colorado. I consider that I can do more good for the horticultural interests of the Arkansas Valley by this move. I shall be glad to coöperate with the State Experiment Station in every way possible."

"The move will also, I think, better my condition financially and otherwise. I desire to move as soon as possible and shall be glad to have you put a man in this place by the first of March, or sooner. I shall endeavor to make the proposed improvements which I have begun on the station property before leaving."

"Thanking your Honorable Body for past consideration, I remain, Yours truly,

W. FRANK CROWLEY."

The resignation was duly accepted, and an election to fill the vacancy thus created resulted in the unanimous choice of Harvey H. Griffin, at an annual salary of $900. Mr. Griffin graduated from The State Agricultural College of Colorado in 1888. From that time until now, he has been actively engaged in station work. He assumed charge of the sub-station at Rocky Ford, March 1, 1898, and at once began intelligently and vigorously

the carrying out of the season's work as scheduled prior to his appointment. His first year's work promised well, but in the very midst of the growing season came a destructive hailstorm that made havoc of many of the experiments from which such desirable outcome was confidently expected. I am confident that, under usual conditions, the future work of the station will meet the reasonable expectations of the public.

A part of the land belonging to the station has been leased, as the total acreage was not needed for the proper carrying on of the scheduled station work. At a meeting of the Executive Committee, held August 30, 1898, Chairman Kellogg was authorized to re-lease the land, unused by the station, to Francis Harson.

For the year, closed June 30, 1898, the expenditures were as follows:—

Superintendent's salary	$833.33	
Labor	976.96	
Other expenses	387.28	
Total		$2,197.57

Farm sales, for the same year, amounted to $519.69.

Divide Station—This station has not been operated as an experimental farm since March 31, 1896, since which time it has been leased to W. A. Diebold, of Table Rock, who has proved a prompt-paying tenant. The station land, forty acres, is rented for $40 per annum, the tenant making repairs and improvements at his own charge. The station house is in bad condition but the barn and sheds are in good repair. The cottonwood trees have maintained their reputation for hardiness but the apple and cherry trees have died. A seventeen-acre tract of land, sown to wheat April 8-11, yielded 18 bushels to the acre. A six-acre barley field gave a yield of over 11 bushels per acre, from seed sown May 24. The potato crop, from a four-acre field planted May 18-23, proved of little worth, the yield not exceeding 1,000 pounds per acre.

SOME COLLEGE BUILDINGS—EAST FRONT, COLLEGE AVENUE.

The San Luis Valley Sub-Station—The station land, 180 acres, had been leased to J. H. Stone who has furnished some statements of crop production. Thirty-eight acres, of the east 80-acre tract, produced 1,405 bushels of oats of good quality. The rest of said tract gave two tons of field peas per acre. Nine acres of alfalfa land produced 18 tons of hay. The west 80-acre tract, sown to wheat, gave a yield of 30 bushels per acre.

Rent receipts from this sub-station amount to $161; the year's expense—water rent—is reported to be $25.

The Delta County Sub-Station—A sub-station in Delta county was authorized by act of the Legislature approved April 4, 1887. No steps looking to the establishment of a station were taken until about two years ago when a 40-acre tract of land, eligibly located and well adapted to fruit culture, was donated to the college authorities, having ultimate control of station work, by Delta county. Then effort was made, without avail, to secure a legislative appropriation to enable the Governing Board to open the station for the prosecution of that experimental work of greatest value to the people of the Western Slope.

The following action relating to the land donated by Delta county for the establishment of an experiment station was taken by the Executive Committee at its April meeting, 1898:—

"Whereas, The State Legislature has entirely failed to aid The State Board of Agriculture in the maintenance of experiment stations located in different parts of the State; and

"Whereas, It is in direct violation of the spirit of the law, as construed by the Department at Washington, for any portion of the money derived from the so-called *Hatch Act* to be expended upon outlying sub-stations; therefore,

"Resolved, That the Secretary be instructed to notify the County Commissioners of Delta county that, for reasons above given, The State Board of Agriculture is unable to comply with the (at least implied) contract to keep up an experiment station in Delta county and that it is the sense of the Executive Committee of The State Board of Agriculture that all holdings of said

Board, derived from said Delta county for the purpose of establishing an experiment station, be deeded back to the proper authorities of said county, if their wish is to receive the property."

At the semi-annual meeting of The State Board of Agriculture, held June 1, 1898, the following action was taken:—

"Resolved, That the President and Secretary of The State Board of Agriculture be and they are hereby authorized to execute a deed to the County Commissioners of Delta county, Colorado, for the south-east quarter of the south-west quarter of section thirty-five, township fourteen, south of range ninety-five west of the sixth principal meridian, being the forty acres of land deeded by said county to The State Board of Agriculture for an experiment station, together with a transfer of the water stock thereto belonging."

The deed authorized in the resolution has been drawn, properly acknowledged, and forwarded to Delta county. Thus eleven years of ineffectual effort to make provision for experimental work in fruit growing in Western Colorado have come to a close.

The Rainbelt Sub-Station—This station, established at Cheyenne Wells nearly five years ago, has had an uneventful history. The advisability of opening a station in the "arid region" is a question about which "much might be said on both sides." The so-called rainbelt district of Colorado is of considerable extent and contains soil of acknowledged fertility. Stockmen have used the most accessible and promising portions of it as grazing fields for their herds but, until recently, no efforts worthy of consideration have been made to test the adaptability of the plains of Eastern Colorado for the homes of an agricultural people. The prime object of the work in Cheyenne county is to settle, as far as intelligent, scientific investigation can give answer, the questions of most importance to the people of a semi-arid region. If any considerable portion of lands now regarded as well-nigh valueless can be shown to be fit

for the homes of an industrious, frugal people, a result worth the cost of station maintenance for many years will be reached.

After the gubernatorial veto, two years ago, of a bill making provision for the support of this station by money taken from the general revenue for college support, the following action was taken by The State Board of Agriculture, at a special meeting held April 20, 1897:—

"Ordered, by The State Board of Agriculture of Colorado, That the sum of two thousand five hundred dollars ($2,500) be and is hereby appropriated out of any available college revenue for the support and maintenance of the agricultural experiment station located at Cheyenne Wells, Colorado; said appropriation being for a period of two years."

"The purpose of this action is to set at rest, definitely, the statements that have been made by certain parties that the Board contemplated the abandonment of said station at Cheyenne Wells, or would, in the case of its continuance, fail to give it such financial support as would secure the best results from it."

"The Executive Committee is hereby directed to make such drafts upon the appropriation herein specifically set apart for the support of said station as in its judgment may be necessary for the full realization of the purport and intent of the order above given."

There is yet a balance of appropriation, in the station treasury, for the support of this sub-station, amounting to $481.38. With this sum must be met all expenses connected with the sub-station maintenance up to March 1, 1899.

The station expense for the fiscal year, ended June 30, 1898, may be summarized as follows:—

Superintendent's salary	$800.00	
Labor	146.40	
Equipment and incidentals	437.56	
Total		$1,383.96

The sale receipts are insignificant, being only $10.

At a recent meeting of your Committee, Messrs. P. F. Sharp and B. F. Rockafellow, a sub-committee, who had visited the sub-station at Cheyenne Wells, and investigated its workings and possibilities, made report as follows:—

"The location being on the Great Plains, about 175 miles east from Colorado Springs, where the buffalo and grama grasses are abundant, owing to the lack of water and all growth except native grasses, indicating its being heretofore the summer range of the buffalo and the possibility of its being made the limitless range for domestic animals and, if certain conditions are complied with, the homes of a large population engaged chiefly in such pursuits as permanent as agriculture or mining, we deemed it our duty to cast about to see if our experimental work is on the lines of providing a possible success."

"It has been shown to our minds that if the Government and the possessor of the land-grant, the joint owners of the country, can join, with the railroad as a base line, in sinking bore-hole wells on the line between belts of stock range extending back for miles, that water, without which the country can not be made habitable the year round, can be secured, as is done here, at a depth of 300 feet and in sufficient quantities for domestic and stock purposes—then, as proving what kind of development is possible to make the home of the future possessors of this vast region habitable, we consider the location of this experiment station wisely chosen."

"We found, by low-trained living apple and cherry trees, five years set and of healthy though slow growth through monthly stirring of the surface by the cultivator, by a moderate growth of alfalfa yielding the second year about one ton per acre, Bromus inermis or Russian grass, sorghum, corn, peas, broom corn, Kaffir corn, large sweet-potatoes, small but exceedingly rich Irish potatoes and melons, and gooseberry bushes in bearing, that there is sufficient moisture to promote slow growth and small yield where the conditions are made and kept as favorable as possible. Thus, it is possible, in this otherwise treeless belt, to make living possible, less monotonous, and more enjoyable."

"The station having been established only a few years, and consequently its work but fairly commenced, we believe in its continuance and recommend certain expenditures now necessary."

"We deem the location of the station, partly at the foot of slopes and thus taking the wash from the higher lands in time

of storms, as demonstrating the advantage of such locations where any sort of cultivation is aimed at."

"The soil of this region being rich, experiments have been made with grasses from Asiatic and other arid countries with the hope to find some forage plant that will produce larger yields than our native grasses, without success so far, except on the short-time test of Russian grass of which a good stand has been secured. This grass will be anxiously watched to note the outlook after the winter has passed. As this forage plant has a large blue-grass blade and has so soon shown its kindly adaptation to this climate, we are hopeful that the cost of this station to the Government has, in its growth, already been returned manifold, but if not, some other plant filling the requirements will yet be found by the persistent, able efforts of our painstaking Superintendent, J. E. Payne, whose studious, industrious, and faithful service we most earnestly commend."

"Successful experiments in the use of gypsum as a moisture retainer, as well as a stimulating fertilizer for making the properties of the soil active, have been made, showing in one instance 60% advantage."

"The machinery and appliances for testing the *Campbell Theory* are on the ground and their use, part of the season, has proved very satisfactory. They will be given thorough use the coming season."

CONCLUSION.

Our station workers, particularly those of the Home Station, have rendered much and acceptable service as lecturers before farmers' institutes, horticultural conventions, and other bodies whose aims and purposes intersect the industrial life of the people.

The station work prosecuted outside of Larimer county, in which the Home Station is located, has cost the experiment station fund not less than $6,000 within the year. The station publications, sent into nearly every post-office district of the State as well as to other states and foreign countries, made drafts, upon the same fund, amounting to a sum but little less than $2,000. All station work is designed to promote the agricultural interests of the whole State, whether it is done at the Home Station, the sub-stations, or elsewhere.

Herewith are presented the reports of members of the Station Council, in the order in which they reached my office; also the reports of Superintendents of the sub-stations.

An early planning of station effort to be put forth the coming year is recommended.

Respectfully submitted,

ALSTON ELLIS,
Director.

Fort Collins, Colorado, December 14, 1898.

Report of the Section of Botany and Horticulture.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—I have the honor to submit the following report on the work of the Section of Botany and Horticulture for the year 1898.

In 1894 the Department commenced a systematic test of varieties of orchard and small fruits. The horticultural work of this season has been mainly a continuation of this test. Some additions to the lists of varieties previously reported have been made. Much of the effort of the Department has been required in the care of trees and plants set in previous years, and in the maintenance of records that, when compiled on the completion of the test, may show the complete history of each particular variety.

In the spring of 1896 a new apple orchard was planted with trees from the station nursery. The area planted was about five acres, requiring 480 trees which represented 140 varieties. The land lies high, the soil is good, and the subsoil of such nature that water is not retained, but quickly seeps to the lower land adjoining. It is dependent for water upon the No. 2 ditch, and for the three seasons since the first planting the supply has been wholly inadequate for the successful starting of young trees.

The record for 1896 shows that planting began as soon as water was available, April 24, but the next day

the water was turned out of the ditch and the remaining trees were watered, in part from a hydrant and in part by water hauled in barrels. The further record of irrigation for the season is as follows. May 1 and 2 a small stream was obtained and run on about half the orchard; May 13 to 15 a run was secured, and again June 22 to 25. No water was available during the balance of the season. Under these conditions the summer loss was considerable, and the living trees entered the winter in very poor condition. The winter of 1896-'97 was a very open one; much of the time there was no frost in the ground and evaporation was continuous, proving destructive to the trees. The planting in 1897 was practically a resetting of the whole orchard, the number of trees required to fill vacancies being 315. Two additional rows were added, making the total number of trees planted 344. The planting was done May 6 to 8 and water was at hand until the work was completed. From this time until the 14th of June no water was available; then we had it for two days, and again June 28 and 29, and this was the last obtainable during the season. The loss during the summer and winter of 1897-'98 amounted to 115 trees or about 22%, being nearly evenly distributed between the trees planted in 1896 and those planted in 1897. Vacancies were again filled this last spring, the work of planting being commenced on May 9 (as soon as the ground was in fit condition after the storm of April 30 to May 5, during which 3 inches of rain fell) and was finished on May 11. Between planting and the end of the season, water was available for but two days, May 23 and 24. On October 12 water again came in the ditch and continued for five days. During this time it was run on the orchard night and day, and the ground thoroughly soaked.

A count of the orchard made last month shows 46 existing vacancies, 33 of these are among trees set last spring, 9 among trees set in 1897, and 4 among trees planted in 1896. It is proposed again to fill these places next spring. As the orchard now stands it contains 461

trees representing 145 varieties, but many of these trees show very low vitality and have made very little growth.

In any assemblage of a large number of varieties it is to be expected that some, perhaps a considerable portion, will prove failures, but under the conditions as above outlined the trial of these varieties can hardly be regarded as fair, and we are not warranted in condemning them. During the past season we have made a special effort in the direction of cultivation, keeping the surface soil continually loose. This has undoubtedly aided in preventing evaporation, but it did not supply the deficiency which was apparent in the appearance of the trees.

The experience of the three seasons has forced the conviction that unless an adequate water supply can, in some way be secured, further attempt to establish the orchard will be effort thrown away. I have, therefore, presented the facts in some detail and would respectfully ask your consideration of the matter.

The plum orchard is under the same conditions regarding water supply as the apple orchard, but the trees have in the main made a reasonable growth, and such losses as have occurred are among varieties that have proved too tender to withstand the cold of winter. The effect of short water supply has, however, been apparent among the varieties now fruiting. It was most noticeable in 1897 when the crop borne was heavy, but even this season when the trees bore only a light crop, the fruit was below normal in size.

This orchard as now platted has places for 601 trees. There are 58 vacancies, to be filled next spring, and 543 living trees representing 153 varieties. These varieties are distributed among the different classes of plums as follows—

Prunus Americana	71
Wild Goose group	24
Prunus domestica	30
Japanese group	17

Chicasaw group	6
Beach plum	1
Hybrids, unclassified	4

It is evident from our work thus far with plums that the native American varieties are the ones to be relied upon for this region. A few of the Wild Goose group like Miner and Prairie Flower are hardy and do well, and it is probable that a few of the domestica plums, and possibly some of the Japanese varieties may after further trial prove valuable additions, but the greater number of these last mentioned groups and all of the Chicasaw group, so far as we have tried them, are practically worthless for this part of the State, because they do not survive the winters.

Last spring, studies on the blossoming periods, on self-fertility, and on crossing were outlined and carried out. The results are of some value although seriously interfered with by the cold storm which prevailed from April 30 to May 5. Early varieties began opening flowers on April 27 and many varieties were sufficiently advanced to be badly injured by the prolonged cold, and the snow which held to the branches for several days. Domestica varieties received the greatest injury; on some the fruit buds being all killed, even though still dormant. All varieties were in some degree injured and the light crop can be directly attributed to this cause. The work with plums has been made the subject of a bulletin which is now ready to be submitted.

The test of varieties of strawberries and bush fruits has been carried on as in years previous, and the records accumulated are sufficient to warrant a report on the varieties under trial. This matter is now being arranged for publication.

The coöperative experiment with the division of Forestry of the U. S. Department of Agriculture to test the relative hardiness of forest-tree seedlings as grown from seeds produced in different sections of the country has been continued this season. As started in

1897 there were provided 88 packages of seeds representing 11 species from 22 states and Canada. The addition made last spring consisted of 52 packages representing 9 species from 14 states. The range of climate now represented is sufficiently extended to make the test an interesting one. Under instructions from the Forestry Division the seedlings of 1897 were transplanted in May to allow them room for development. The records thus far made, while not regarded as conclusive, show some interesting results that point strongly to the conclusion that in the matter of hardiness the seedlings from northern seed have a decided advantage over those from southern seed. It is the expressed intention of the Forestry Division to continue this experiment until the results justify a positive conclusion.

The addition of five acres to the forestry plantation planned for last spring was deferred owing, as I am advised, to lack of funds. For the same reason the help necessary to keep the plats free from weeds, and in good growing condition could not be employed. No work has been done since July, and the plats have presented an untidy appearance. There being no water available for irrigating, the growth made during the season was small. Under these circumstances the advancement of the plantation has been unsatisfactory and much less encouraging than for the year 1897. The seedlings received last spring were as follows: Maple 5,000, Austrian pine 12,000, Scotch pine 12,000, Bull pine 9,000. Most of these were used to plant between the other trees and to fill vacancies; the balance being planted in nursery rows. Thus far the attempt to grow pines and spruces has been a practical failure, but it is hoped that when the nurse trees attain greater size, affording protection from the sun, these trees will succeed better. I have as yet received no information as to the work contemplated for next year.

In pursuance of the work on a flora of the State and for the purpose of adding to our collection of plants for exchange, several short trips were made during the sea-

son. In May one week was spent in an examination of the spring flora of the Western Slope; collections being made at Palisades, Grand Junction, and Cimarron. During the latter part of June and early July two weeks were spent in the southern portion of the state, and collections made at Antonito, Durango, Silverton, Mancos, and Rico. This was followed late in July by a wagon trip into the mountains west of Fort Collins, and in August one day was spent on Gray's Peak. At all places visited, and when traveling between points, lists of plants seen were made, thus adding largely to our records regarding the distribution of native and introduced plants.

Particular attention was given to the grasses and forage plants found at each place visited, and lists of weeds were also made.

The number of species now available in quantity for exchange exceeds 700 and it is hoped that the herbarium can be largely increased through exchanges to be made. The importance of a larger and more representative collection of North American plants is each year becoming more apparent. The greater the number of species in the collection, the more will it facilitate the work of determining the plants sent to us, and this feature of the department work is increasing each year. Since January first we have named 448 plants which have come to us from various parts of the State, and one collection of about 100 species is waiting attention as soon as time can be spared from other work. Many of the plants sent here are acceptable additions to the herbarium, and coming as they often do from regions not yet visited by the writer they add to our records of distribution.

The number of specimens added to the herbarium by exchange during the year is about 2,000. Several offers of exchange for the coming year have been made, some of which it is hoped we may be able to accept, but the available time for work of this character is so limited that but few exchanges can be undertaken.

The Department has prepared one bulletin during the year, No. 41, "Blight and Other Plant Diseases." The blight of apple and pear trees has, in its spread westward, reached the orchards of Delta and Mesa counties and many inquiries regarding it have been received during the summer.

Colorado orchards have in past years been free from fungus diseases, but the diseases which have given the eastern growers trouble are gradually coming in, and there is a rapidly growing interest in them among the fruit growers. Besides the blight, which is caused by a bacterium, several parasitic fungi have been sent to us from different parts of the State with reports of more or less serious injury. Four of these had been previously reported from other counties; three had not before been reported in the State. The Leaf Spot of blackberries and raspberries (*Septoria rubi*) has come from three counties and is said to be doing much damage. The Orange Rust of blackberries (*Cœoma nitens*) and the Leaf Blight of the strawberry (*Sphœrella fragariæ*) are reported from several localities. The Powdery Mildew of the cherry (*Podosphœra oxyacanthæ*) is reported from the Arkansas valley, and from the same region four growers of cantaloupes have sent a blight disease which is said to be doing much injury, and which proves to be caused by a species recently described by Messrs. Ellis and Everhart as *Macrosporium cucumerinum*. The Anthracnose of the raspberry, and the Apple Scab are also reported, but have as yet done no very serious injury. These fungus diseases are sure to become very important factors in the business of fruit growing, and as the applications for information increase it will be necessary to make the investigation of these diseases and their remedies a more important feature of the department work.

Respectfully submitted,

C. S. CRANDALL,
Botanist and Horticulturist.

Fort Collins, Colorado, December 14, 1898.

Report of the Agricultural Section.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—I have the honor to submit the following report of the work of the Agricultural Section for the year 1898.

The larger part of the time and energies of the Section has been devoted to the investigation of the growth of sugar-beets in Colorado. In connection with the Denver Chamber of Commerce the work has been extended to include all those parts of the State that seem at all adapted to this crop. A large part of the seed was obtained from the United States Department of Agriculture, but some from the Oxnard Sugar Company of Grand Island, Nebraska, through the efforts of the officials of the Union Pacific, Denver and Gulf Railroad, and some from the sugar factory at Rome, N. Y., through the efforts of Mr. M. B. Colt, of Alamosa. When near the end of the season all these sources had become exhausted, the Denver Chamber of Commerce purchased in open market enough seed to supply the remainder of the demands. In all a little over four thousand pounds of seed were distributed to two thousand three hundred persons.

The Denver Chamber of Commerce in connection with the County Commissioners, or the local organizations, offered prizes aggregating nearly two thousand dollars to those who raised the best crops of sugar-beets. These competitions were confined to the irrigated

parts of the State. Seed was distributed, however, to many persons outside of the counties where the prizes were offered. About forty persons agreed to carry on some special tests for this Section, and extended tests were conducted on the sub-station at Rocky Ford and on the college farm. Thus the work of the season has been carried out in four distinct lines.

1. General tests were made on the growth of beets in the unirrigated parts of the State and in some of the counties having irrigation but not enough interest in the matter to offer prizes for large crops. From this source were received ninety-one samples of beets, most of them accompanied by full notes on the planting and cultivation of the crops and by less satisfactory notes on the harvesting and yield.

2. Records were received from nine counties in competition for the prizes. It was recognized last spring that the time had come when there should be a well organized effort to get the most exact information possible on the adaptation of the sugar-beet to Colorado soil and climate. Nearly all the estimates of previous beet crops in Colorado have been based on the yield from a hundred square feet of ground. It was recognized by all that this was too small a plat for commercial estimates. It had been adopted because the beet growers disliked to spend the large amount of time and trouble necessary to make exact experiments on a large scale. It was seen that some substantial inducement must be offered before it could be expected that better results would be obtained than those of former years. It was with this idea in view that the prizes were offered and the results have confirmed the judgment and justified the large expenditure of time, labor, and money. Seventy-two persons competed for the prizes and their records form such a valuable mass of material that they are included in this report.

3. The work of testing foreign grown seed as compared with that grown in the United States was undertaken. Two of the best German varieties, one of the

EXPERIMENT STATION—FIELD CORN, SUGAR BEETS IN FOREGROUND.

French, and one of the Austrian were compared with one lot of seed grown in Utah and one grown in New Mexico. These were distributed to about forty persons in all the principal agricultural sections of the State and some of the most interesting and valuable results have been obtained. The superiority of the Utah grown seed was very marked over the seed from which it originated, so much so that arrangements have been made to grow seed next year on the college farm and at various places throughout the State from some of the beets that made exceptionally good returns the past season.

4. The work at Rocky Ford and the college farm was principally along the lines of different times of planting, distances of thinning, times of thinning, and date of irrigation. About two hundred samples of beets were analyzed from these two sources but the results have not yet been carefully enough studied to know what they indicate.

In connection with the shipment of eight carloads of beets from Loveland and Fort Collins to Grand Island, Nebraska, many samples were taken to ascertain tare in trimming, shrinkage in shipping, and yields from large areas under ordinary farm management.

It will thus be seen that the work has been conducted on a larger scale than ever before attempted. Some idea of the labor involved can be gotten from the fact that my letterbook shows one thousand six hundred and sixty-six letters written during the first eleven months of this year in addition to several thousand mimeograph circulars. To do this in addition to my other work would have been an impossibility and extra clerical assistance was granted through the five summer months.

The records sent in competition for the prizes present the largest amount of the most reliable reports that have ever been collected concerning Colorado sugar-beets. They made such a remarkable showing for the State that they are included in this report. They are based on the yields of one-sixteenth of an acre.

Early in the summer a circular was sent to each one asking for information concerning the planting and cultivation of the crop. Later circulars were sent out giving a statement of the prizes that had been offered and the rules that would govern the harvesting of the crops, the taking and the analyzing of the samples.

The samples for analysis were all sent to the Colorado Agricultural College at Fort Collins and were analyzed by the chemist of the College and his assistants. Through the courtesy of the United States Department of Agriculture, the College was granted the franking privilege so that more than 3,000 pounds of beet samples were sent through the mail free of postage.

The accompanying tables give the results of the season's work. A few words of explanation seem necessary. It was desired that the crops be harvested and samples taken as far as possible at about the same time, between October 15 and November 1. In the case of Logan county the crops were harvested the last week in September so that they could be exhibited at the county fair. The crops were not then ripe and the results are much poorer both in quantity and quality than would have been obtained had the beets remained in the ground a month longer. At my request two of these fields were but partly harvested and the rest of the beets were dug the latter part of October when the beets in the other counties were being harvested. In each case the beets tested in sugar more than 3 per cent. higher than during September. The figures for Mesa county are not yet complete and it is not deemed advisable to hold this report until the returns are all in.

It was desired that the contest be put as nearly as possible on a commercial basis; i. e., the prizes be awarded to the crops in the order of their real value for sugar-making purposes. It was necessary then to take into account three things, the weight of the crop, the amount of sugar in the crop, and the amount of sugar that could be gotten out in the factory. These items are given in the accompanying tables. The column

headed "Gross weight of trimmed beets per acre" gives the weight of the beets in the same condition as they would ordinarily be brought to a factory; i. e., the tops cut off but no attempt made to remove the dirt that naturally sticks to the beet. At a factory, a sample of the beets, usually about half a bushel, is taken and cleaned and the calculation made as to how much dirt there is in the whole load. The column headed "Per cent. of sugar in the beet" represents the character of the beet at the time it was analyzed. On the average this was about three days after harvesting. During this time, of course, the beets had been drying out, which would tend to raise the per cent. of sugar in the sample. The first two columns therefore represent the gross weight or beets and dirt together and the analysis of a partly dried sample, in both cases making the crops apparently better than they were. To offset this, the column headed "Pure sugar per acre" is obtained by multiplying the other two together and deducting one-fifth for tare and drying out. It is probable that this is a larger shrinkage than would have been made had these crops been sent to a sugar factory, but it was deemed best to make sufficient reduction so there could be no possible appearance of an attempt to exaggerate Colorado's sugar-beet crop. The figures, even after the 20 per cent. reduction, show magnificent crops and still more so that we can look at them as a slight underestimate.

The column headed "Coefficient of purity" is the measure of the factory value of the sugar that is in the beet. If a beet tests "80 per cent. purity," it means that for every 80 per cent. of pure sugar that the beet contains it also contains 20 per cent. of impurities that are not sugar. These impurities prevent the factory from saving all the pure sugar and the greater the amount of impurity, the greater the amount of pure sugar that will be lost in the process of manufacture. The "pure sugar per acre" multiplied by the "coefficient of purity" will give the "available sugar per acre," or the approximate amount of sugar that would have been produced

from the crops in an ordinary factory. It is considered that this measures the true sugar value of the crop and it is on the figures of this column that the order of excellence of the various crops is based.

In the table of averages by counties another column is introduced headed "Factory value per acre." This is intended to represent the amount that would be paid for the crop at a factory under present prices. It is obtained by deducting 10 per cent. tare from the gross weight of the crop and multiplying the remainder by the price paid by factories during 1898, where the price is varied according to the quality of the beets. The prices used are: Three dollars and seventy-five cents per ton for beets testing from 12.00 per cent. to 14.40 per cent. sugar and of less than 78 per cent. purity; $4 per ton for the same per cent. of sugar and more than 78 per cent. purity; $4.25 per ton for tests from 14.50 to 15.40 per cent. sugar; $4.50 per ton for tests from 15.50 to 16.40 per cent. sugar; $4.75 per ton for tests of 16.50 or higher per cent. sugar.

SUGAR-BEET CULTURE.

CONEJOS COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
Charles Milne, La Jara	Nov. 7	28.16	17.65	79.8	7,952	6,436
W. M. Martin, Alamosa	Oct. 29	24.57	16.96	86.8	6,684	5,802
W. A. Braiden, La Jara	Oct. 10	20.05	11.45	72.2	3,673	2,803
G. W. Shaw, Alamosa	Oct. 22	12.29	15.30	86.6	3,008	2,605
D. E. Newcomb, La Jara	Oct. 12	12.80	15.65	80.1	3,205	2,563
S. J. Parish, Alamosa	Oct. 16	12.06	16.64	80.5	3 174	2,554
W. G. Bradshaw, Alamosa	Oct. 21	12.40	15.77	80.0	3,129	2,499
A. McKinnon, Alamosa	Oct. 18	7.26	12.54	83.8	1,457	1,213
Peter Legard, Alamosa	Oct. 20	----------	15.58	----------	----------	----------
Average	Oct. 21	16 20	15.26	81.2	3,955	3,221

SUGAR-BEET CULTURE—Continued.

DELTA COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
G. H. Hammond, Hotchkiss	Oct. 22	38.51	17.34	77 4	10,962	8,485
Martin Cade, Delta	Oct. 17	20 57	15.91	89 5	5,236	4,686
G. W. Umbrell, Delta	Oct 31	21.78	14.68	80 9	5,116	4,139
I. S. Hewitt, Delta	Oct 19	19.96	12.87	71.0	4,118	2,924
J. M. Trew, Delta	Oct. 19	10 87	13 40	76.5	2,331	1,783
Charles A. Barnes, Delta	Oct 28	----------	15 44	83.9	----------	----------
Average	Oct. 23	22.54	14.74	80 0	5,301	4,241

SUGAR-BEET CULTURE—Continued.

FREMONT COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
B. F. Rockafellow, Canon City	Oct. 21	30.05	18.05	86.8	8,678	7,533
William Curtis, Canon City	Oct. 29	29.18	16.63	86.9	7,766	6,748
L. K. Mortimer, Canon City	Nov. 2	26.35	17.96	83.5	7,589	6,337
Charles Kaess, Cotopaxi	Oct. 24	29.40	16.63	79.6	7,822	6,226
G. E. Murray, Howard	Oct. 15	29.80	15.33	84.3	7,310	6,162
W. A. Dumm, Canon City	Oct 28	21 33	18.05	82.0	6,160	5,051
J. M. Murray, Howard	Oct. 15	29.52	13 63	79.4	6,444	5,117
John Ripley, Canon City	Oct. 27	21 90	16.96	80.3	5,942	4,772
H. T. Gravestock, Canon City	Oct. 20	14.50	16.48	90.7	3,831	3,475
E. S. Armstrong, Hillside	Oct. 12	16 13	15.68	77.0	4,046	3,116
C. H. Gravestock, Canon City	Oct. 28	8.45	19.00	84.8	2,569	2,178
E. V. Kimmel, Canon City	Oct. 20	.....	18.05	93.5	.....	.....
Average	Oct. 23	23 36	16.87	84.1	6,226	5,236

SUGAR-BEET CULTURE—Continued.

GARFIELD COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
C. H. Harris, Catherin	Oct. 29	37.98	17.20	80.1	10,458	8,397
D. G. Edgerton, Carbondale	Oct. 18	14.91	17.34	91.8	4,113	3,776
Jesse Kerlee, Parachute	Oct. 19	10.77	15.68	88 o	2,702	2,378
Charles H. Miller, Antlers	Oct 17	12.17	14.25	79.4	2,774	2,203
Average	Oct. 21	18 96	16.12	84 8	4,901	4,155

SUGAR-BEET CULTURE—Continued.

LARIMER COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
J. M. Naylor, Loveland	Oct. 23	36.26	16.53	79.3	9,590	7,589
I. W. Clapper, Loveland	Nov. 1	31.60	18.53	80 4	9,369	7,533
C. C. Smith, Loveland	Oct. 27	33.01	14 73	79.0	7,781	6,147
F. G. Bartholf, Loveland	Oct. 31	28.72	15.68	85.3	7,205	6,142
Alfred Wild, Loveland	Oct. 27	31.50	15.25	80.7	7,606	6,138
Alvin Shields, Loveland	Oct. 29	27.47	17.43	79.7	7,490	5,970
Harvey Skinner, Loveland	Oct. 27	24.80	17.38	85.3	6,896	5,882
R. O. Joslyn, Loveland	Oct. 27	14.10	18.05	84.8	4,072	3,453
R. S. Cox, Loveland	Oct. 27	21.05	13.40	75.7	4,513	3,416
P. C. Benson, Loveland	Oct. 31	10.72	19.05	86.0	3,267	2,810
N. R. Faulkner, Loveland	Oct. 22	19.35	12.07	74.0	3,456	2,765
Average	Oct. 28	25.32	15.69	80.9	6,356	5,091

SUGAR-BEET CULTURE—Continued.

LOGAN COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
Fred Bernhard, Sterling	Sept. 26	34.15	13.40	72 7	7,322	5,323
W. C. Propst, Merino*	Sept. 25	24.50	14.72	76 2	5,771	4,397
A. F. Krause, Sterling*	Sept. 27	21.50	14.50	84.7	4,988	4,175
J. H. King, Sterling	Sept. 27	18.10	13.30	79.1	3,852	3,047
C. D. Brownell, Iliff	Sept 26	14 60	14.72	80 0	3,438	2,750
C. M. C. Woolman, Sterling*	Sept. 27	12.50	14.30	72 4	2,860	2,071
C. E. Harter, Sterling	Sept. 27	9 50	15.33	78 8	2,331	1,837
T. A. Whiteley, Sterling	Sept. 26	7.65	14.15	71 6	1,730	1,239
James Weir, Sterling	Sept. 26		14.49	78.2		
M. V. Propst, Sterling	Sept. 26		14 25	78 8		
John Landrum, Sterling	Oct. 1		14 10	79.2		
R. C. Perkins, Sterling	Sept. 27		13.30	79 1		
H. C. Hatch, Sterling	Sept. 26		12 63	73.3		
Average	Sept 27	17 8	14.09	77.3	4.013	3,102

*The crop from 100 square feet of ground is used in making these estimates of yield per acre. The rest of the yields are based on one-sixteenth of an acre.

SUGAR-BEET CULTURE—Continued.

OTERO COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
J. W. Ruble, Rocky Ford	Oct. 25	31.40	18.19	86.2	9,138	7,877
J. P. Pollock, La Junta	Nov. 7	33.52	18.01	77.7	9,652	7,520
B. F. Wyckoff, Rocky Ford	Oct. 25	23.21	14.16	78 3	5,259	4,108
Albert Conner, Rocky Ford	Oct. 27	27 70	10.83	72 8	4,800	3,494
C. S. McKinley, Fowler	Oct. 20	13 27	16.06	84.7	3,411	2,889
Fred Janrow, Fowler	Oct. 29	18.17	13.30	73.6	3,906	2,875
Richard Mason, Higbee	Oct. 20	10.70	15.20	78.3	2,603	2,048
C. S Heath, La Junta	Oct. 26	----------	15.39	76.8	----------	----------
Average	Oct. 26	22 59	15.14	79.8	5,474	4,379

SUGAR-BEET CULTURE—Continued.

WELD COUNTY.

Name and Place	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds
Leonard Burch, New Windsor	Oct. 25	17.17	17.10	83.5	4 699	3,924
Newton Clegg, Greeley	Oct. 25	12.20	16.25	78.1	3,172	2,477
Martin Nelson, Greeley	Oct. 18	12 58	15.68	74.2	3,154	2,340
Fritz Niemeyer, Evans	Oct. 26		14 54	82.4		
Average	Oct. 23	13.98	15.89	79.8	3,562	2,850

SUGAR-BEET CULTURE—Concluded.

AVERAGE RESULTS BY COUNTIES.

County	Date of Harvesting Crop	Gross Weight of Trimmed Beets Per Acre, Tons	Per Cent. of Sugar in the Beets	Coefficient of Purity, Per Cent.	Pure Sugar Per Acre, Pounds	Available Sugar Per Acre, Pounds	Factory Value Per Acre
Conejos	Oct. 21	16.20	15.26	81.2	3,955	3,221	$ 62 02
Delta	Oct. 23	22.54	14.74	80.0	5,301	4,241	86 23
Fremont	Oct. 23	23.36	16 87	84.1	6,226	5,236	99 75
Garfield	Oct. 21	18.96	16.12	84 8	4,901	4,155	76 98
Larimer	Oct. 28	25.32	15 52	80.2	6,278	5,023	102 56
Logan	Sept 27	17.80	14 09	77.3	4,013	3,102	64 00
Otero	Sept. 26	22.59	15 14	79 8	5,474	4,374	86 40
Weld	Sept. 23	13.98	15 89	79.8	3,562	2,850	56 70
Grand average	Oct. 20	20 05	15 43	80 8	4,955	3,995	$ 76 67

In considering the foregoing tables one is struck at once with the high average excellence of the sugar-beets of Colorado as regards both quantity and quality. In the districts of the United States where beets are raised for factories, 12 per cent. of sugar and 78 per cent. purity are considered standards and that one who has raised ten to thirteen tons of beets per acre has done well. A fair estimate of the cost of raising sugar beets is $30 per acre, while the above table gives $76.67 as the average factory value for the whole state. The difference of $46.67 profit per acre will compare well with any other kind of farming practiced in Colorado, not even excepting the famed cantaloupes of the Arkansas valley, the orchards of the Western slope, or the lambs of the northern feeding districts.

Among the other subjects considered by this Section, during the year, may be mentioned the feeding of sheep and lambs on alfalfa. An experiment along this line was conducted on the college farm and data were secured on the subject from nearly every person in the Arkansas Valley that had tested this method of feeding. The results will be ready for issuing as a bulletin early this winter.

We completed our tests of raising early lambs and the final report will be made in connection with the above bulletin.

The second year's test of our three years' test of corn grown from seed from different altitudes and latitudes was somewhat injured by the early frost the first week in September, but it served to emphasize the differences of the plats in their time of ripening.

We are now engaged in our final tests of feeding ensilage and sugar-beets to cows and sheep.

The bulletins issued by this Section during the year have been one, in connection with the Chemical Section, on "Sugar Beets in Colorado in 1897" and a technical bulletin entitled "Further Notes on Colorado Birds." The collection of data on the above subject was kept in

mind during the past season in connection with the trips made over the State on the sugar-beet work and almost as many additional notes collected as were given in the above-mentioned bulletin.

Respectfully submitted,

W. W. COOKE,
Agriculturist.

Fort Collins, Colorado, November 30, 1898.

EXPERIMENT STATION—SUGAR BEETS, SOME COLLEGE BUILDINGS IN THE BACKGROUND.

Report of the Entomological Section.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—I have the honor to submit herewith the annual report of the Entomological Section of the Agricultural Experiment Station for the year 1898.

While this is hardly the place for a detailed account of experimental work, I presume it will not be out of place for me to call attention to the more important results that have been reached.

EXPERIMENTS WITH THE CODLING MOTH (*Carpocapsa pomonella*).

The experiments with this insect were chiefly for the purpose of determining the comparative values of different methods of combatting the pest, to determine the number of broods in the vicinity of Fort Collins, and to compare the results of early with late spraying.

The three remedies compared were, gathering the fallen apples daily to destroy them, catching the larvae under bandages put around the trunks of the trees, and spraying twice with Paris green. To test the first remedy, the fallen apples were gathered each morning and examined for worms throughout the season. In this manner 16% of all worms infesting the fruit of Duchess trees and 3½% of the worms infesting the fruit of Ben Davis trees were taken. By the bandage system 17% of the worms were taken on all trees up to the time of gathering the fruit.

By twice spraying with Paris green and estimating the benefits by the effect upon the first brood only, it was found that 83% were destroyed upon Ben Davis trees. The Ben Davis trees were sprayed when the calyx cups were still wide open. This work was compared with the result on a Duchess tree where the calyx cups had closed before the first spraying. The saving in the latter case was only 25.4%.

The experiments also show quite conclusively that there are but two broods of the codling moth a year in northern Colorado.

ORTHOPTEROLOGICAL SURVEY.

Good progress has been made in a study of the Orthoptera (grasshoppers, locusts, crickets, etc.) of the State. Quite extensive collecting has been done in the vicinity of Fort Collins, both inside and outside the foothills. Mr. Ball spent two weeks in the southeastern portion of the State collecting and studying these insects, and the writer made one trip to Delta and Grand Junction and another to Marshall Pass, Salida, Palmer Lake, and Boulder for the same purpose. Not less than two thousand specimens have been added to the station collection during this work and the number of Colorado species in the collection has been very largely increased. It will probably require two or three summers yet to bring this work to a fair stage of completion.

In the fruit-growing districts on the west side of the Range I found the differential locust (*Melonoplus differentialis*) the chief depredator this summer, though the two-lined locust (*Melonoplus bivittatus*), the red-legged locust (*Melonoplus femur-rubrum*), and a green locust (*Schistocerca emarginata*) were doing decided injury in many places. On this side of the Range the two-lined locust has been by far the most injurious species. Next in importance has been the red-legged locust. These two species are the only ones that we have found doing very serious harm to cultivated crops on this side of the foothills.

EXPERIMENTS WITH SHEEP SCAB.

Possibly the most important result reached in studying this disease the past year has been the determination of the life history of the mite. Seventy-five eggs were taken from the back of an infested sheep and put, in about equal numbers, upon the skin of the backs of two lambs that were free from the disease. The mites began hatching the 1st day and continued until the end of the 4th day; on the 9th day the earliest hatched individuals were mature and were seen in copula; and on the 11th day eggs began to be deposited. This would indicate that, to cure scab, the second dipping should not be sooner than five days after the first nor should it be postponed longer than ten days. Otherwise there will probably be some eggs upon the sheep, unhatched when the second dipping is made.

The experiment also shows the time required for the full round of development from egg to egg again is fourteen or fifteen days, as the oldest mites in the experiment came from eggs that were ready to hatch when first transferred and hence must have been about four days old when the observations began. The transfer of the eggs was made by the writer and the observations upon the sheep were made by Mr. E. D. Ball.

TESTING INSECTICIDES.

"Woodbury's Summer Spray" and "Woodbury's Kerosene Emulsion" were tested to determine their value for the destruction of insects, the samples being sent gratis by the manufacturers. The emulsion was of good quality, diluted readily, did not separate badly, and was used with satisfactory results upon plants for the destruction of plant lice. The "Summer Spray" which the manufacturers recommend for the destruction of "all insect pests" and which they guarantee to give better results than can be obtained from arsenical solutions, proved to be perfectly harmless to those insects to which it was applied. It was tested upon plant lice,

cherry slugs, and three species of cabbage-feeding caterpillars; namely, *Pieris rapæ*, *Plusia brassicæ*, and *Mamestra picta*, without any apparent discomfort to the insects. The manufacturers say of this spray that it "is absolutely non-poisonous" which probably accounts for its failure to harm the insects that ate it.

EXPERIMENTS IN THE APIARY.

The experiments in the apiary this year were chiefly with different kinds of foundation, including the artificial drawn foundation manufactured by The A. I. Root Company, of Medina, Ohio, with plane sections and with fence separators.

One question that has long been a matter of dispute among beekeepers seems to have been settled beyond farther question and that is in regard to bees removing wax or foundation from one place and using it in another. The experiments proved beyond question that this is done. When the bees were given heavy foundation to build comb upon, it was always thinnned but the amount of thinning varied rather widely. In some cases nearly half the weight was thinned away. Where the artificial drawn comb was used it had the septum, which is thinner than in natural comb, thickened by the bees, but the thickening was in spots and not evenly spread over the surface. It was also observed that the bees accepted the artificial drawn comb more readily than they did the ordinary foundation. They also built it rather more firmly to the sides and bottom of the section leaving fewer holes as passage ways.

The plane sections and fence separators gave excellent results. When filled with honey, the sections were particularly handsome in appearance and well filled out about the margins though the average weight was a little below the average in the old-style section which is notched above and below for a bee-space.

INSTITUTE WORK.

I have, during the past year, attended and delivered addresses at two meetings of the State Bee-keepers' Association, at the annual meeting of the State Board of Horticulture, and at two institutes, one held at Delta and one at Grand Junction.

INSECT COLLECTION.

Without making an actual count, it will be safe to say that more than 10,000 pinned insects have been added to the insect collection during the year, and far the greater part through the efforts of my assistant, Mr. E. D. Ball. These insects are chiefly in the orders *Hemiptera* and *Orthoptera*.

BULLETINS.

Two bulletins, Nos. 43 and 47, comprising 100 pages, have been issued from this Section during the past year.

Very respectfully submitted,

C. P. GILLETTE,
Entomologist.

Fort Collins, Colorado, December 8, 1898.

Report of the Chemical Section.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—The work of this Section has been continued in the lines indicated in my former reports. The Station Laboratory was moved into the new building in June last. The station work was, of course, interfered with to some extent by the moving from one building to the other and the accompanying delays subsequent to such changes.

The work on the bulletin entitled "A Soil Study," of which Part I. has already been published, has advanced at a fairly satisfactory rate considering the interruptions to which it has been subjected. The field work, in this connection, has been prosecuted this year, as it was last, on the plat of ground set aside for this purpose. Last year sugar-beets constituted the crop chosen for the experiment. The cultivation of the crop has again been carried on by this Section. The chief object has been the study of the effects of manuring with good, well-rotted sheep manure as compared with no manure or dressing of any kind, and with a dressing of straw, cut the length of about one inch. The study of the water level and the chemical composition of the ground water has been continued up to the time of harvesting the crop. The results of the study of the composition of the ground water, the composition of the soil, and the effects of the manuring upon the crop and soil will be recorded in a bulletin entitled "A Soil Study," Part II. This bulletin

will conclude the work of the Section on this subject. The time through which the study will have extended is shorter than desirable from many points of consideration, but I will have attained my object in undertaking the study, and as other work is waiting to be undertaken, it seems advisable to conclude this, or at least to record the work already accomplished and leave the further study of it till another time.

During the year, coöperative work on the general culture of sugar-beets has been carried on jointly with the Agricultural Section. Much of this work is the enlargement of the work recorded in Bulletin No. 46.

I have undertaken, in coöperation with the Botanical Section, to study the composition of the grasses of the State. The volume of my work will probably force me to confine this to a smaller number of species than may be desirable. But as this is a study which I have long considered as one which it is very desirable to make, I shall endeavor to give it as much time as can possibly be commanded for this purpose. A bulletin has already appeared on this subject, but new and fuller analyses seem desirable, therefore, I have most willingly consented to undertake the work, especially as I believe that the subject of our native forage plants is as worthy of our study as our cultivated crops.

A considerable amount of work on the artesian waters of the San Luis Valley has already been completed and should, I think, be published as an independent bulletin as soon as the remaining work can be completed.

The new Station Laboratory has proven to be very convenient and well adapted to the purposes for which it was intended. A definite measure of the volume of work accomplished by the Section may be conveyed by the fact that the number of determinations made between December 1, 1897 and December 1, 1898, amounts to thirty-nine hundred, which is to be considered in connection with the outdoor work done by my force and the delays caused by our moving from the old building into the new one.

I would not commend any increase in the working force at the present time, but I earnestly urge that it be maintained at its present number and that the salaries of the junior assistants be increased to at least six hundred dollars per annum, which is only a fair compensation for their services.

Respectfully submitted,

WM. P. HEADDEN,
Chemist.

Fort Collins, Colorado, December 9, 1898.

Report of the Section of Meteorology and Irrigation Engineering.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—The scope of the work of this Section is too well known to need recapitulation. Nevertheless its work touches that of the College in the corresponding Department under my charge in so many ways that the work of one can scarcely be mentioned without consideration of the work of the other and their mutual relations. During the year the work of this Section has been carried forward as close as possible to the general plan, and as much accomplished as the time and means at my disposal would permit. From some of the work conclusions of immediate value may be drawn during its progress, as is the case with determination of the seepage gains and losses from streams and canals; while much more requires investigations extending over several years and much labor in working out the results to obtain the most valuable results.

In a general way, it may be said that about 450 linear miles of streams have been measured during the year to determine the gains or losses from seepage, and about 100 linear miles of canals and ditches measured to investigate further the amount of losses from canals and ditches. The ordinary records in meteorology, in stream flow, in evaporation have been maintained in the vicinity of Fort Collins. Records from a number

of voluntary observers and the sub-stations have been regularly received and reduced. Most of these are near the water shed of the Cache a la Poudre river, but others have become necessary by the other investigations in progress. A study of the sub-surface waters in their relation to the surface applications by irrigation has been begun. A series of observations to determine the amount of water used in irrigation and to study the methods of irrigation has been commenced in other parts of the State. It has long been evident that the observations and measurements on the use of water in the Poudre valley needed to be checked by measurements under other conditions and in other parts of the State. The lateness of the season before this latter work could be undertaken give the results for only a part of this year, but forms a point of departure for the work of the coming year which by being begun earlier can be organized on a more extensive scale without material increase in cost.

In the prosecution of this work there has been some 3,000 miles driven by horse; some six or eight thousand miles of railroad travel, and several hundred miles by bicycle. No attempt has been made to keep account of these distances, but this estimate is believed to be below rather than above the sum total traveled by myself and assistants.

Three bulletins have been prepared during the year and seen through the press. The charts, diagrams and maps needed for the study of the data relating to a number of other topics are prepared, and many of those needed for use in future bulletins, several of which are quite advanced in their essential preparation. The amount of material now on hand furnishes the foundation for a good many. Ten years of continuous service was closed during the summer. There are thus ten years of observation carried on under the same plan and with the same purpose in view. In a number of cases the accumulation of at least ten years data has seemed desira-

ble before attempting to seriously discuss the observations and their lessons. The termination of this period now renders it possible to enter upon the reduction and discussion of certain of these lines with available opportunity.

Several years ago I took occasion to visit the irrigated regions of France, Italy and Algeria, to observe their conditions and learn what lessons drawn from their long experience would be applicable to our conditions. It was evident then, and the several years that have since elapsed have strengthened the conclusion, that in many ways our development under irrigation conditions is parallel to theirs, but that our experience is developing within a shorter period. I have gradually collected nearly all the works which would aid in the study of their irrigation, and have constantly planned to utilize the results of that visit before again passing over their ground to study some phases not sufficiently studied when there before. I am more than ever convinced of the desirability of studying their experience and rendering it available to save some of the mistakes which are constantly being made. The experience of the older countries long might have prevented the commission.

The correspondence of the year has increased considerably. The letter copying books show that the letters sent out have required about 1,200 letter pages. The inquiries received cover several phases of the irrigation question, and have been received from many states and many foreign countries. One day's mail this fall brought letters from Alberta and the N. W. Territories of Canada; from Scotland; France; and the province of Oudh, India. The correspondence received during the year includes Ontario, New Brunswick, Nova Scotia; England, Holland, Germany; Mexico and Peru; Algeria, Italy; Western Australia; Victoria; New South Wales, New Zealand, and Russia in addition.

METEOROLOGY.

The meteorological observations have been maintained with no material change. The intent has been to record the elements important in Agricultural Meteorology. These include rainfall, moisture, humidity, temperature, cloudiness, evaporation, wind, air pressure, soil temperature, etc. Such observations need to be maintained for a series of years before the averages are of any great value in determining the normals for the climate.

To determine our rainfall normal at this place, we now have twenty years' observations for most months. The normal thus obtained for the whole year is 13.26 inches. Treating the observations by the method of least squares, it is found that it is an even chance that in a longer series of years, the normal is .62 greater or less than this. It is thus probable that with a longer series of observations the annual will not be found to be lower than 13.24, or more than 14.24 inches. For single years it is an even chance that the total will be as low as 11.64 or as great as 16.08 inches.

In a number of special lines, some attempt has been made looking forward to special study for separate application as to soil temperatures, evaporation, etc. The character of the observations themselves has been shown in the annual reports hitherto given up to 1891, after which date, according to the request of the Director as stated in the report for 1893, they were omitted.

SUNSHINE.

In the Agricultural applications of Meteorology, as well as from its climatic and sanitary aspects, the amount and intensity of the sunshine, is one of the most important of the elements to measure. The energy which exhibits itself in the growth of plants, is derived principally from the heat received from the sun and is converted into the forms of plant growth. The relation is obscure,

but there is no question but that there is such a relation, and the only way to find it is to make attempts with that purpose in view. Records of the sunshine have been maintained during the past nine years, but available time has not permitted the measurements of the sheets, except those of a few years. There is now enough data on hand to warrant a more careful study. During the past summer some progress was made in measuring and reducing these measurements with the intention of bringing the ten years' observations, with the several years' records at the sub-station, into form for publication in a bulletin on "Sunshine in Colorado." The records are not completed, and probably a couple of months of continuous work will be required to complete the measurements, and at present without additional help, this cannot be done.

Observations along the same line to determine the intensity of sunshine have been carried on for some years. Additional observations to determine the intensity at high elevations were made at altitudes of 9,000 feet and over 14,000 feet during the summer, but were incomplete, from the disabling of one set of actinometers, and from taking but a short "vacation," in which such observations could be made. We now have sufficient data to make an instructive bulletin and probably to clear the ground for more systematic work along the related lines.

SOIL MOISTURE.

Early in the year, an instrument of the Whitney pattern, to determine the temperature and amount of moisture in the soil was ordered, and the instrument was received in the summer. The instrument is intended to determine the temperature by the change in electrical resistance with the change in temperature, the material used being a solution of salt. The amount of moisture is also determined by its effect upon the electrical resistance, the less the moisture the greater being the re-

sistance. An alternating electric current is used and the resistance found by the use of a rheostat.

Before placing the instruments in the soil, it seemed desirable to thoroughly test the tabulated temperature corrections, and determine the accuracy of the apparatus. The resistance of these temperature cells ranges from 1,400 to 2,000 ohms, at 60°, and the change for one degree of temperature is from 5 to 20 ohms per degree, within the range of our temperature changes. As this is a variation which can be determined by ordinary means of measurement, it was at first hoped that these instruments would furnish the means for much more sensitive determinations of soil temperatures than the thermometers hitherto in use, and when once provided with a rheostat box, the expense of additional tubes would be nominal. The accuracy has not, however, been as great as hoped for.

Probably three weeks were taken in these tests by Mr. Stannard. The results were disappointing so far as leading to any very accurate results. Single readings varied at times over two degrees from the correct temperature.

WATER SUPPLY.

Continued record and study has been made on the Poudre river, the stream nearest to our door and which is typical of the streams which supply nearly all of the water for irrigation in Colorado. Its study has thus been of more than local application. We now have fifteen years of continuous record, for most of the time made with the self registering instrument, and thus have not only a longer but a more complete record than any other stream in the West. Additional attention has been given during part of the time to the questions pertaining to the watershed, and rain-gages have been put in the hands of observers who would furnish observations on rainfall. It has been difficult to find people who lived where such observations were desirable, and to find those who would be interested in tak-

EXPERIMENT STATION—SOME ANIMALS TO BE SEEN ON COLLEGE FARM.

ing them. But the data thus obtained is of value not only for this stream, but as an indication of the fluctuations in the other streams in the State. The general conditions which cause high or low water are more than local, so that it is often the case that the various streams reach high water on the same day.

The sheets on the instruments have been changed weekly, requiring a visit to our rating station, which is about fourteen miles from the College. The results of these weekly records have been furnished in manuscript or mimeograph copies to the papers in northern Colorado, and for a portion of the year, through the courtesy of the Fort Collins Courier, printed slips have been sent to other papers. The reports have been furnished to the papers in northern Colorado and to a number of ditch companies or those specially interested in the distribution of water. Altogether 28 of such weekly reports have been issued. These have been printed widely in the local papers and in the Denver dailies, and occasionally in papers as far south as Pueblo. The weekly distribution of the report has thus sometimes reached as high as 150,000 copies. These reports were begun some five or six years ago as a matter of accommodation to the local irrigation interests. As the printed slips have been furnished gratuitously, I could not urge the printing office to lay aside profitable work to print them. In consequence the reports have sometimes not been distributed until too late in the week to reach some journals before their day of publication, and therefore have not been as useful as they would otherwise have been.

There is no good reason why these slips should not be printed as special bulletins of the Experiment Station, and thus distributed under the Station frank. By so doing a small sum that is now expended for postage can be paid to the printing office, and we can consistently expect that the printing will be done promptly. Thus without greater expense than at present they may be made more useful, and the distribution can also be made more

widely than at the present, when from 40 to 80 copies are distributed weekly.

A portion of the last weekly bulletin of the year of more than ephemeral value is herewith given.

"The year 1898 has been exceptionally low in its water supply. The small amount of snowfall in the mountains last winter gave indication of this and the little which fell early in the winter gave reason to expect that the late water would be unusually low, unless maintained by storms. These were the general features of the year, and while the rains of May were abundant the dry ground absorbed a large proportion of the rainfall, and a relatively small amount reached the river. Fortunately, storms have helped out the year to some extent on the Poudre, but not so much as on the Arkansas; nevertheless the stream has been abnormally low.

Since the early settlement the areas of forest have become much less from fires, and by denudation for mining and railroad purposes. The amount used for domestic purposes is of small importance, except as careless and irresponsible cutting gives conditions favoring the start and spread of the devastating forest fires. From the standpoint of the water supply on which our agriculture depends, the protection of the forests becomes of vital importance. The protecting influence of the forests on the snow cover is of the greatest importance. The letting in of the sun and wind melts and evaporates the snow without sensible formation of water, dries the springs and lessens the amount of water available for use. It is safe to say that with the former forest cover, even with the small snowfall and little rainfall of the past year, the low stage of the river would not have fallen to 34 feet as it did this year. It would have been several times more, for the innumerable small springs would have continued their supply. If the forest cover continues to be removed, autumns of low water like the present will cease to be exceptional, but become the rule, the river will be lower than it has been this year, and may become as dry as some of its tributaries.

During the current year, starting with an average of 184 second feet for the week ending April 26, the river rapidly rose after the middle of May. The highest of the year was the week of June 21, which averaged 1543 feet. Then the river rapidly dropped, the next week to 1200 feet, and the week following to 744 feet. By August 1, there was only 220 feet. Early in September there was only 100 feet, and by October 1 it had reached the unprecedented low stage of 34 cubic feet per second. After a couple of weeks the early snows in the mountains had the effect of raising the river.

In comparing with previous years it is instructive to compare with the high water and with the average for the whole season.

Taking the record by years, the closing dates of the weeks of high water and the average for the week have been given as below. The dates of high water are the resultant of the amount of snow, the periods of warm weather, and the effects of rains, and no attempt to distinguish the causes is made.

Year.	Week Ending.	Average for Week.
1884	June 14	5071
——	June 28	5075
1885	June 7	3330
1886	May 31	2439
——	June 14	2120
1887	June 7	2400
1888	June 14	1240
1889	June 7	1545
1890	May 31	1592
1891	June 14	2692
1892	June 28	2057
1893	June 14	2445
1894	June 7	3196
1895	June 14	2914
1896	May 31	1736
1897	June 14	2220
1898	June 21	1543

The average for the 27 weeks of 1898, from April 26 to November 1, has been 451 cubic feet per second, an amount less than for any other year of which we have record except 1888, when the average fell to 400 cubic feet per second. After the middle of July the river fell lower than in 1888, the higher average being due to the higher water in May and June.

For the period of 27 weeks the record in the different years has been as follows:

Year.	April 26 to Nov. 1.
1884	1761
1885	1196
1886	747
1887	720
1888	400
1889	482
1890	567
1891	671
1892....(May 17 to September 6, only)	753
1893....(May 10 to September 6, only)	815
1894	804
1895	914
1896	520
1897	793
1898	451

The year 1898 has thus averaged but little over one-fourth of the amount received in 1884 for the corresponding time and if deduction be made of the water received from other watersheds it would be less than one-fourth.

The river water of 1898, during this 27 weeks, if applied to the whole of the irrigated area of the valley, which may be called 130,000 acres, would cover it to a depth of about 16 inches. The rainfall during the same time has been about 8 inches, or the total moisture has amounted to about 24 inches, which would be increased by the amount stored in the various reservoirs during the winter and spring."

It has been increasingly evident that in the study of many of the questions of irrigation, a simultaneous study of the water conditions below the surface of the soil, and of the quantities and times of application of water at the surface is needed. It was mentioned in the last report that continuous records had been maintained for several years of the height of the ground water in a disused well, and records on small holes of a moderate depth near by. During the present season, a similar trial has been made on a larger scale, a series of wells extending to the foot hills four miles away, being taken. Wells already sunk were used. Their elevations were obtained by running a line of levels connecting them. The distance from the surface of the water was determined weekly. The uppermost well was above irrigation ditches. The trial was tentative to find out the character of the questions involved and to determine what might be expected to be settled by such an inquiry, if carried out more fully. Enough is found to show that valuable information can be obtained by extending such an inquiry over a more extended area and made more complete, according to the topography, examining at the same time the canals and the irrigation records of the tracts. Such a record is very desirable in connection with the duty of water in irrigation and before the last word is said on the subject, such an investigation will be necessary.

The following table shows the weekly changes in level in the water surface. Some of the more marked changes of level are due to the irrigation of lands near the well.

Poore's well is above all irrigation, and as shown in the notes the water table is a considerable distance from the surface of the ground.

MEASUREMENTS OF WATER SURFACE.

(IN FACT.)

Date.	Miller's.	Parsons.	Harris.	Zenner.	Andrews.	Ward's.	Poore's.
April 13.....							
April 19.....	0	.....	— .30	.....	+ .47	+1.63	+ .03
April 26.....	+ .02	— .14	— .10	+3.13	+ .48	— .15	+ .00
May 6.....	+ .56	— .11	+1.23	+3.67	+ .58	— .65	— .22
May 13.....	+ .60	— .05	— .13	+ .43	+6.10	+ .34	— .04
May 20.....	+ .39	+ .09	+ .80	+ .41	—5.46	+ .59	+ .09
May 27.....	+ .45	+ .13	+ .57	— .26	+ .18	+ .49	— .04
June 3.....	+ .25	+ .24	+ .45	— .67	— .04	+ .35	— .01
June 10.....	+ .28	+1.38	+ .30	+ .25	— .32	+1.27	— .04
June 16.....	+ .12	+ .48	+ .15	— .86	— .07	+ .54	— .10
June 24.....	+2.47	+1.24	+ .50	+ .03	— .23	— .27	+ .08
June 30.....	+ .21	+ .50	+ .56	— .40	+1.17	+ .48	— .00
July 7.....	— .70	+ .18	+ .78	— .31	—0.62	+ .54	— .08
July 14.....	— .05	+ .26	+ .56	— .30	+ .79	— .48	— .00
July 22.....	— .78	+ .37	+ .88	— .34	— .61	—1.16	+ .03
July 28.....	— .61	0	+ .41	— .25	— .59	— .39	— .01
August 4.....	— .50	— .01	+ .07	— .22	— .59	— .09	+ .05
August 13.....	+ .55	— .07	+ .57	+ .75	— .28	— .28	+ .09
August 18.....	—1.33	— .13	+ .02	+ .15	— .58	— .15	— .27
August 26.....	— .43	— .37	— .04	— .07	— .35	— .45	0
September 2..	— .04	— .35	— .34	+ .03	— .35	— .03	+ .06
September 17..	— .70	— .69	— .73	+ .04	— .68	— .90	— .03
September 24..	— .30	— .26	— .51	— .15	— .01	— .43	+ .01
October 4.....	— .35	— .38	— .68	+ .30	— .05	— .65	— .01
October 11.....	— .15	— .08	— .41	— .08	— .59	— .07	— .01
October 18.....	+ .66	— .25	— .35	— .17	— .32	— .19	+ .07
October 25.....	+ .65	— .24	— .39	— .23	+ .04		— .13
November 1..	— .05	— .10	— .30	— .06	— .03		+ .07
November 11..	— .27	— .22	— .50	+ .43	+ .40		+ .01
November 18..	— .18	— .15	— .31	+ .20	+ .13		— .02
November 25..	— .14	— .14	— .47	+ .09	+ .10		+ .01

Miller's well, observations generally taken 8-9 a. m. Distance to water from point 2 in. above ground at first observation, 11.81; at last observation, 11.18.

Parsons's well, observations generally taken 8-9 a. m. Distance to water from point 3 ft. above ground at first observation, 20.96; at last observation, 19.83.

Harris's well, observations generally taken 8-9 a. m. Distance to water from point 3 ft. 6 in. above ground at first observation, 23.85; at last observation, 21.56.

Zenner's well, observations generally taken 8:15-9:15 a. m. Distance to water from point 3¾ ft. above ground at first observation, 11.96; at last observation, 6.42.

Andrew's well, observations generally taken 8:30-9:30 a. m. Distance to water from point 3 in. above ground at first observation, 20.11; at last observation, 21.44.

Ward's well, observations generally taken 8:40-9:40 a. m. Distance to water at first observation, 4.58; at last observation, 4.69. Measured from point about 6 feet below general surface level.

Poore's well, observations generally taken 9-10 a. m. Distance to water from point 3 in. above ground at first observation, 29.93; at last observation, 30.34.

DUTY OF WATER.

Observations have been continued looking toward the further determination of the amount of water used in irrigation. These have included the continuance of the observations on a farm of 160 acres under the direction of J. H. McClelland of Fort Collins, devoted to mixed crops and on a native meadow belonging to Capt. W. M. Post of Fort Collins, both of which have been used for this purpose for the past eight years. Owing to change of management, other farms in the vicinity of the Agricultural College used in previous years were not used for this purpose this season. Three of the instruments which have been used to record the amount of water were transferred to the Arkansas valley. We were then fortunate in obtaining the aid of some of the most successful and widely known horticulturists in the valley. Measurements were maintained at Cañon City on one of the largest orchards of that region, belonging to Hon. B. F. Rockafellow, also on a part of the Frederica mesa under the Bessemer ditch near Pueblo; at Rocky Ford on a portion of the fruit farm belonging to Hon. J. H. Crowley, on a portion of the sub-station farm of the Experiment Station under the superintend-

ence of H. H. Griffin; and at Holly on the newly established fruit farm of W. F. Crowley.

The valley at Cañon City is at the base of the mountains, and is widely known for its fruit interests. The orchard of Mr. Rockafellow is one of the oldest and finest of that region. It is devoted to apples, cherries, grapes, etc., principally, and has been in bearing for several years, its commercial success being well known. The water used on 41 acres was measured. A flume was put in place and a recording instrument, being attended by Philip Sheridan, who had immediate oversight of the place and attended to its irrigation. The soil is heavy. Across the river on the south side the soil is of quite a different character, being much lighter. It was hoped to conduct similar measurements under those conditions at the same time, but the lateness in organizing the work precluded an attempt this year. Arrangements are made for next year, however, whereby it is expected to have the use of the fruit lands on that side in comparison.

In addition, the Fruitland Ditch Co. at Cañon City were kind enough to supply full information of the amount used by them day by day throughout the year, and also for the previous years since their pumping plant —said to be the largest west of the Missouri river—has been in operation.

The fruit farm of J. H. Crowley at Rocky Ford is well known. A portion of mature trees, including apple, plum, cherry, peach, is situated close to one canal, not convenient for measurements. A part, about 23 acres above the canal mentioned but below another canal, was more conveniently located for such purpose. This portion, planted to fruit for a few years, was kindly furnished by Mr. Crowley.

This orchard gave one of the clearest instances of the effect of cultivation in conserving moisture as shown by its effect on the growth of the trees that I have seen.

The Experiment Station farm or as much as could be supplied through one measuring box was used, and the record kept by Mr. Griffin.

On the Frederica mesa a tract of 219 acres was kindly placed at our disposal by the kindness of Mr. C. K. McHarg. A box was put in place by Mr. Hawley and the measurements made by Mr. Petrie.

Mr. W. F. Crowley, the superintendent of the Arkansas Valley sub-station in 1897 and formerly well known as a young horticulturist of great activity and promise, started an orchard on the plains north of Holly and under the Amity Canal early in the Spring. I had happened to see the tract of land as it lay in unbroken prairie but a short time before. It is generally believed that the need of land for water becomes less after a few years. This was an excellent opportunity to observe the change, if any from the first use of water. Mr. Crowley took a keen interest in the attempt, putting in the box and caring for the instrument. Mr. Crowley is a skillful irrigator and the results of the measurements will be of great interest. As there had been no previous irrigation given in the immediate vicinity, it affords a model case of original irrigation. The only draw-back is that it is over 300 miles from the Home station, and the opportunities for examination are not so frequent as desirable.

A survey and topographical map has been made of each of the tracts thus used during the past year, and will form the basis of the more detailed measurements for the next year, which is hoped to begin earlier in the year, in order to include all of the irrigation season.

None of the measuring weirs or instruments could be put in place as early the past season as desired, as the question whether funds could be used for the purpose was not decided until July.

By that time the most important irrigations of the season were over, and the results that we obtained are only for a portion of the year. They however will show the amount of water used in these special irrigations and give means of estimating the amount used for the whole season. They will insure that tracts with boxes in place will be ready for next season's operation. These meas-

urements need to be carried on more extensively and are very desirable to extend.

In addition to the tracts above mentioned, the information from other sources, as from ditch companies that maintain a system of measurement will materially increase the amount of data available.

At this date the observations resulting are not reduced and the results of the determination cannot be given. We have now some six years' continuous observations since the Bulletin 22 on "The duty of Water" was published in 1892, enough to warrant another and more extensive investigation of the data at hand.

SEEPAGE MEASUREMENTS.

We have made in round numbers some 1,200 linear miles of river measurement to determine the loss or gain from seepage since bulletin No. 33 was published on this subject in 1896. These measurements have included three on the Poudre, one on the Platte in connection with the State Engineer's office, two on the Arkansas from the mountains to the State line, three on the Rio Grande in Colorado, two on the Big Thompson and the Little Thompson, and one on the St. Vrain.

The first measurements on the Big Thompson and on the Arkansas were made in 1897, on the St. Vrain, in 1898. We have found from experience that the first year's measurement is usually defective, the first trip being required to learn the location of the headgates, the roads or paths to get to them, the location of the wastegates, and in general obtaining the detailed local knowledge necessary to prevent oversight of important points, or in order to select the most desirable points for gaging, accessibility and topographical features being considered. The Water Commissioner usually possesses this detailed knowledge in his district. Still we have often had occasion to visit ditches which the Commissioner had never seen, the ditch perhaps having an early appropriation and thus requiring no regulation

from the Commissioner. We have sometimes found disturbances brought in from wastegates which had been overlooked by not learning that there were several sets. The measurements after the first year have usually been free from such errors.

At the time of writing the last annual report late in November, 1897, the measurements were reported in progress on the Arkansas river. The river at that time contained considerable water and was at times difficult, if not dangerous to wade. The water was sometimes breast deep. The temperature was low, and before the 200 miles were completed the water was at freezing temperatures and running slush ice. At one place the observer lost his footing and was entirely submerged.

The work was simultaneously carried on in two field parties. I was able to do but little myself, the first attempt in October having been stopped by a heavy storm. The measurement of 1898 was more satisfactory, both because of the detailed knowledge gained in 1897, and because the river being lower the gagings were more easily made by wading.

From Cañon City to Pueblo, a distance of 40 miles, for a large part of the way the river is in a chasm with no wagon road convenient to the river. The measurement was made by covering the distance on bicycles along the railroad grade. Below Pueblo horses were used and the assistance of Water Commissioners Reece and Cressey and of the Fort Lyons, Lamar and Amity Canal companies through P. J. Preston, A. E. Bent and W. M. Wiley, is gratefully acknowledged.

I was able to pass personally over the ground in detail for most of the distance from Cañon City to the State line. I gave more particular attention to the conditions affecting seepage, and to a study of the geological stratigraphy as it bears on seepage, and find a close relation between the rock strata and the gain and losses from the river.

Wherever the drainage of an important watershed discharged into the main river, it was desired to take a

measurement both above and below to obtain a measurement of the water entering the stream in the sands, if any such existed.

Before starting the measurement, the names and the location of the headgates were determined as far as possible, and from general knowledge of the country and from the topographical maps, which though often seriously incorrect, were found useful. The points of gaging were selected. Blue prints were made showing the available information, and typewritten sheets of instruction of which the following is an example, were given to the observers.

The points selected for gaging stations were chosen from their accessibility, from their being critical points in the topography, or at some place where the information was desirable, as at the head of important ditches.

INSTRUCTIONS IN SEEPAGE MEASUREMENTS, DISTRICT 14.

Water District No. 14, Carlile Springs to Nepesta.

River gaging No. 4. At Carlile Springs, on west side of Pueblo County.

No. 5. Head of Bessemer ditch, distance 9 miles.

No. 6. At Rock Cañon, distance 4 miles.

No. 7. Above Pueblo, about opposite or a little below the Insane Asylum, distance 5 miles.

Gage Fountain creek at its mouth.

No. 8. Below the Fountain, and below Pueblo. This should be about a mile below the Fountain, or if the roads are more convenient, about two miles. According to the map the road seems to reach the river on the north side about two miles below the mouth.

Gage the St. Charles near its mouth.

The St. Charles needs to be gaged above the Bessemer ditch; this can probably be done by L. G. C.

No. 9. Gage the river below the St. Charles, distance 6 miles. This can be at the road crossing about a mile below the St. Charles.

No. 10. Above the Huerfano, above the plain formed by the river. Gage the Huerfano, or see the amount of water it contains. It will probably be dry.

No. 11. Gage below the Huerfano. A favorable place about a mile below, near the head of Bob Creek Canal, or, better, a little lower yet.

No. 12. The river at Nepesta at or above the railroad bridge.

No. 13. Head of the Otero Canal. Measure all streams going in, and all canals taking water out.

MEMORANDUM OF DITCHES, IN ORDER, ALONG THE RIVER.

No. of Section.	Range of Township.	Name of Ditch.	Side of River.
1	68	Hobson	North
16	67	Fields	North
15		Ritchie	South
23		Brooks	South
33	66	Bessemer	South
36		Hampbell	South
31	65	West Pueblo	North
27		Morey	North
27		Haden	North
34		Riverview	South
34	65	Pueblo Water Cos	South
4	64	Barnum	South
18	64	The Arkansas	North
16		I. N. Sater	South
32		The Booth	North
35		Warrant, Barnes & Baxter	North
32	63	Excelsior	North
6	62	Ballow Hill	North
8		Collier	South
10		Colo. Canal (Bob Creek)	North
1		Arkansas Valley	North
17	61	Rocky Ford High Line	South

No. of Section.	Name of Township.	Name of Ditch.	Side of River.
16		Allen	South
31	60	Enterprise	North
31		Oxford Farmers	South

SEEPAGE GAINS AND LOSSES, ARKANSAS RIVER.

The following summary shows the seepage gains and losses that were found on the Arkansas river in 1897 and 1898, the measurements being given in cubic feet per second.

Place.	Dist. Miles.	Area of Trib'ut'y Water-shed Sq. Miles	1897. Gain. Sec.	1897. Loss Ft.	1898. Gain. Sec.	1898. Loss. Ft.
Canon City to Bessemer ditch	33	1,481	54.40	....	55.17	....
Bessemer to Pueblo	10	255	....	42.18	....	15.96
Pueblo to Orchard Grove	8	1,101	....	9.40	19.41	....
Orchard Grove to Boone	16	1,335	103.47*	....	20.30	....
Boone to Nepesta	10	2,235	40.44	....	....	17.65
Nepesta to Otero Canal	8	182	....	5.78	....	11.00
Otero Canal to Apishapa Creek	7	57	16.90	....	18.15	....
Apishapa Creek to Rocky Ford	16½	1,667	30.55	....	31.21	....
Rocky Ford to Fort Lyon Canal	9	749	35.59	....	22.39	....
Fort Lyon Canal to La Junta	3	88	13.04	....	8.20	....
La Junta to Jones Ditch	11	115	10.85	....	14.76	....
Jones Ditch to Las Animas	9	193	28.51	....	20.08	....
Las Animas to Old Fort Lyon	6	3,509	38.14	....	13.26	....
Old Fort Lyon to Caddoa	11	660	3.63	....	....	0.16
Caddoa to Amity Canal	10	445	....	....	....	6.64
Amity to Lamar	11	256	....	....	6.68	....
Lamar to Holly	30	461	13.21	....	14.20	....
Holly to Coolidge, Kansas	7	1,171	....	....	....	....
Total	215	15,960	387.43	57.36	243.81	51.41
			57.36		51.41	
			330.07*		192.40	

*Evident error.

* Assuming the result of 1898 from Orchard Grove to Boone as correct, the gain would be 250 ft.

The river as it crosses Colorado, passes through several basins caused by the folding of the rocks. The larger one has its western rim at Rock Cañon, a few miles west of Pueblo, and the eastern rim near Old Fort Lyon, about 15 miles east. The rocks also dip to the north away from the river. The significance of this latter condition, is, that so far as the water penetrates these rocks it does not return to the river, but is lost to the agriculture of the valley. If the water thus taken up is considerable, it means a serious loss to the valley.

Practically the measures seem to indicate that at the places of cutting through the sandstones above Pueblo and from Old Fort Lyon to the Amity Canal, there is a loss, while in between there is a gain with few exceptions.

My studies on this point this year have not been extensive or detailed enough to warrant any conclusive statement further than to say, that the facts so far found seem to indicate that this loss is not so serious as has been feared. The conditions of the north side of the river especially under the larger canals, like the Colorado, the Holbrook, the Fort Lyons and the Amity, need to be examined more in detail for evidence bearing on this subject.

On the Platte the understanding with the State Engineer was that his office would make the measurement in 1897, and he was preparing to make it in 1898. We coöperated in the measurement in 1896. I wish to make a further examination of this valley giving more special attention to the conditions relating to seepage, before publishing the results made since those detailed in Bulletin 33. The conclusions there given have been strengthened by the subsequent development.

SEEPAGE MEASUREMENTS ON THE BIG THOMPSON.

The measurement for seepage on the Big Thompson and Little Thompson were referred to in the last annual report. The measurement in 1898 was postponed beyond

the time desired, because the water was being changed from one ditch to another giving daily a new condition of the river outflow. Until the conditions became more stable it seemed useless to make the measure. The valley is one of the oldest in the state. Some water from this stream irrigates area which is tributary to the Poudre river and a little land tributary to the Little Thompson is irrigated by water from the St. Vrain.

The following is a summary of the results of the two years.

	1897.	1898.	Distance. Miles.
Handy to the Home Supply Canal	0	....	1.0
Home Supply to the Barnes Ditch	15.78	8.13	5.7
Barnes Ditch to the Loveland & Greeley	4.62	3.52	3.1
Loveland & Greeley to the Big Thompson Ditch	12.38	13.31	10.5
Big Thompson Ditch to the Hill & Brush	4.52	6.62	5.3
Hill & Brush to the Big Thompson & Platte	12.42	9.59	10.6
Big Thompson & Platte to the Evanstown Ditch	14.36	11.59	11
Total	64.08	52.74	47

ON THE LITTLE THOMPSON.

	1897.	1898.
From Eagle Ditch to Dry Creek	1.35	3.16
Dry Creek to Rockwell Ditch	2.77	1.52
Rockwell to Miner Ditch	2.43	1.32
Miner Ditch to Mouth	4.08	2.89
Total	10.63	8.89
Total for both Big and Little Thompson	74.71	61.63

It is noticed that the increase in 1898 is less than in 1897, probably due to the smaller water supply in the past year. The measurements are given in cubic feet per second.

ON THE ST. VRAIN.

The St. Vrain creek rises in the high mass of mountains from the south slope of Longs Peak southward to the headwaters of Boulder creek, and waters one of the most fertile of the tributary valleys of the Platte.

The following were the gains found in the measurement made Oct. 26-28, 1898 by Mr. Trimble with the aid of Mr. L. H. Dickson of Longmont, Water Commissioner of Water District No. 5.

	Distance, miles.	Gain, sec. ft.
From Lyons to the Oligarchy Ditch	3.7	2.63
From the Oligarchy to the Niwot ditch	2.7	3.24
From the Niwot to the Boulder-Weld Co. line	6.7	7.39
Co. line to Boulder creek	2.2	5.34
Boulder creek to Fleming place	5.8	4.21
Fleming place to Platte river	7.0	2.98
Total	28	25.79

This does not include the seepage return entering Left Hand creek, a tributary of the St. Vrain and which is supplied with water by ditches from the St. Vrain principally, nor seepage entering Boulder creek. Both of these streams need to be measured to include the return waters from their water sheds.

The amount of land irrigated from the St. Vrain is approximately 89,000 acres according to the report of Water Commissioner Dickson.

THE RIO GRANDE RIVER IN COLORADO.

A measurement to determine seepage on the Rio Grande was made in 1897, this being the third year of measurement and the results are satisfactory. The measurement of this year again shows that the losses from the river in the upper part equal or exceed the subsequent gains of the remainder of the river in Colorado. I have attempted to get information bearing on the con-

ditions south of the San Luis valley which should confirm or disprove the hypothesis I had formed to explain the excessive loss, indicated by the loss from the river and by the disappearance of the numerous side streams. In 1896, I crossed the valley at the lower end and in 1897 took a hurried trip as far as Santa Fe, New Mexico, and crossed the valley in the vicinity of Espanola. Now it seems desirable to pass lengthwise of the valley from San Luis to Taos. The country is very sparsely settled and is mostly a barren country. By correspondence, I have been able so far to obtain little definite information which would serve to narrow the search for indications thought to be there.

In the measurement of the Rio Grande in 1898, it is noticed that the river begins to gain, or perhaps it would be better to say ceases to lose, at a point higher up than was noticed in 1896. Whether this is the effect of some fluctuation in the river or is an actual fact, is an important question. If the latter, it is significant in interpreting the greater amount of water taken by the valley. As this was not noticed in comparing the observations of 1896 and 1897, it emphasizes the need of caution in drawing conclusions before sufficient data is accumulated. Desire is sometimes expressed for results to be published before sufficient data is at hand, but it may be said that unless there are enough and long enough continued observations to make the conclusions more than probable, publication is apt to be more harmful than beneficial.

	Gain in 1898.
From gaging station to Del Norte	—51.69
Del Norte to Prairie Canal	+ 2.11
Prairie to Monte Vista bridge	+ 6.26
Monte Vista to Kenilworth ditch	+ 8.82
Kenilworth to Hickory Jackson ditch	+18.10
H. Jackson to Alamosa	+ 2.78
Alamosa to Conejos river	+ 1.57
Conejos to Lava canon	— .92
Total loss	13.17

The measurement in 1898 was made from Aug. 19 to 25 by Mr. J. D. Stannard aided by Water Commissioner M. D. Blakey of Monte Vista. The last measurement was below the Mexican village of Los Sauses where the river enters a cañon.

CACHE LA POUDRE RIVER.

	1896. November.	1897. October.	1898. August.
Weir to Fort Collins Water Works	— 2.92	+ 1.39	— 7.76
La Porte to Larimer and Weld Canal	?	}	+ 0.41
Water Works to La Port		} 16.61	+ 8.75
Larimer and Weld Canal to No. 2 Reservoir Supply	— 5.68	— 3.96	+ 3.37
To Strauss Bridge	—22.87	— 2.90	+14.84
Strauss Bridge to No. 2 Canal	+16.41	+10.42	+ 1.28
No. 2 Canal to Eaton Ditch	+10.42	+13.36	+ 8.34
Eaton Ditch to Greeley No. 3 Canal	+ 5.77	+35.72	+15.44
No. 3 to Greeley Mill Power Canal	+16.64	?	+21.16
Mill Power Canal to Camp Bros. Ditch	+25.52	+26.57	+25.98
Camp Ditch to Mouth	+21.98	+23.58	33.37
Total			135.18

In 1898 measurement made Aug. 9-12 by R. E. Trimble and Prof. G. L. Swendsen Aug. 9-10, and the remainder by R. E. Trimble and J. C. Mulder.

In 1897, the measurements were made Oct. 7-14, by R. E. Trimble and R. Q. Tenney.

In 1896, the measurements were made Nov. 11-14 by R. E. Trimble and R. W. Hawley. Water was being changed from power to canal purposes and from night to day, causing fluctuation in the river and throwing doubt on one of the upper sections.

LOSSES FROM DITCHES AND CANALS.

Bulletin 48, issued in July, on "The Losses from Ditches," was intended to call attention to a source of loss whose extent had been little realized by the agricul-

tural community, to arouse attention to its importance, and to point out some practicable methods of lessening it. The importance of this source of loss is evident when we consider that from one-fourth to two-thirds of the water resources of every ditch is wasted without beneficial use. In one ditch measured this summer, which pumps water over 100 feet high, one-fourth of all the water is lost in the first half mile of ditch. It therefore takes one-fourth of all their coal to supply the waste in this extent of ditch. In another case the loss has amounted to 18 to 20 feet in depth at places.

As opportunity served during the year, additional measures of this type have been made, mostly on ditches in the Arkansas valley. This included a number of ditches around Cañon City and the determination of the losses on the whole length of the Bessemer ditch. As it will be some time before the subject is taken up in the form of a bulletin, some of the measurements are here given.

ORIGIN OF SEEPAGE WATER.

In the case of the Bessemer ditch, which extends some ten miles above Pueblo to about twenty miles below, the conditions are unique and are such as to enable a determination to be made of the amount of water entering the river from seepage from the canal and the land which it waters. In almost every case in the state it is difficult to determine the origin of the return water because several ditches are found one above the other, and the source of the seepage that is found thus becomes doubtful. Even in those cases where there is but one ditch, it is not at all sure that all of the water entering the river comes from this ditch, or that all of the water coming from the ditch is collected in a given stretch in the river. In the case of the Bessemer ditch, however, the mesa over which it extends is underlaid with a stratum of shale rock which slopes towards the river and forms a shelf along the bluffs of the river for the whole length of

LOSSES FROM DITCHES AND CANALS.

MEASUREMENTS IN 1898.

DATE AND HOUR	NAME OF CANAL	Temp. of Water	Amount of Water, Sec.-feet	Amount Withdrawn, Sec.-feet	Surface Width in Feet	Assumed Average Width in Feet	Depth in Feet		Average Velocity, Ft. per sec.	Distance from Previous Measurement, Miles	LOSS OR GAIN		Observer	REMARKS
							Average	Greatest			Second Feet	Depth over Canal, Feet in 24 hrs.		
July 20—10:40-11:20 a. m.	Greeley No. 3	72.5°	11.94		13 8		0 44	0.60	1 88				T.	
July 20—12 m	Greeley No. 3	74.5°	10 26	0	14 4		0 83	1 01	0 81	760 ft.	−1.68	−14.2	T.	Same place as measured in 1897.
Aug. 13—8.45 a. m	Greeley No. 3	68°	7.06		13.6		0.32	0.45	1 63				T.	
Aug. 13	Greeley No. 3	68°	6.73	0	13.2		0.58	0 68	0.89	760 ft.	−0 33	−2 8	T.	Same place.
Aug. 10—2 p. m	Hottell's Mill Race	81°	2		4.3		0.28	0.40	1.70				T.	
Aug. 10	Hottell's Mill Race	87°	1.19	0	8		0.70	0.70	0.20	4 m.	−0.81		T.	
Oct. 5—11 a. m	Bessemer D, 34+37	56°	64.74		26		1.56	1.85	1.53				H.	At scouring gate.
Oct. 5—2:30 p. m	Bessemer D, 372+90	55°	50 40	11 12	16		2 28	2.35	1.38	6 40	−3.22	−0 46	H.	At rating flume.
Oct. 5—5 p. m	Bessemer D, 692+10	51.5°	43 98	2.23	15.5		1 63	2 30	1.64	6.05	−4 19	−0.73	H.	Flume No. 16.
Aug 10—9.40 a. m	Bessemer D, 692+10		59.61		16		2 87	3 30	1,30				H.	
Aug 10—3 p. m	Bessemer D, 1039+0	73.5°	32.12	15 62	17		0.95	1.55	2.00	6.57	−11 85	−1 82	H.	Lower end Siphon under the St. Charles.
Aug. 10—5.30 p. m	Bessemer D, 1411+0		30.60	5.89	15		0.98	1 60	2.08	7 05	+4 37	+0.64	H	Road crossing 3 miles southeast of Artmanu
Aug. 11—5:20 p. m	Bessemer D, 1879+0		10.01	17.07	9.7		0.75	1.35	1 03	8.85	−3.50	−0.79	H	Below headgate McHarg lateral.
Aug. 23—4:09 p. m	Bessemer D, 1879+0	72°	7.11		6.2		1 20	1 60	0.95				H.	
Aug 23—5:45 p. m	Bessemer D, 2780+0	67°	4 21	2 04	6		0.87	1.35	0 77	5 70	− 0.80	−0.38	H.	End of ditch.
Aug. 6—10 a. m	Bessemer D, 34+37		62.56		19		1.60	1 72	1.80				H.	
Aug. 6	Bessemer D, 372+90		50 03	6 36	16		2.40	2.50	1.30	6.40	−6.12	−0.88	H.	
Aug. 6—6:20 p. m	Bessemer D, 525+10		49 39	2 75	18		1.57	2 70	1.75	2.89	+2 20	+0 74	H.	Van Buren Street bridge, Pueblo.
Sept. 9	Bessemer D, 372+90	55°	53 21		16		2 42	2 50	1 40				H.	At rating flume.
Sept. 9—3:30 p. m	Bessemer D, 550+0		52 14	0.31	14 5		2 01	2 80	1.66	3.35	−0 76	−0.25	H.	At street railway bridge, Pueblo.
July 9—3 p. m	McHarg Lateral		20.51		10		1 54	2	1.29				H.	At headgate.
July 9—4 p. m	McHarg Lateral		19 75		11	10	0.77	0 90	2.09	Estimated 2,000 ft.	−0 76	−3.30	H.	At first divisor.
July 23	McHarg Lateral		19.99		9.6		1.52	2	1.25				H.	Same as above.
July 23	McHarg Lateral		21 40		11		0.77	0 90	2.26	Estimated 2,000 ft.	+1.41	+6	H.	
Aug. 11	McHarg Lateral		5.70		5.7		0.63	1	1.53				H.	Same as above.
Aug. 11	McHarg Lateral		5 09		5 2		0.53	0.70	1.80	Estimated 2,000 ft.	−0 61	−4.88	H.	
Aug. 24—8 a. m	McHarg Lateral	68°	4 73		5.4		0.61	1.55	1.40				H.	
Aug. 24	McHarg Lateral			4.80						1.9 m.	+0.07	+0.19	H.	For seepage on Frederica Mesa.
Aug. 10—11:30 a. m	Hartig Lateral		1.16		2 1		0.50	0.80	1.12				H.	
Aug. 10	Hartig Lateral		0.90		1 8		0.62	1 10	0.76	1¾ m.	−0.26	−1.24	H.	
Aug. 5—5 p. m.	McGrew Lateral		1 28		1.2		0.22	0.22	4.83				H.	
Aug. 5—5.20 p. m	McGrew Lateral		0.94		3.0		0 43	0.55	0.72	2 m.	−0.34	−0.93	H.	
Aug. 26—6:45 a. m	Canon City Ditch	54°	31.97		10.2		1.12	1.50	2 57				H.	Near headgate in canon.
Aug. 26	Canon City Ditch		31 44	1.10	12.4		18.6	2.30	1.31	1.59 m.	+0 57	+0.49	H.	At Second Street bridge, crosses Sand Creek, in section.
Aug. 26—11:30 a. m	Canon City Ditch	69°	25.23	6 95	8.8		1 55	1.65	1 85	2 15 m.	+0 74	+0.58	H.	At first flume E. of Canon City. Under Fruitland ditch.
Aug. 26—2 p. m	Canon City Ditch	78.5°	0.70	20.69	3 0		0 23	0.35	0.94	3	−3.84	−3.54	H	Waste at Four Mile or Oil Creek.
Aug. 26—5 p. m	Mill Ditch	71 5°	24 20		7.0		1 42	1.60	2 30				H.	Opposite old smelter, Canon City.
Aug. 26—2:30 p. m	Mill Ditch	72°	9 95	{ 14 31 } * { −4 95 }	5.5		0 52	0.55	3.40		−4 89		H.	Flume over Four Mile Creek.
Aug. 30—1:50 p. m	Deweese and Dye Ditch	81°	11.11		4.5		1 23	1 35	1.96				H.	At rating flume, near headgate.
Aug 30—3 p. m	D. and D. Ditch Sta. 158+40	80.5°	9.42	0.92	6.0		1.11	1.40	1.37	3	−0.67	−0.61	H	Below Cemetery.
Aug. 30	Deweese and Dye Ditch		2.95	5 89	2 3		0.25	0.25	5.19	3.52	−0.58	−0.54	H.	On line ¼ mile E. of W. side of Sec. 2.
Aug. 27—9:45 a. m	South Canon Ditch		33 80		13		1.80	2 25	1 38				H	At bridge at Hot Springs Hotel.
Aug. 27—12:35 p. m	South Canon Ditch		21.44	8 81	10		1.57	1 90	1.32	2.20 m	−3.55	−2.22	H.	At bridge above pumping plant.
Aug. 27—1:15 p. m	Fruitland Ditch	73 5°	13 37		6.5		1 24	1.50	1 42				H.	Below reservoir connection with ditch.
Aug. 27	Fruitland Ditch		9 36	{ +1.00 } * { −2.24 }	6.0		1.06	1.50	1.33	0.50	−4.01	−20 56	H.	At point of leaving shale hills.
Aug. 27—3 p. m	Fruitland Ditch		8 53	{ +1 27 } * { −8.74 }	3 75		1	1	2.27	1.09	+0.41	+1 27	H.	At 2d flume along line, over small creek
Aug. 27—3:45 p. m	Fruitland Ditch					2.25				1.32	−1 06	−4 42	H.	At Coue avenue.
July 30—3:15 p. m	Catholic Ditch	79.5°	5 30		3.8		0.58	0.80	2.20				H.	Near headgate on Amity ditch.
July 30	Catholic Ditch		4 96		6 3		0 48	0.70	1.56	1 m.	−0.34	−1 11	H.	At first road south.
July 30	Catholic Ditch	78.5°	4.65		5.6		0.49	0.75	1.57	2.4 m.	−0.31	−0 36	H.	At second road crossing.
Aug. 1—10 a. m	Las Animas Ditch	65.5°	17.15		4.9		1.72	2.90	1.87				H.	
Aug. 1—11:45 a. m	Las Animas Ditch		16.96	1.48	6 0		1.57	2.10	1.70	1½ m.	+1 29	+2 37	H.	North of Las Animas pump house. Passes under Jones ditch.
Aug. 1—12:30 p. m.	Las Animas Ditch		15 72		3.5		2.31	2.55	1.97	1½ m.	−1.24	−2 73	H.	Road crossing east of Las Animas.
Aug. 23—11 a. m	Excelsior Ditch	72°	5.77		11		0.80	1.15	0.62				H.	Below waste gates.
Aug. 23—1 20 p. m.	Excelsior Ditch	75°	4 81	6 81	9.6		0.56	0.90	0.70		+5.85		H.	At west side of orchard.
Aug. 23—3:10 p. m	Excelsior Ditch	76.5°	0 41	4 40	2 5		0.23	0.40	0.62		+0.16		H.	At road crossing north from Chico bridge.

* Water flowing into the canal is preceded by the + sign.

the ditch. It thus forces all the seepage to the surface, renders it evident, causes it to collect in streams at the edge of the bluffs and thus permits it to be measured. The opportunity was too exceptional to omit taking advantage of it, and in 1897 the measurement was made by Mr. Trimble from Pueblo to Grant Arroyo, and in the fall of 1898 by Mr. Hawley for the whole distance. It was necessary to walk most of the distance. Without entering into detailed statement of the measurements, it is sufficient to say that about one-half of the amount of water entering the river is derived from the losses from the ditch itself, the other half being supplied by the water which is applied to the farms by the farmers. When the whole conditions are taken into account and the flow throughout the year is considered, it is possible that the amount coming from the ditch will not be as large a proportion of the whole year's inflow, as during the irrigation season.

The general result is borne out by the measurement made in the valley around Cañon City. In this case the losses from the various ditches were measured and the gain of the corresponding stretch of the main river. The gain in the river was found to be about twice the loss in the ditches. This measurement is not so conclusive as in the case of the Bessemer ditch, because of the uncertainties in the measurement of the river and from several other conditions.

Some systematic attempt was made during the year to obtain photographs showing the methods of irrigation with view to use in connection with studies that have been more or less systematically made for a number of seasons. We have found in the past that when postponed until the latter part of the summer, as the demands of field work at the earlier part of the season has usually required, the growth of plants and weeds have prevented obtaining successful photographs. It is both hard to find the conditions which shall clearly show the points desired, to find the application of water and to find the state of vegetation such as to exhibit the meth-

ods desired. In the several days' trip made for this special purpose, a few, but only a few, successful photographs were obtained.

ACKNOWLEDGMENTS.

The work of the Section could not have been as successful without the conscientious work of those connected with the department: Mr. R. E. Trimble, assistant in the Experiment Station, on whom has devolved the details of the local observations at Fort Collins, and much of the reduction; Mr. J. D. Stannard, assistant in the College, who has helped with some charts and with the seepage measurements in the San Luis valley; R. W. Hawley, who aided in the field in the Arkansas valley from July to December; J. C. Mulder, principally in office draughting during the summer vacation; W. R. Headden, in office work for a couple of months during the summer, and Miss Ella Goldsborough, for typewriting services during the rest of the year.

We are indebted to many throughout the State for material services, rendered at considerable expense of time and expense to forward the investigations in progress. Among these are Henry Earle, manager of the Fruitland Ditch, who has materially helped with obtaining valuable information and freely placed the records of his company at my service; Dr. J. L. Prentiss, also of Cañon City, proprietor of the Hot Springs Hotel, who has taken daily samples of water for the determination of sediment; Philip Sheridan, in charge of the irrigation of the orchard of Hon. B. F. Rockafellow at Cañon City, who has taken care of the instrument and record intended to record the water used in irrigation; Hon. B. F. Rockafellow, for the use of his orchard as a field for observation. At Pueblo Mr. C. K. McHarg, manager of the Bessemer ditch, and Hon. J. S. Greene, ex-State Engineer, took active interest in the measurements and investigations and were instrumental in having land placed at our disposal, as well as aiding with the Bessemer

ditch; Water Commissioner Reece, who has not only aided with records, but assisted for several days in the seepage determinations along the river; Mr. Bentley, superintendent of the Bessemer ditch, also gave material aid, as did Messrs. Taylor and Keasby, of Vinland, in the arrangements for determining the duty of water. At Boone, Messrs. Philip and —— Burton, Deputy Water Commissioner, aided in the stretch of the river to Nepesta. At Manzanola, Mr. M. D. Lyle, superintendent of the Fowler ditch; in water district 17, S. W. Cressey, Water Commissioner for that district, actively aided in person and with vehicle in the measurements; Hon. J. H. Crowley, in the use of his orchard and in many other ways; Mr. Harvey Griffin, superintendent of the Arkansas Sub-Experiment Station; and the Hon. A. L. Kellogg, President of the State Board of Agriculture, whose intelligent interest helped in rendering the work possible.

At Las Animas Mr. P. J. Preston, superintendent of the Fort Lyon Canal system, one of the longest in the United States, and Mr. C. W. Beach, an engineer for the same company, both graudates of the Agricultural College, took active interest in the work, expended time, furnished transportation, and Mr. Preston was instrumental in putting the facilities of the canal at our disposal. Hon. A. E. Bent and Thos. Berry, of Lamar, president of the Lamar Canals, and engineer in charge of the Amity Canal, E. C. Hawkins, chief engineer of the latter system, also aided by helping in the seepage measurements, in the sediment observations, in attempting to determine the losses from a long stretch of canal and in many other ways. Likewise Hon. W. M. Wiley, of Holly, the general manager of the Amity and other canal systems, placed every facility at our disposal, arranged in many ways to facilitate the work and to render it possible. W. F. Crowley, of Holly, placed his fruit farm at our service, constructed weirs and maintained the observations on the water used. W. F. Montgomery, connected with The Great Plains Storage Company, also aided, as did numerous others connected with the company.

Mr. H. O. Brown, a graduate of the College living at Salida, took an interest in the sediment observations and began their collecting.

In the San Luis Valley, M. D. Blakey, of Monte Vista, Water Commissioner of district No. 20, helped in the seepage measurements on the Rio Grande. A number of others helped in various ways, as M. B. Colt, at Alamosa; W. R. Hapney, of Alamosa, with information concerning artesian wells, and observations on their pressures.

Hon. L. H. Dickson, of Longmont, Water Commissioner of district No. 5, aided for several days in the measurement of the seepage on St. Vrain creek.

J. H. McClelland and W. M. Post permitted their farms to continue to be used as a field of experiment, and Mr. McClelland actively aided in the collection of the data desired.

Mrs. F. W. Sherwood, of Glen Eyre; Geo. Barnes, of Pinkhapton; Carlyle Lamb, of Estes Park; P. H. Boothroyd, of Arkins; C. B. Andrews, of Home P. O. and Fort Collins, all aided materially as volunteer observers, as did John Deaver, of Home P. O.

Mr. Enos A. Mills, of Estes Park, took a special trip to the top of Long's Peak, at an elevation of nearly 14,300 feet, in order to make simultaneous actinometric observations in connection with myself, who took observations at 9,000 feet.

Also to Messrs. Frank Trumbull and Henry Michelsen, of the Union Pacific, Denver and Gulf railway, and to Messrs. Paul Morton, vice president, and J. E. Frost, land commissioner of the Atchison, Topeka and Santa Fe railway, for important courtesies, without which the work of the summer could not have been carried on.

Our thanks are due to all of these, besides many others who have aided in a lesser degree. The assistance has been freely rendered, and has served to stretch the possibilities of the funds placed at our disposal.

Nor should many of the press of the State be omitted from the list. Their support has materially aided

the work. I would especially mention the Fort Collins Courier for its gratuitous publication of the weekly river bulletins, and the furnishing enough slips to send to the ditch men and papers of Northern Colorado.

Thanking the Committee for their active support, this report is respectfully submitted.

L. G. CARPENTER,
Meteorologist and Irrigation Engineer.

December 14, 1898.

Report of the Rainbelt Experiment Station.

To the Executive Committee of The State Board of Agriculture:

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

The season of 1898 was the shortest in the history of the Station. Snow fell May 1st, accompanied by a severe storm which did considerable damage to young cattle on the range. Then a severe snowstorm occurred September 10th.

Planting was delayed on account of the ground being too wet to work during the first ten days of May. The season continued to be favorable for crops until towards the last of July, when dry weather at critical periods cut down the yields of many very promising crops.

The following table shows the precipitation at this Station from the time record-keeping began until the present:—

	1894.	1895.	1896.	1897.	1898.	Means.
January	...	.67	.45	.26	.03	.35
February	...	.27	Tr.	.10	.00	.09
March	...	.16	.71	1.58	.61	.77
April	...	1.67	3.41	1.20	2.20	2.12
May	...	1.46	2.28	1.44	5.54	2.68
June	.48	2.69	3.03	2.22	3.95	2.47
July	1.99	6.38	2.27	4.19	2.09	3.38

	1894.	1895.	1896.	1897.	1898.	Means.
August	1.03	1.22	3.07	3.24	1.33	1.98
September	.14	Tr.	.84	.92	2.00	.78
October	.14	.21	.78	2.73	....	.96
November	.00	.30	.00	.10	...	.10
December	.55	.42	.60	.20	...	.44

The crops were planted according to the schedule. All crops on the special schedule were cultivated carefully as in past years, but the south half of the cultivated land was planted to sorghum and millet and allowed to produce what it would without further attention. Light crops of fodder were cut from the south half of the field; but that which received special care yielded fair crops of forage.

The small grain was all cut when in the dough stage, except small plats which were left to mature seed for the purpose of estimating the yields. According to the schedule, all small grain was to be planted by the "Campbell Method," so all planting was delayed until after the sub-surface packer arrived, April 25th.

HORTICULTURE.

All forest trees have made a good growth this year. The wind-break around the orchard, composed of ash, black locust, and Russian mulberry, now affords considerable protection. In the spring of 1897, seeds of black locust, black cherry, red mulberry, Russian mulberry, and box-elder were planted. None germinated last season except the black locust, and the seedlings from these are now five feet high. The box-elder and black cherry seeds came up this season, and the seedlings are about a foot high.

All fruit trees have grown well. None has died since the last report.

The standard cherry trees bore some fruit this year. The Rocky Mountain cherry trees were loaded, as usual, with fruit, which, for all ordinary purposes, is worth-

less. The plum trees bore a small quantity of fine fruit. The gooseberry bushes bore a heavy crop of extra fine fruit. Two Missouri Pippin apple trees blossomed, but dropped their fruit before it matured.

Two dozen seedling peach trees have been grown this year from pits planted here. They appear to be quite healthy.

THE GARDEN.

Good yields of various garden crops were produced. Salzer's tree bean yielded especially well. It seems to be the bean to plant here instead of the Navy bean, which does poorly in this region.

The melons, squashes, cucumbers, and pumpkins were planted just before a heavy rain. The rain packed the ground so hard that but few of the plants came up, and these did not grow well. A few melons of good quality were produced.

Fifteen varieties of sweet corn were planted May 18th. From these, roasting ears were used from July 26th until September 25th. The best varieties this year proved to be Maule's First of All, Black Mexican, Early Bonanza, Nonesuch, New Champion, Country Gentleman, and Egyptian. These came into roasting ear in the order named. All these varieties produce ears which are long enough so that a worm can live happily and eat all he needs, while there will still be a good-sized roasting ear left for the table.

Queen's Golden and White Pearl pop corn made good crops.

Parsley, anise, sage, and upland cress were added to the list of garden crops which do well in this region.

Irish potatoes were a poor crop here this year. The earliest varieties got a good start before the beetles attacked them, and made a fair crop. The Early Sixweeks, Early Ohio, and Early Montana made the best yields. The late varieties were so damaged by the beetles that we may call them total failures. The vines

were kept covered liberally with Paris green from the time the beetles began to come until late in the season. But as soon as one horde of beetles would eat and die, another moved in to commit suicide in the same way, until the vines were completely defoliated and some of the stems eaten into the ground.

I furnished a small quantity of seed potatoes to a neighboring ranchman. His were early sorts, and were planted the first week in June. He reports a yield of 60 bushels per acre.

FIELD CROPS.

California Barley—Two acres were sown broadcast upon corn stubble, April 30th, and disced in. All except a small plat was cut for hay. The test plat showed a yield of 18 bushels per acre.

Bromus inermis—Two acres were sown to bromus inermis, April 30th, on deep-plowed ground, a part of which was packed with a Campbell sub-surface packer. A good stand was obtained. Some on high land died during a dry time in the summer, but there is still enough left to make a fair test of the value of the plant for hay.

Alfalfa—One-half acre of alfalfa was sown in May 1897. This was cut in June of this year, making a yield of a ton per acre. It did not grow high enough to cut again during the season.

Other Forage Plants—Eight varieties of non-saccharine sorghum, four varieties of cow peas, one of Canada field peas, and one of Idaho peas were planted on ground plowed eight inches deep and packed. All these were carefully cultivated.

The following table shows the yields:—

Kaffir corn No. 39, 12 bushels seed per acre.
Brown Duhra, 20 bushels seed per acre.
Jerusalem corn, 15 bushels seed per acre.
Red Kaffir corn, 5,320 pounds of fodder.
White Kaffir corn, 6,720 pounds of fodder.

Black-hulled White Kaffir corn, 6,565 pounds of fodder.

Black Rice corn, 4,970 pounds of fodder.

Yellow Milo-maize, 5,110 pounds of fodder.

Kansas Orange sorghum, 8,400 pounds of fodder.

Early Amber sorghum, 6,192 pounds of fodder.

Black-eyed cow peas, 6 bushels of seed.

Black cow peas, 1.5 bushels of seed.

Whip-poor-will cow peas, only a few pods matured.

Clay cow peas, only a few pods matured.

Idaho peas, 11 bushels of seed.

Canada field peas, 8.5 bushels of seed.

Red Kaffir corn, White Kaffir corn, and Kansas Orange sorghum failed to mature seed. Yellow Milo-maize, Black Rice corn, and Early Amber cane produced some mature seed.

THE USE OF GYPSUM.

A plat extending across a patch of land which had never yet produced a crop on account of some unknown qualities it possessed, was treated with gypsum at the rate of one thousand pounds per acre. This plat and another adjoining one were planted to Early Amber cane the same day. The cane was planted in rows with a planter drill. Both plats were cultivated alike. The crops growing on the two were cut the same day. After curing, it was found that the treated plat yielded 2,880 pounds of fodder per acre, while the untreated yielded but 1,620 pounds of fodder per acre, making a difference of 1,260 pounds of fodder per acre which seems to be due to the use of gypsum. In harvesting the crop, the barren spot could hardly be noticed on the treated plat.

MIXING CORN.

In this region, where hot winds are likely to blow at critical times, the corn crop is frequently an entire failure on account of a day of hot winds. The hot winds,

coming when the tassels are in blossom, kill all the pollen and thus leave the seeds unfertilized. If only one variety of corn is planted in a field and all is in tassel when a hot wind blows one afternoon, it will produce but a few ears. But, if a number of varieties which blossom a few days apart are planted, some tassels will escape the hot wind and live to fertilize many ears, thereby increasing the yield considerably. With this in mind, we made three mixtures for planting this year. The seed was chosen from the crop grown here in 1897. Six varieties of white dent were mixed for white dent. Eight varieties of yellow dent, and twelve varieties of flint were mixed to plant for flint corn. These mixtures were planted in separate plats. Each was thinned to two stalks in a hill, and all suckers were pulled off. After it tasseled, all stalks which had no ears started were de-tasseled so that no barren stalk could reproduce its kind. The corn grew well, but as no hot winds occurred during the blossoming period, we can not say that any gain resulted from the mixing of varieties. We shall choose the best matured ears from the strongest stalks for next year's seed, and hope to get a number of cross-bred ears for future use.

We have found that varieties of corn do better here after they are acclimated. So, we hope to produce a few "natives" by the process above described. It is a haphazard way of crossing, but is just what any farmer can do for himself and what most farmers have done either accidentally or purposely. We believe that the idea should be more used in this region, where our climatic conditions make it necessary.

VARIETIES OF CORN.

Twenty-two varieties of corn were planted. The following table gives the yields of the different varieties:—

	Variety.	Kind.	Bushels per acre.
1	Mercer	Flint	14.0
2	Houghton's Silver White	Flint	13.1
3	Sanford's Early	Flint	14.6
4	Waushakum (yel.)	Flint	8.6
5	King Philip	Flint	13.4
6	Squaw	Flint	12.3
7	N. D. Flint	Flint	13.0
8	S. D. Flint	Flint	8.6
9	Golden Row (yel.)	Dent	15.4
10	Angel of Midnight	Flint	8.6
11	New Leaming (yel.)	Dent	10.8
12	Star Leaming (yel.)	Dent	11.7
13	Parson's White	White flint	16.0
14	Murdoch's 90-day (yel.)	Dent	10.0
15	Early Yellow Rose (yel.)	Dent	8.6
16	Dakota Dent (yel.)	Dent	10.8
17	Queen of the Field	Yellow dent	12.3
18	Queen of the North	Yellow dent	13.1
19	Early Huron	Yellow dent	4.5
20	Canadian Yellow	Yellow dent	9.6
21	White Cap Yellow Dent	White dent	12.6
22	Swadley White	White dent	13.1

According to the experience of this Station, and also of the settlers here, the most reliable varieties of corn for this region are those which mature in from 90 to 100 days from planting.

THE CAMPBELL METHOD OF SOIL CULTURE.

What is commonly called "The Campbell Method of Soil Culture" has been so extensively advertised, and so much has been claimed for it, that it was thought best to give it a careful trial at this Station.

Mr. B. A. McAllaster, of the Land Department of the Union Pacific System, kindly loaned us tools for this purpose.

The ground for small grain was plowed and packed April 25th to 27th, and the grain was drilled immediately with a press drill across packed and unpacked ground. A part of the grain was cultivated after rains with a Campbell Jr. cultivator. All except enough to test the yield was cut for hay. The following table shows the results given in bushels per acre:—

	Packed.		Unpacked.	
	Cultivated.	Uncultivated	Cultivated	Uncultivated.
Wheat, Blount's No. 16.....	3.50	3.75	4.75	4.50
Oats, Black Russian.....	18.00	23.00	30.00	27.00
Rye, Giant Spring.....	5.25	5.00	5.15	4.10
Barley, Beardless.....	22.6	20.60	25.70	14.60

Early Amber Cane—One and one-half acres were planted to Early Amber cane May 25th. All the land was plowed eight inches deep and three-fourths of it was packed. The seed was planted with a planter drill. The cane was all carefully cultivated until August.

The cane on the packed ground yielded 6,444 pounds of dry fodder per acre, while that on the unpacked ground yielded 5,940 pounds per acre, a difference of 504 pounds for packing.

CORN.

Four acres were planted May 21st to corn. The same method was used in preparing the corn land as in the case of the sorghum plats. The corn was planted in check rows, by hand, three grains in a hill. The seed was Yellow Dent, White Dent, and Flint, grown at this Station in 1897. It was chosen from the best of six varieties grown. All was carefully cultivated after each rain and more frequently when conditions seemed to require it. The suckers were pulled off, and all weak stalks were removed after they had shown their form. It was also thinned to two stalks in each hill. The following table shows the results:—

Variety.	Packed. Bu. per acre.	Unpacked. Bu. per acre.	Differences. Bu. per acre.
White Dent	10.5	10.9	.4 Loss
Yellow Dent	13.4	8.7	4.7 Gain
Flint	14.3	12.6	1.7 Gain

Potatoes—One-fourth of an acre was planted to Carman No. 3 potatoes, May 13th. One-half the ground was packed and one-half left unpacked. The potato beetles committed such depredations in this section of the field that only a few tubers were produced.

REMARKS.

1. All ground in this test was plowed eight inches deep.

2. All ground not packed was thoroughly harrowed as soon as it was plowed.

3. All crops in this test which are usually cultivated were cultivated alike on both packed and unpacked land.

4. The moisture in the soil was tested a few times during the season by sampling with soil sampling tubes to a depth of one foot, and to the depth of six feet with a sampling auger. It was found that immediately after a rain, the upper foot of the unpacked plats contained more moisture than the upper foot of the packed plats. Later, the reverse was the case. Also, the moisture falling upon the unpacked plats sank deeper into the ground than that falling upon the packed plats. Later in the season, after several rains had fallen and all plats had been cultivated several times, the differences were not so noticeable.

We give no figures here because we had not the time to make as many moisture determinations as we wished, but could go over the ground only in a general way. It is possible that with more work in this line, we should be forced to draw different conclusions.

STUDY OF EVAPORATION.

Tools for use in these experiments were ordered April 15th, but many delays caused by non-arrival of essential tools and inability to get help when needed, prevented work in this line before July 1st.

We had planned to determine the amount of water used by a crop of corn in this region, but it was considered too late to give this matter a fair test by the time the necessary tools were at hand, so evaporation from water and soil surfaces was tested during the remainder of the season.

EVAPORATION FROM WATER SURFACE.

Two galvanized iron cans eighteen inches in diameter and fifty-two inches deep were set close together in the ground so that the tops of the cans were on a level with the surface. These were filled with water. During July, the evaporation was 11.38 inches. Both were exposed equally to the action of the sun and wind during this time. August 1st, one was screened from the direct rays of the sun and the other was left uncovered. From August 1st until September 24th, the one in the shade lost 14.75 inches while the one in the uncovered can lost 18.43 inches.

The can which was uncovered was left until October 3d, when it was found that it had lost 35.31 inches during the time from July 1st until October 3d, or 95 days.

EVAPORATION FROM DIFFERENT TYPES OF SOIL.

In this test four types of soil were used. No. 1 is a soil very common here on level upland. It is of a mulatto color, containing a small per cent. of clay, considerable sand, and enough lime to cement it so that it is quite hard when in its natural condition.

No . 2 is a type found on a hilltop. It is a very fine black soil upon which very little vegetation has grown since the Station has been in operation.

No. 3 is a rich clayey soil of a dark color, upon which all crops grow well whenever the location is such that the crops are supplied with water in moderate quantities. The best crops grown on the farm grow upon this type of soil.

No. 4 is a fine light-colored soil commonly called "gopher clay." Where it crops out, it supports quite a scanty vegetation, as a rule. It occurs in many places as a subsoil.

One can, eighteen inches in diameter and fifty-two inches deep, was used for each kind of soil. The cans were filled as the soils occur in nature. Subsoils occupied the lower parts of the cans, but the upper eight inches were filled with the types to be tested. All cans were placed side by side in a trench so that their tops were on a level with the surface of the ground. They were weighed at the beginning of the experiment and at intervals through the summer. Water was added from time to time to all the cans at the same time. The water was introduced through a piece of gas pipe which extended two and one-half feet below the surface. In this way water equal to three inches of rainfall was added to each can of soil, besides the natural rainfall. Nothing was allowed to grow on any of the soils. After standing 85 days, the amount of loss was estimated. It was found that type No. 1 had lost water at the rate of 1,038 tons per acre; type No. 2 at the rate of 527 tons per acre; type No. 3 at the rate of 435 tons per acre; and type No. 4 at the rate of 600 tons per acre. None of this soil was cultivated. Four other cans just like the ones described were filled with subsoil and soil of type No. 1. In two of these, millet was planted, while two of them were left bare. After 85 days it was found that the average loss from the bare soils was 905 tons per acre, while the average loss of the two upon which millet was growing was 1,056 tons per acre. The millet grew to be only four to six inches high before it formed heads. Three inches of water besides the rainfall was added to each of these cans also.

Another test of evaporation from soil surface was in connection with a wind-break test. Twenty galvanized iron buckets, each eleven and one-half inches in diameter, were all filled to the same level with the same kind of soil and sunk into the ground so that their tops were on a level with the surface. Ten of them were in buffalo grass sod and ten in a millet field. Their positions represented a sufficient variety of exposure and protection to make a fair test, and to consider that they would represent average conditions on the farm for that type of soil. Type No. 1 of the soil was used, as representing the widest area of any of the soil types found here.

The buckets were left in position sixty days. Water was added to each bucket occasionally by means of glass tubes which reached nearly to the bottom of the buckets. In sixty days, beginning July 13th and ending September 13th, the average loss of water per acre from the soil in the buckets was 705 tons. Nothing was allowed to grow in the soil in the buckets. The soil was left unstirred.

INFLUENCE OF A WIND-BREAK UPON EVAPORATION FROM SOIL SURFACE.

In 1896, twelve rods of sod wall were built east and west across a field of buffalo grass which sloped to the south. In 1897, this wall was extended eight rods by building a tight board fence. All the wall and fence was made four feet high. Buckets were placed in the ground on each side of the wall. All the buckets were filled alike with the same type of soil. On the north side, the buckets were placed at one, three, five, seven, and ten rods distance from the wall. On the south side, they were placed one, three, five, seven, and eight rods distant. The table below shows the results of evaporation from the pairs of buckets during 62 days, from July 14th to September 14th.

North side of Wall, in sod.	Evaporation—tons per acre.
Buckets one rod from wall	677
Buckets three rods from wall	633
Buckets five rods from wall	700
Buckets seven rods from wall	703
Buckets ten rods from wall	712
South of wall in millet field.	
Buckets one rod from wall	647
Buckets three rods from wall	686
Buckets five rods from wall	738
Buckets seven rods from wall	764
Buckets eight rods from wall	761

Some negative results are apparent here, but the general results show that the wind-break did save moisture. We do not feel able to explain the differences which appear. As an experiment to test the influence of wind-breaks upon evaporation, we consider it very unsatisfactory, but for testing evaporation from soil surface, it shows some interesting figures. The location of the buckets was such that their weights could be but little, if any, affected by the blowing of dust which had been considered as the greatest source of probable errors in this test.

ADDITIONS TO TOOLS AND APPARATUS.

A Campbell sub-surface packer and a Campbell Jr. cultivator were furnished the Station by the Union Pacific System for use as long as ten acres of the station land are devoted to testing the "Campbell Method of Soil Culture."

Ten galvanized iron cylinders, 18 inches in diameter and 52 inches deep, for use in testing evaporation and also in testing the amount of water used by plants, three dozen galvanized iron buckets for general use in soil work, one evaporating oven, four dozen evaporating

dishes, twenty feet of special copper tubing, thirty-five soil-sampling tubes, and one special weighmaster's beam have been added to the apparatus for the study of soils and other problems.

CONCLUSIONS.

The Station has been in operation five seasons, and during that time no grain crop has been produced which would pay if the producer had to depend upon the sale of it for his living. Fair crops of fodder have been raised each year since the first, when the seed was planted on sod. That year was an extremely dry year, but enough fodder was raised then to feed the station stock until the next season's crop was ready for use.

No fair test of fall grain has yet been made. Fall grain was sown but one year on the Station soil. Some good crops of fall wheat have been raised in this county.

The cost of producing fodder is the most important question to be considered in this region. It is believed, from our experience here, that fodder can be produced, on a large scale, at a cost of not to exceed two dollars per ton. The figures below show the estimated cost per acre of growing fodder.

Preparation of ground and planting	$1.00
Seed	.10
Cultivating three times	1.20
Cutting and putting in shock	1.00
Total	$3.30

The yield of the Kaffir corns and of Early Amber cane is usually between one and one-half and five tons per acre. If improved harvesting machinery be used, we believe that the cost of putting fodder in the shock would be still less than the above estimate, which is based upon the use of sled cutters in harvesting the fodder.

ACKNOWLEDGMENTS.

Members of The State Board of Agriculture have greatly assisted me by their sympathy with my efforts to make the most of conditions here. I have also been helped very much by suggestions from members of your Committee.

Respectfully submitted,

J. E. PAYNE,
Superintendent.

Cheyenne Wells, Colorado, October 15, 1898.

Report of the Arkansas Valley Experiment Station.

To the Executive Committee of The State Board of Agriculture:

Gentlemen—Herewith is presented the Eleventh Annual Report of the Arkansas Valley Experiment Station.

My connection with this Station dates from March 1, 1898, at which time the schedule of the season's work had been adopted: hence the most of my duties have been to carry out the line of work laid down therein, as far as conditions would permit.

The present year has been an unfortunate one for the agricultural interests of a large portion of the Valley, including the Station.

On the 6th day of June, a severe hailstorm devastated this section, and for the time being thrifty crops were transformed to a bare waste.

Nor was the destruction of the crops the only severe feature of the storm affecting subsequent agricultural operations, as is evidenced by the poor mechanical condition of the soil induced by the severe flooding.

For nearly eight hours most of the station land was under water to a depth of about eight inches, the effect being thoroughly to compact what was previously a loose, mellow soil, which conditions could not be overcome by surface cultivation.

The season, in general, has been characterized by an excess of rain and by moist conditions, causing heavy

dews. An unusual amount of fungous diseases has been prevalent.

During the storm referred to, 2.08 inches of rain and hail fell in two and one-half hours.

Subsequent to this, and of results almost as disastrous as the previous one (except no hail), was the storm of July 8th, when 1.5 inches of rain fell in a few hours; sufficient again to place the station land under a considerable depth of water.

An excess of water is very detrimental to the soils of this Valley, especially so if allowed to stand. Better results would often be obtained by more cultivation and less irrigation.

AGRICULTURAL DIVISION.

Wheat—The wheats grown for a comparative test were destroyed by the hail of June 6th, at which time they were well headed.

The last week of September 1898, twenty-one varieties, including some Russian wheats, were sown on 2.8 acres of land.

March 17th, 350 pounds of Polish wheat, or Mammoth rye, were sown on 3.7 acres of land. This seed came up nicely without irrigation, and the crop was looking well at the time of the hail, just as the heads were forming.

All the main stalks were destroyed; the tillers afterwards grew and produced 35 bushels of grain.

We consider this grain a valuable one that promises to enter largely into feeding rations. It produces well with but little water, and is especially valuable for lands under canals with scant water supply.

Corn—Test on culture; cultivation *versus* irrigation. The schedule called for nine acres to be laid off into plots of one acre each and treated as given in Table I.

TABLE I.

No. of plot	No. of cultivations.	No. of irrigations.
1	3	3
2	3	2
3	3	1
4	2	3
5	2	2
6	2	1
7	1	3
8	1	2
9	1	1

Table II. gives the dates of cultivation and irrigation, together with the yield.

TABLE II.

No. of plot.	Yield in pounds.	Dates of cultivation.	Dates of irrigation.
1	1,775	July 6 and 12, Aug. 4	July 22, Aug. 8 and 23
2	2,010	July 6 and 13, Aug. 4	July 22, Aug. 9
3	2,005	July 6 and 13, Aug. 4	July 30
4	2,120	July 7 and 12	July 23, Aug. 8 and 23
5	2,115	July 7 and 13	July 23, Aug. 9
6	1,695	July 7 and 13	July 30
7	2,395	July 12	July 27, Aug. 8 and 24
8	2,215	July 12	July 27, Aug. 9
9	1,685	July 12	July 29

This land was planted to Golden Beauty corn on May 14th, and at the time of the hail was up, in good stand, about four inches high. The storm reduced the stand considerably by covering some hills with mud.

The whole crop had received the same attention up to July 6th; viz., one cultivation with shovel plow to kill small weeds, and after the hail the use of an Acme plow to stir the soil. Some hogs running at large de-

voured a considerable quantity of corn on Plat 1, and for this reason this plat must be eliminated in drawing any conclusions.

The fertility of this soil was not uniform, as we afterwards learned; cattle having been fed upon plats 7 and 8 the previous winter.

In general it may be said, that corn should seldom be irrigated until near the time of tasseling; after which one more irrigation will be sufficient to produce the crop.

Corn on alfalfa sod—This is the third year corn has been grown continuously on this land (4 acres) for the purpose of testing how long the fertility of alfalfa will remain.

One and one-half acres near by were planted at the same time as a check upon this work. The first mentioned produced 8,470 pounds of ear corn, equivalent to 30.2 bushels per acre, of 70 pounds each.

The latter portion produced 3,535 pounds of ear corn, or 33.6 bushels per acre.

The appearance of the corn during growth showed very plainly that the fertility from the alfalfa had been exhausted. The unhealthy, yellow appearance showed that the supply of nitrogen was not sufficient for a maximum crop. On the check portion (a soil naturally much weaker), the growth was rank and of a dark healthy green.

Grasses and Forage crops—Under this head, as outlined in the schedule, the following were sown:—

Turkestan alfalfa, Italian Rye grass, Brome grass (*Bromus inermis*), Tall Meadow Oat grass, Kentucky Blue grass, Sheeps' Fescue, Meadow Fescue, Idaho coffee pea, Mummy field pea, Southern cow pea, Soja bean, Rape, and Hairy Vetch.

The alfalfa and brome were sown April 14th and a good stand secured, but the hail beat them to the ground so severely that the weeds took the start and choked them out.

The alfalfa was sown September 9th, and promises to do well.

The rye grass and fescues are also a failure, due to hail and weeds.

The meadow grass was not sown until June 28th, and promises to be of value.

Some are growing the Kentucky blue grass for pasture. It can not be utilized for this purpose except where water is abundant. We are of the opinion that fall is the preferable time to sow this grass, as the weeds do not then become so troublesome.

The Idaho and field peas were severely injured by the hail. Of the former, we threshed 300 pounds, or nearly 14 bushels per acre. It is probable that under normal conditions 30 bushels per acre can be grown.

Early field peas might be grown to a profit. As a food for young hogs during the summer months, when growth and not fat is desired, they are excellent.

The hail required us to replant the cow pea and soja bean. The former ripened but few seeds; only the earliest varieties will be productive here. We think it a plant of much value, both for its grain and as a fertilizer for small tracts.

The Hairy Vetch—This we wish to test both for its value as a forage plant and green fertilizer. Two sowings were made, May 23d and again in July. Early sowing of this plant is not desirable as but little growth is made during the hot weather. Further time is necessary to determine its value.

Essex Rape—An early planting was destroyed by the flea beetle.

A second planting, August 3d, made a growth of 12 to 16 inches, but we do not consider it a desirable plant here.

Since the Station has been in operation, tests have been made of most of the more common grass and forage plants. But three were growing when I assumed charge, *Bromus inermis*, orchard grass, and red clover. A test of the first for the past six years has not established it as a pasture grass for this section. It commences to grow quite early in March but in summer does but little, again

making some growth in the fall. We think in sections of greater rainfall and lower mean temperature it would prove valuable. However, to test it still further, a fall sowing has been made and is doing well.

From our present knowledge we consider orchard grass the best one for pasture purposes. It thrives either alone or in connection with alfalfa. At the time of the hail it stood from 2½ to 3 feet high. It resists drouth well, and for pasture or to improve the quality of alfalfa it can be advantageously used.

GARDEN.

Celery—Three varieties of celery were grown, White Plume, Golden Self Blanching, and Boston Market.

This plant requires a moist, cool, loamy soil made very rich by heavy manuring.

Our trials have shown the following particulars must be observed:—

Run off quite deep furrows east and west and place the plant on the south side of them to insure partial shade. None but the strongest plants should be used, as the smallest will not survive the heat.

For a time, after transplanting, almost constant irrigation must be given. Of the two early varieties we much prefer the White Plume for its richer and better flavor.

The only method of blanching used was with earth. More extended notes are reserved for the future.

Potatoes—Our trials comprised five varieties, Burbank, Barclay's Prolific, Rose Seedling, Prolific Rose, and Mammoth Pearl.

On a half acre plat, May 2d, twelve rows, each 100 feet long, were planted to the Rose Seedling variety to compare the time of planting with that of a later date. May 25th, the remainder of the half acre was planted to the above varieties; twenty rows being of the Rose Seedling.

To five rows of this variety wood ashes were applied in the furrow. A top dressing of 150 pounds of gypsum was applied to six rows June 28th.

The following table gives the area and yield of the different varieties; no mention being made of those too small for seed purposes.

Variety.	No. of rows each 100 feet.	Total yield in pounds.	Yield per acre in bushels. Estimated.
Rose Seedling	9	116	31.1
Burbank	7	400	138.0
Barclay's Prolific	7	275	94.8
Mammoth Pearl	8	300	90.5
Rose Prolific	8	315	95.0

From the five rows treated with ash we secured 40 pounds, from those treated with gypsum 90 pounds, and from the twelve rows planted May 2d, 98 pounds. Our experience, as well as the tests of former years, has shown that the early plantings are not successful nor are early maturing varieties as productive as the late maturing ones; that to insure success late blooming varieties and late planting are essential.

As a further test six rows each (100 feet long), were planted of the Burbank and Rose Seedling varieties and covered with straw to a depth of eight inches.

The former yielded 182 pounds and the latter 72 pounds. There is no advantage in this method; the potato requiring cultivation to secure best returns.

A difference in the mechanical condition of the soil was noticeable where gypsum had been applied; its tendency being to make it more mellow and friable.

The soil and climate here do not favor the potato, but we see no reason why by judicious planting and irrigation the farmer should not supply his own needs.

Of the varieties tested we much prefer the Mammoth Pearl on account of its smooth growth and uniform size.

Sugar-beets—One-half acre of beets was grown, under instructions from the Agricultural Section of the

College, to derive information in regard to the following:—

(a) The best time to plant.
(b) The proper depth to plant.
(c) The quality of water required.
(d) Irrigation *versus* natural moisture for the germination of the seed.

Four plantings were made, April 18th, May 2d, May 16th, and June 1st.

The plants from all sowings (except June 1st), were up at the time of the hail and were greatly injured by it. The rainfall this year has been sufficient to grow good beets. From a plat planted to the Vilmorin variety, and irrigated four times, 1,300 pounds were harvested; from the same amount of land without irrigation, 1,315 pounds; and from the plat receiving one irrigation, 1,365 pounds. Our work shows that 18 inches between the rows is not sufficient where irrigation is employed; that two feet is close enough, and where the product is designed for stock use a still wider distance is preferable.

The half acre produced a total yield of 7 tons and 855 pounds.

As the work with the sugar-beet will probably appear in bulletin form, further details will not be entered into in this report.

HORTICULTURAL DIVISION.

Orchards—Twenty-nine varieties of apples, in the old orchard, put forth bloom from the 24th to the 30th of April.

The hail destroyed all of the first set except those of the Ben Davis variety, which were afterwards used in taking notes upon the codling moth. But two varieties of pears remain in the orchard (Keiffer and Longworth), which blighted in the bloom.

The work with the blight has comprised; first, spraying with the Woodbury Blight Cure and with the Bordeaux mixture; second, to determine to what extent the

blight may be carried to healthy trees in the operation of pruning and to note the efficacy of a germicide upon the implements employed.

In the spraying experiments, trees were left in such localities as carefully to check our work, and the results of this year show that no benefit is derived from either of the mixtures used.

The directions for applying the former, together with the Woodbury wash, were strictly adhered to, and had the farmers of this vicinity been content to allow the Station to test it before they purchased, hundreds of dollars might have been saved to them this year.

All vacancies in the young orchard were filled with the same varieties as formerly set, as far as they could be obtained.

Nearly all these trees had commenced a good growth when the hail of June 6th stripped them of their bark from the ground to the top of the tree.

The stone fruits repair the damage done by such storms much more rapidly than do apples or pears.

There are in this orchard at present 119 trees, comprising apple, peach, plum, cherry, quince, apricot, and nut that appear to have survived the storm sufficiently to remain.

Of the elm trees set along 80 rods bordering the avenue, all but one are living.

INSECTS AND FUNGOUS DISEASES

Experiments to ascertain the per cent. of wormy to non-wormy apples were conducted upon eleven Ben Davis apple trees.

The same trees were also used to determine the number of worms going down the tree compared to those going up.

The results of the work have been reported to Professor Gillette, and further investigations along this line are contemplated.

The Striped Cucumber beetle, which is very destructive to the cantaloupe plant, first appeared (in increased numbers) during the last week of May. Experiments as to the best means to combat this insect were conducted but were not completed owing to the destruction of the plants by the hail.

The remedies used were Paris green, tobacco water, kerosene emulsion sprays, and dusting with a mixture of lime and Paris green.

The emulsion is the only effective remedy of those above mentioned. Dusting the plants with lime and Paris green answers for a short time, but the beetles may soon return.

Notes were taken upon the Strawberry Leaf-roller, and upon an adjoining patch we are studying the efficacy of burning the vines in the fall to rid them of this insect.

The 8-Spotted Forester, which eats the leaves of the grape in May, is successfully combatted with a Paris green spray (10 oz. to 10 gallons of water).

A poison spray is effective for the Yellow-Necked caterpillar, which destroys the foliage of the apple.

Cottonwood-leaf beetles appeared in abundance upon the trees belonging to the poplar family. A poison spray may be used to combat them.

The Melon louse appeared upon the cantaloupe vines in a few localities. It is important that this insect should be at once exterminated to avert serious injury to an important industry. Some information to this end was given our farmers by means of the local press.

A fungous disease affecting the cantaloupe has proven quite serious in a few localities.

In conjunction with Professor Crandall, we are investigating the subject, and experiments to control it may be entered into another year.

The bean blight has proven quite serious and suggests future study.

Mildew was more troublesome than usual on account of an unusually moist season.

METEOROLOGY.

Records of temperature, hygrometer, precipitation, wind, clouds, and sunshine have been kept and reports sent monthly to the Department of the College and to the Weather Bureau in Denver.

FERTILIZERS.

Decomposed gypsum and wood ashes constitute the fertilizers employed for experimental purposes.

Upon 124 square rods of land, that had previously received so much water as to destroy its productiveness, gypsum was applied to alternate plats. This land had been plowed in the fall and coarse manure spread upon it during the winter. In the spring the soil appeared quite mellow and apparently the freezing and thawing had put it in proper condition for crops. It was again plowed this spring and corn and beans (which are widely different in character) selected as the crops to be grown upon it.

Upon one-half (43 square rods) the area planted to beans, 375 pounds of gypsum were applied as a top dressing. The blight seriously affected them and a yield of 156 pounds was secured from the plat receiving gypsum, while that receiving no application returned 150 pounds. Three plantings were required to secure a stand of corn upon this soil; there seemed to be some condition not favoring germination. The stand that was secured was late, making an excellent growth of stalk but not thoroughly maturing the grain.

From 18.7 square rods receiving gypsum 276 pounds of ear corn was obtained; from the same area, but no application, 178 pounds were taken. Brome grass was not benefited by an application of gypsum. We also applied it to trees, but time is needed to determine results. Our work with gypsum this year was not intended to be more than preliminary.

While we do not look for any *decided* benefits from its application to soils similar to those of the Station, yet there is much land in this Valley that would be greatly benefited by its use, as we know from former trials with it under similar conditions.

FEEDING EXPERIMENTS.

An important line of work was inaugurated this fall when fifteen calves were purchased for experimental feeding.

ALFALFA.

About three acres of land was seeded to alfalfa, September 9th, and at the present writing it is looking well. About 30 tons of alfalfa hay, which will be used for feeding purposes, have been put up.

CONCLUSION.

Many items of importance accumulate, in the course of experimental work, that can not be enumerated in a report like this, but may prove to be of much value in the work of the future.

Respectfully submitted,

H. H. GRIFFIN,
Superintendent.

Rocky Ford, Colorado, November 30, 1898.

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