



GIRLS' BUILDING.

ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

OF THE

UNIVERSITY OF MINNESOTA.

Fiscal Year July 1, 1897, to June 30, 1898.



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OFFICERS OF THE STATION:

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WILLET M. HAYS, M. Agr.,	Agriculturist.
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OTTO LUGGER, Ph. D.,	Entomologist and Botanist.
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THOS. SHAW,	Animal Husbandry.
T. A. HOVERSTAD, B. Agr.,	Asst. in Agr., Crookston.
ANDREW BOSS,	Asst. in Agr., Univ. Farm.
R. S. MACKINTOSH,	Asst. in Hort., Univ. Farm.
J. A. VYE,	Secretary.

The Bulletins of this Station are mailed free to all residents of the State who make application for them.

MINNEAPOLIS, MINN., July 1, 1898.

To His Excellency, David M. Clough, Governor of Minnesota:

I have the honor to transmit to you herewith the annual report of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1898.

JOHN S. PILLSBURY,
President Board of Regents.

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REPORT

OF THE

Director of the Experiment Station Corps.

This annual report of the agricultural experiment station of the University of Minnesota contains copies of the bulletins published during the year from June 30th, 1897, to July 1st, 1898, inclusive, and a detailed statement of the receipts and expenditures of the annual appropriation from the United States treasury. Following this is a summarized statement of receipts and disbursements from June 30th, 1897, to July 1st, 1898, showing that the University of Minnesota has expended \$11,086.57 more in carrying on the experimental work than the "Hatch" fund (\$15,000) received from the United States government. Following this statement is a financial report of the two stations established by an act of the legislature in 1895, one at Crookston, Minnesota, the other at Grand Rapids, Minnesota. Also statement of the station previously established on the farm of Mr. O. C. Gregg, superintendent of the Farmers' Institutes of Minnesota, near Lynd, Lyon county, Minnesota.

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THE UNITED STATES APPROPRIATION, 1897-8.

Dr.		
To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1898, as per act of Congress approved March 2, 1887.....		\$15,000.00
Cr.		
By Salaries.....	\$10,196.60	
Labor.....	1,572.15	
Publications	271.00	
Postage and stationery.....	194.04	
Freight and express.....	4.23	
Heat, light and water.....	86.03	
Chemical supplies.....	203.09	
Seeds, plants, and sundry supplies.....	290.28	
Feeding stuffs.....	547.58	
Tools, implements and machinery.....	133.85	
Furniture and fixtures.....	4.00	
Scientific apparatus.....	52.50	
Live stock.....	1,048.60	
Traveling expenses.....	35.09	
Contingent expenses.....	261.16	
Building and repairs.....	99.80	
		<hr/>
	\$15,000.00	15,000.00

FINANCIAL STATEMENT.

Statement of disbursements and receipts of the Minnesota Agricultural Experiment Station for the twelve months beginning July 1st, 1897, and ending June 30th, 1898, inclusive.

	Disbursements.	Receipts.	Cash Outlay.
Station.....	\$ 9,464.20	\$ 523.79	\$ 8,940.41
Agriculture.....	5,741.57	310.02	5,431.55
Horticulture.....	3,703.10	688.87	3,014.23
Chemistry.....	1,916.65	105.60	1,811.05
Entomology.....	1,031.81	1,031.81
Veterinary.....	1,522.59	444.12	1,078.47
Dairy.....	1,349.99	1,349.99
Animal Husbandry.....	5,803.10	2,940.66	2,862.44
	<hr/>	<hr/>	<hr/>
	\$30,533.01	\$5,013.06	\$25,519.95
Crookston.....	4,594.84	1,845.67	2,749.17
Grand Rapids.....	2,410.90	1,156.60	1,254.30
	<hr/>	<hr/>	<hr/>
	\$ 7,005.74	\$3,002.27	\$ 4,003.47
Coteau.....	*566.62	566.62

*Paid by current expense.

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The work carried on at the Northwest experiment farm near Crookston under the supervision of T. A. Hoverstad, has been along the same lines outlined in the annual report for 1896. Much work has been done in putting the farm in condition for experimental work, in draining the land, and in making roads, fences, etc. The farm barn which was destroyed by fire, caused by lightning, July 28th, 1897, has been rebuilt. The damage done by this fire seriously delayed much work and made it impossible to carry out intended improvements. In field work, varieties of wheat, oats, barley, and flax have been tested. The better varieties have been grown in larger quantities and sold for seed to farmers in the various parts of the state. Forage and pastures from annual crops have been tried on a small scale. This has been carried far enough to show that in this field work can be carried on that will be fruitful of very much good to the farmer. Varieties of the different species of vegetables have been grown with great success. Small fruit bushes have been planted, fruit trees of apple and plum have been set in the orchard. So far the trees and bushes are too young to bear fruit, but they have nearly all made good growth. Several acres have been planted to forest trees with varying results. The grove planted in '96 now makes quite a respectable showing. Of the many species of grasses sown, some of the more recently introduced are very promising. Live stock experiments have been largely confined to horses. The purpose has been to determine the amount to feed a horse at work and when idle; the relative proportion of roughage to concentrates; and the relative feeding value of the various rough foods for the horse. In a smaller way experiments have been prosecuted in feeding and pasturing cattle, hogs, and sheep.

Warren W. Pendergast of the Northeast experiment farm located at Grand Rapids, Minnesota, died August 26th, 1897. He was entrusted with the responsibility of the superintendency when the station was located in the spring of 1896. From the first he gave vigorous attention to planning new fields, buildings, roads, fences, investigation of soils, drainage of swamps, protection of young timber, reforestation

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the burned areas, and the development of grasses, grain, and forage foods.

During the brief time he was engaged in this important work, he acquired much valuable information by his experience and observations and had plans for the future development of the station that merited approval. His marked ability, clear perception, strength of purpose in accomplishing work, his rare good sense in dealing with men and his splendid character peculiarly fitted him for the position he so ably filled. His loss is most severe. The work during the summer and fall of '97 was placed in charge of R. W. Clark, who was assisting Mr. Pendergast at the time of his death. On February 1st, 1898, Herman H. Chapman, a graduate of the State University and School of Agriculture, was appointed superintendent of the station and the work has been continued along the lines mapped out when the station was established. Much valuable information as to methods and cost of clearing lands in this region has been acquired. The farm now has 95 acres of land from which the stumps have been completely removed and practically freed from roots and stones. In the three years large fields have been transformed from a heavily wooded condition to one of perfect tilth, permitting the use of all modern farm machinery. The work of subduing the peat or muskeg swamp land is progressing very satisfactorily. An extensive open drain has lowered the water level in two of these swamps permitting the work of burning and breaking them to commence. The management of the fields is being carefully studied with especial reference to maintaining the fertility of that portion of the farm on which the soil is light and sandy. Manuring and the use of green manures and fertilizing crops is an important part of this work. The tests conducted the last three years to determine, as far as possible, the varieties of grain and other crops best adapted to the soil and climate, have placed a large store of information at the disposal of settlers in this region. Especial attention has been given to grain and root crops, including potatoes. It is hoped that a variety of corn will be developed that will far surpass any that can be grown there at present. A large quantity of an-

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nual forage crops of different kinds is raised on the farm to illustrate the practicability and advantages of this method of feeding dairy and other stock. Tests of the different grasses for permanent meadow are being conducted to show their hardihood and suitability to different soil conditions. The farm buildings are being remodeled and improved to serve as models for the incoming settlers. A large vegetable garden has shown the possibility of raising nearly all kinds of vegetables of the finest quality. A great many ornamental shrubs and flowers have been tested for hardiness. The orchard is now in its third year and a few varieties of apples and crabs give promise of being able to withstand the climate. Small fruits, as raspberries and strawberries, have been very successful. A part of the farm is devoted to experiments in tree culture in co-operation with the United States Division of Forestry. Seedlings and transplants of the White, Norway, Jack, Scotch, and Austrian pines, from one to three years old, show splendid growth. The co-operative experiment in the effect of locality on the vitality of seed has given instructive results.

The experiment work in charge of Wm. G. Smith at the Coteau Farm started in 1894 under Prof. Hays has resolved itself into a study of soil moisture, soil fertility, production of forage crops, and forestry protection. The soil moisture studies are facilitated very much by the use of an electrical device perfected by Dr. Milton Whitney, chief of the Division of Soils, Washington, D. C. The principle on which this method rests is that the electrical conductivity of soils varies regularly, according to fixed laws, with the amount of water in the soil. By this method the moisture conditions of the soil are noted daily instead of in periods of from ten to fifteen days as by the old method. The temperature of the soil is taken by the same device. Some two dozen temperature and moisture observations can be made with this device while one moisture determination is being made by the old method. Mulching, surface cultivation, spring and fall plowing, sub-surface packing and sub-soiling are tested for their moisture and temperature conditions with and without crops, the object being to find the treatment that not only

conserves moisture but which also gives rise to moisture and temperature conditions in which the decomposition of organic matter is quickly brought about and the best crops produced. A complete set of meteorological instruments furnished by the weather bureau enables us to secure a complete weather record to use in connection with the soil moisture and temperature work. This section of the state lies in the driest portion of Minnesota and the method of soil culture that will best conserve the soil water for the use of crops here should succeed elsewhere. During the past two years data have been gathered along this line that are being prepared for publication in a much more comprehensive form than anything of the kind presented before. When it is remembered that from three to five hundred tons of water are necessary in growing one ton of field crop the importance of this work is more evident. The soil fertility studies are shaped by the suggestion that the products of organic decay, uniting as they do with the inert minerals of the soil, give rise to important plant foods. The practical methods of thus building up the soil are being carefully studied. The significance of using a leguminous crop every fourth or fifth year to supply the food which the non-leguminous plants consume, is also receiving systematic attention. Adding organic matter to the soil by pasturing animals on summer crops and grass lands is also under way. This year three crops were grown on the same piece of land and each crop was pastured off as soon as ready. In this manner much organic matter is added to the soil. The size of fields and the cost of fencing comes up for solution in connection with this system of field management, while at the same time better crops may be grown. The value of this method of soil culture is to be compared with continuous wheat growing. Methods of grass and clover culture are a necessary study in connection with the soil fertility work. Much success attends the grass and clover experiments. The forestry plantation started in 1894 under the direction of Prof. S. B. Green is doing well. It is much appreciated by those who have heretofore been unsuccessful in tree growing. Quick growing trees, such as the willow and caragana, are

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planted for protection to the slower growing evergreens and deciduous trees. In this work we are aided very much by the active interest of Supt. O. C. Gregg on whose farm the work is done. He is having marked success in growing small fruits and orchard fruits aided by this system of forestry protection. In the field work he is giving substantial aid by shaping his farm into demonstration fields along the lines suggested by the experiment work.

The work in the division of agriculture is largely a continuation of that outlined in previous reports. The experiments in farm and field management are progressing year by year. The present year marks the end of the first cycle of five years in the rotation experiments in which the division of chemistry shares with the agricultural. The soil, soil water and the roots of field crops have been especially studied at University and Coteau Farms. The experiments with pastures, permanent, rotation, summer and shift, though requiring many years for their completion are progressing at University Farm, and at the outside farms co-operative work has been started. The efforts in seeking the best varieties of each kind of field crops for each portion of the state that better kinds may be disseminated are being continued and with the aid of three sub-stations valuable results are being reached. The breeding of the best varieties of our staple crops is being carried on with system and on a sufficiently extensive scale to insure good results. A good variety of corn has been disseminated and others are being bred for large yield and other good qualities. Several new varieties each of wheat, flax, timothy, field peas and bromus promise added yields. The methods of breeding plants are year by year being worked out in a manner which gives promise of important economic results. In connection with this breeding the floral organs of the leading field crops are being described and figures drawn. The gross anatomy of the stems and roots of the important crop plants likewise are being studied and sketches are being made for publication. Experiments are continued in preparing the soils. Methods of planting and cultivating the staple crops, harvesting and storing fodders are under experimentation. Prof. W. M.

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Hays and Mr. Andrew Boss express special satisfaction and gratitude for the loyal and efficient services of the various college and school students and the workmen who have been interested in this division during the past year. Training young men in the science and art of agricultural experimentation is a most important function of the station.

In the division of horticulture the experiment work has been done along about the same lines as indicated in the report of last year. No bulletin has been published but the reports of the division have been printed in the proceedings of the Minnesota Horticultural Society. A large amount of time has been used in preparing material for a text book on forestry for use in the School and College of Agriculture that will be published the coming year so as to be in readiness at the opening of the school. Considerable attention has been given to the care and management of the grounds about our school buildings, grading around and laying out drives adjacent to the new Girls' Building and Power House and to the laying of new cement sidewalks from the Home Building to the Laboratory and Drill Hall. A new and very complete card index system has been adopted for keeping the records of our orchards, small fruit plantations, vegetables, trees and shrubs. This will undoubtedly help us very much in keeping track of our large and increasing collection of plants. Several hundred record photographs have been added to the collection already on hand, which now numbers over six hundred. The collections of fruit trees and plants, ornamental and timber trees, shrubs, etc. have been increased by suitable additions so that they are now very complete. About seventy varieties of apples have fruited the season just passed and considering the fact that our location and soil are poorly adapted to the growing of apples the results have been very satisfactory. Nearly all of our varieties of plums, raspberries, strawberries, blackberries, and gooseberries fruited heavily. Grapes yielded a fair crop. The forestry plantation has been increased by additions of much interest and it is in excellent condition. About sixty varieties of potatoes of the newer kinds have been raised in competitive trial and the results tabulated. Enough varieties of other

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vegetables have been raised to keep our records up to date and in sufficient quantity in most cases to supply the Dining Hall. The studies of potato machinery have been continued and are regarded with much interest by visitors and students. The timely and abundant rains did away with the necessity of using our irrigation plant to any great extent. Considerable interest has been shown in the results of some very successful experiments carried on here to destroy plum aphid by the use of a tent and tobacco smoke. Prof. Green has advised with the superintendents of the Northwest and Northeast Experiment Stations and with Supt. O. C. Gregg of Coteau Farm as to the horticultural and forestry work at these places.

In the division of entomology bulletin No. 55 was issued. It is a text book of nearly 300 pages in which all the grasshoppers, locusts, crickets, cockroaches, and allied insects found in Minnesota are fully described and illustrated. Both their external and internal anatomy is given. The methods used to combat these destructive insects successfully are discussed in detail and a glossary of the terms used assists the reader to understand the descriptions which are necessarily somewhat technical. Over 6000 tin boxes filled with spores to combat the chinch-bugs were mailed to those desiring to use them, but especially to millers who distributed this material among their farmer customers. The results have been very gratifying in numerous instances, as indicated by many letters.

Generally speaking the past season has been a remarkable one so far as insects are concerned, and the damage caused by these pests has been exceptionally slight, excepting in some individual cases. Reports of injuries to our grains, caused by the frit-fly, the wheat steam maggot, and the Hessian fly, were less numerous than in the previous year, while the number of letters in regard to the wire-worms, several kinds of cut-worms, and a boring cut-worm became very numerous for a time, showing that these insects are increasing in numbers and destructiveness. Grave fears were entertained for a time that the genuine Rocky Mountain locust had reached or would reach our state. Happily

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these fears were unfounded, as the nearest region in which this insect occurred in destructive numbers was some 100 miles west of our boundary line in North Dakota. At the invitation of the Northern Pacific Railway Company, and later of that of the Soo line, the entomologist visited the infested region and showed the farmers how to go to work to prevent further injuries. Later the proper authorities in North Dakota took the matter in hand, and with very marked results. In some of our older cities the shade trees are badly infested with the cottony scale and there is great danger that many kinds of trees will be killed if no proper steps are taken to destroy this pest, which is rapidly spreading to many other cities and even to wind breaks and timber claims. The entomologist made a number of trips to arouse the people in the infested cities to united action to save their trees. A number of nurseries were also visited to inspect the stock so that it could be sold to other states and to Canada. During the busy season it is not unusual for the entomologist to receive fifty or more letters per day, hence correspondents cannot always expect to receive lengthy answers. The museum, which contains not alone entomological specimens but also mounted specimens of mammals and birds, has grown very rapidly in size and in importance, and is not alone visited by the students but by many visitors and quite frequently by classes from the public schools of the twin cities.

In the chemical division bulletins 53, 54 and 56 have been issued. The most important subjects treated were: Effects of the rotation of crops upon the fertility and humus content of soils, and the production of humus from manures; the gluten of wheat, digestibility and composition of bread, losses in boiling vegetables, the rational feeding of men; summary of investigations of sugar beets from 1888 to 1898. In connection with the office of Experiment Stations of the U. S. Department of Agriculture, Bulletin No. 43 Department of Agriculture was published entitled "Losses in Boiling Vegetables and the Composition and Digestibility of Potatoes and Eggs." Prof. Snyder has work in progress as follows: *Fodders*. Factors, as seeds, soils and cultivations,

which influence composition and feeding value. *Manures*. Losses which occur in the handling of manures. Comparative value of different farm manures. *Ventilation of stables*. The composition of air from poor and from well ventilated stables. *Soils*. Influence of different methods of cultivation upon the moisture content of soils. Analysis of soils from farms where the fertility has been kept up and from farms that have declined in crop-producing power. Work as referee on soils and ash for the Association of Official Agricultural Chemists. *Human Foods*. Continuation of the work outlined in 1895. In 1897 a study was made of the chemical changes which take place in bread making. This work was carried on in co-operation with the U. S. Department of Agriculture. Twenty-six digestion experiments were made with milch cows, in connection with the dairy division, to determine the relative feeding value of corn fodder cut at different dates, etc.; and analyses of crops raised on rotation plots in co-operation with the agricultural division were made. A free analysis is made of all agricultural materials sent in by farmers of the state, provided the work is of such a nature that it can be used for publication in bulletins. The station does not undertake to make analyses of materials as mineral water, minerals, or general assay work. Numerous analyses have also been made of feeding stuffs as bran, oil meal and milled products, supposed to be adulterated. Some little time has also been spent in the analysis of limestones for different localities where beet sugar factories are contemplated. The result of this work has been highly satisfactory. Four localities have been found where the limestone is of sufficiently high purity to allow its use in the manufacture of beet sugar. Many analyses have also been made of adulterated flour products collected in the large trade centers as Chicago, Cincinnati, Richmond, etc. This work was done because of the threatened injury of adulterated flour to our wheat and milling industry. These analyses were made at the time the pure flour law was before congress with the object of showing the extent to which flour was adulterated.

The work in the dairy division the past year, as well as

the five previous years, has been directed chiefly toward determining the cost of milk production. During the winters of 1895-96 and 1896-97 experiments were carried on to ascertain why some cows in the station herd made so large returns in dairy products while others with like care and under similar conditions produced a much smaller return. This has been a very complicated problem to solve as it involves several distinct questions: First, the amount of food nutrients needed for bodily maintenance; second, the amount of nutritive substance required for a pound of gain; and third, the amount of food nutrients represented per pound loss of bodily weight. The food nutrients needed for bodily maintenance are not fully understood, since some cows gain during their period of lactation while others lose, and some produce more solids, not fat, in their milk. Prof. Haecker has found it exceedingly difficult to trace the disposition made of the nutritive substance in the food taken. In order to ascertain the amount of food required to maintain the body, several cows that had passed the period of usefulness in the dairy and had gone perfectly dry, were used in this part of the work with new and highly satisfactory results. The experiment in rearing dairy calves is still in progress with most promising results, and will be the subject of a bulletin to be prepared for publication early next season. A number of experiments are in progress with a view to getting all the data necessary for a complete analysis of the cow best adapted for the dairy, the work being confined to one line, that of economic milk production.

In the veterinary division the work during the past year has been largely with hog cholera, which has prevailed to a serious extent over the entire southern portion of the state. The infection probably came from Iowa and Nebraska, and spread rapidly during the seasons of 1896 and 1897. It has been the plan to scatter information among the farmers concerning the disease and arouse local health officers and stockmen to the seriousness of the situation. The station has issued two editions of press bulletin No. 5, both of which are exhausted. This bulletin deals with the cause and nature of the disease, symptoms, how it is spread, mistakes commonly

made by farmers in dealing with it, and gives full information concerning what can be done in case the disease appears. Dr. Reynolds has spent considerable time in the infected district with the State Farmers' Institute talking on hog cholera. During this first season with work of this kind it has been difficult to get farmers and local health officers to realize that much could be done by proper precautions to limit the spread of hog cholera and even to entirely avoid it. It is quite evident that we have two infectious swine diseases in this state, swine plague and hog cholera; and for some reason not yet clearly explained the two diseases almost invariably appear together and hogs that die usually show a mixed infection. While there can be no doubt that these diseases are caused by specific germs, it is believed that other factors have to do with the causation. Conditions of food and care undoubtedly have quite an important bearing, and the veterinary division has been studying this feature of the problem. For this purpose a small blank was gotten out for field data and when a blank is filled out for each outbreak we have full information concerning the conditions under which the outbreak occurred. During the season of 1897 the experiment station has also been conducting some inoculation experiments with hog cholera serum. This work has been done in collaboration with the veterinary division of the Nebraska station. Dr. Peters of the latter station furnished the serum and did the laboratory work; Dr. Reynolds has planned and managed the field work for this state. The results will be published in bulletin form when completed. The results of the test experiments were not as satisfactory as was expected, but the work is to be continued, and it is to be hoped that we will soon have a vaccine that will give immunity against hog cholera for a reasonable period. It is difficult to secure a vaccine that will give a sufficient period of immunity, and be at the same time concentrated and cheaply produced. The Bureau of Animal Industry has promised to furnish us limited quantities of the new government serum and we expect to do some experimental work with this next year.

The animal husbandry department has carried on num-

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erous experiments with cattle and sheep. The experiments with swine were rudely broken off for a time by the visitation of hog cholera referred to in the preceding report, but extensive experiments in the line of cross breeding and of growing bacon are now under way. Steers from the range have been fattened on light and heavy rations to determine the relative value of these. Steers of different types have been fed to demonstrate the influence of type on meat production, and cattle have been grown for meat from birth to finish to determine the outcome in cost and profit. Experiments have been conducted in fattening home grown and range lambs on similar foods, that the results may be compared in fattening range lambs on various foods to determine their practicability on the average farm, and also the relative suitability of the foods used; and in fattening range wethers and lambs respectively, to ascertain which of these lines of work is attended with the greatest profit. Most extensive and highly successful experiments have been conducted in growing summer forage for sheep. These experiments have drawn no little attention and favorable comment from all parts of the United States and Canada. Comprehensive experiments are now being carried on in growing winter fodders for sheep. Three bulletins have been issued since the previous report, covering ten experiments, and a fourth is now nearing completion. This department has also produced a text book, "The Study of Breeds," which is now being used in some of the foremost of our agricultural colleges.

The farmers of Minnesota as well as the business and professional men of the cities have shown a great interest in our work during this year. Many delegations of farmers from the various counties of the state have visited the farm this summer. During the past winter we received many visitations from farmer delegations as well as from the chamber of commerce, St. Paul, and the board of trade, Minneapolis. Scarcely a day passes that we do not have from five to twenty visitors. The Grange people and also the Horticultural Society make this their home for their annual meetings. All are cordially received, as their coming is

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an evidence of interest in our work and most encouraging to those who are devoting their energies and best thought to giving assistance to all who are pursuing the general lines of agriculture.

Since the organization of this station there has not been such an earnest desire for information and a lively demand for help along the lines of agriculture as this year. Our mail is increasing daily, and we make it a rule of this station to answer promptly every inquiry, either by a personal letter or mailing some printed matter giving the information desired.

Seven bulletins have been published during the year. Twenty thousand copies of each issue, excepting 53 and 55 (the former seventeen thousand, the latter fourteen thousand) making over ten million four hundred thousand pages, giving the results of investigation and observation made by the station staff, have been issued.

In addition one thousand copies of our annual reports are forwarded to other stations and libraries. We have many calls for these reports from all parts of the United States that we cannot supply. As the publishing of this report is paid out of our current fund, it is not possible to print more than our exchanges demand.

WM. M. LIGGETT,
Director.

