ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION

1890.

BANGOR:
B. A. BURR & CO., PRINTERS.
1891.

MAINE STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION.

STATION COUNCIL.

WILLIAM H. STRICKLAND, ESQ., Bangor.	Committee of Trustees.
RUTILLUS ALDEN, ESQ., Winthrop.	
ARTHUR L. MOORE, ESQ., Waterville.	

ADVISORY MEMBERS.

B. W. MCKEEN, ESQ., Fryeburg, *State Board of Agriculture.*

D. H. KNOWLTON, ESQ., *State Pomological Society.*

PROF. I. O. WINSLOW, St. Albans, *Maine State Grange.*

MEMBERS FROM STATION STAFF.

M. C. FERNALD, PH. D., ... President College.

PRESIDENT.

W. H. JORDAN, M. S., ... Director Station.

SECRETARY

WALTER BALENTINE, M. S., ... Professor of Agriculture.

F. L. HARVEY, M. S., ... Professor of Natural History.

F. L. RUSSELL, V. S., ... Veterinarian to Station.

STATION OFFICERS.

W. H. JORDAN, M. S., ... Director.

M. C. FERNALD, PH. D., ... Meteorologist.

WALTER BALENTINE, M. S., . . . Botanist and Entomologist.

F. L. RUSSELL, V. S., ... Veterinarian.

J. M. BARTLETT, M. S., ... Chemist.

L. H. MERRILL, B. S. . . . . Chemist.

F. P. BRIGGS, B. S., . . . Assistant in Botany and Entomology.

A. M. SHAW, ... Foreman on Farm.

MRS. J. HAMLIN WAITT, ... Stenographer and Clerk.

TREASURER'S REPORT.

THE MAINE AGRICULTURAL EXPERIMENT STATION.

In account with

THE UNITED STATES APPROPRIATION.

RECEIPTS.

From the Treasurer of the United States, as per appropriation for the year ending June 30th, 1890.		$15,000 00

EXPENDITURES.

Salaries	$8,290 80	
Construction and repairs	748 83	
Printing	749 76	
Stationery and postage	32 72	
Travelling expenses	181 25	
General expense	184 72	
Library	156 78	
Dep't Botany and Entomology	106 39	
" Veterinary Science	447 96	
" Meteorology	110 40	
" Horticulture	123 85	
Fertilizer Analyses	172 38	
Water Supply	1,046 50	
Field and Feeding Expts	1,867 22	
Chemical Laboratory	780 31	
		$14,999 87
Unexpended balance		$0 13

I hereby certify that the above is a correct statement of the amount expended by the Maine Experiment Station from the United States appropriation, for the fiscal year ending June 30th, 1890.

GEORGE H. HAMLIN, Treas.

TRUSTEES MAINE STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

I hereby certify that I have examined the accounts of the Maine Experiment Station for the fiscal year ending June 30th, 1890; that I have found the above to be a correct statement of expenditures both as to amounts and classification, for all of which proper vouchers are on file.

WM. H. STRICKLAND, Auditor.

TRUSTEES MAINE STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

DIRECTOR'S REPORT.

M. C. Fernald, Ph.D., President Maine State College:

SIR—A report of the work of the Maine Experiment Station for the year 1890 is herewith submitted. The nature of the work which this Experiment Station is undertaking to do is best understood by a reference to the subject matter of this report. A glance at the table of contents very clearly shows that the time and attention of the Station force have been occupied by matters directly related to practical agriculture. Moreover, it is found by the treasurer's report that the large item of expenditure outside the funds devoted to the payment of salaries, is for the maintenance of field and feeding experiments, these being of necessity practical in their character. If any other assurance is needed that the Station is working along the lines which would be commended by the good judgment of the farmers themselves, it is only necessary to point to the constitution of the Station Council. Of the six gentlemen connected with that Council who are not members of the Station staff, five are directly and intimately associated with the agricultural interests of the State, and as from this Council proceed largely the suggestions which control the work of the Station, it is safe to assume that under present conditions, the Station will not drift into lines of experiment and investigation purely theoretical and scientific that stand in a remote relation to agricultural interests.

It is deemed wise, however, and rightfully, that more or less time shall be given to a study of those principles which underlie all the operations of the farm, and of which we have still far too scanty a knowledge. Some of the mistakes from which practical agriculture still suffers might be avoided by the proper use of facts already known, but there are other errors which will undoubtedly be avoided by a better understanding of facts which we now see but dimly, and a knowledge of facts of which we are now ignorant.

FERTILIZER INSPECTION.

The annual inspection of fertilizers is still carried on by this Station, although no State appropriation is made to the Station for that purpose. The United States officials are certainly giving a very liberal interpretation of the congressional enactment establishing these stations when they allow a portion of these funds to be used for the purpose of doing police work in several states. The time may come when this use of station money will not be allowed, and it will then be necessary for the state to provide for this annual inspection by the direct taxation of its own citizens. It is gratifying to note that the station inspection of fertilizers is productive of good results.

Very many farmers of the State have in the past distrusted the practical value of the analyses and valuation of the various brands of fertilizers offered for sale in the State, and have been much inclined to take as their basis for judging values, the very unsafe verdict of a single year's test of different brands of fertilizers under conditions that are likely to give any thing but a correct answer. Farmers are more and more coming to believe in the truth of the statement so often made in their hearing, that a fertilizer is in general valuable in proportion to what it contains.

Fertilizers Experiments.

The experiments which have been planned with a view to solving certain problems involved in the maintenance of the fertility of the soil are by no means confined to the College premises. They are widely distributed through the State and are being conducted through the co-operation of farmers who are greatly interested in the work, and who with their neighbors are very carefully watching the results. Such a distribution of this kind of experimental work accomplishing two purposes: (1.) An answer to several questions is more certainly reached than if the experiments were confined to the College Farm. (2.) The experiments are more widely observed, and for this reason more largely stimulate habits of observation and accurate thinking.

Dairy Breeds.

Perhaps no investigation which the Station has undertaken has attracted more attention throughout the State than the test which has been made during the past two years of the various breeds of dairy cows. It has been recognized and repeatedly stated that the possible safe conclusions from these tests are limited, and that the characteristics and economic value which they would tend to fasten upon certain breeds of animals might not be wholly in accordance with later and more extended tests. It is very satisfactory to find that so far such is not to any very great extent the case, and that the work being done at other experiment stations seems likely to accord very fully in its outcome with the facts recorded by this Station.

Publications of the Station.

Many of the experiment stations are publishing the results of their work in the form of bulletins which are either additional to, or finally form part of, the annual report. The plan which this Station has adopted, is to publish the annual report in several parts, these being in the nature of bulletins. This Report will be published in four parts. The publications of the Station are mailed to not far from fifty-seven hundred addresses, which, considering the population of the State, and as compared to the mailing lists of other stations, is a very generous distribution of printed matter. There is still room, however, upon our mailing list for the additional names of farmers who are interested in progressive agriculture.

Facilities for Work.

The buildings, apparatus and other appliances used in the work of this experiment station are much the same as stated in the reports for 1888 and 1889, the chief addition being the erection of a forcing house 20x100 feet, which will, in part, be used for expermental purposes. It seems certain that early in 1891 a horticulturist will be added to the Station staff, who will undertake to work in the interest of the market gardeners and fruit growers of of the State.

W. H. JORDAN,

Director.

Maine State College,
Orono, Me., Dec. 31, 1890.

TABLE OF CONTENTS.

REPORT FOR 1890.

PART I.

PART II.

PART III.

PART IV.

INSPECTION OF FERTILIZERS.

The Station Report for 1889 shows that in that year forty-three (43) brands of fertilizers were inspected. In 1890 the number of brands has been increased to sixty-four (64) (including seven (7) brands of bone), for the inspection of which one hundred and fifty (150) samples were selected. There is evidently quite an increase in the activity of the fertilizer trade, as new firms are introducing their goods, and those manufacturers having an established trade are adding to the number of brands which they offer.

In all cases three samples of each brand have not been secured. In general this has been owing to the following causes, viz.: Sale of the fertilizer at but very few points; and finding only the goods held over from last year's sales in the hands of nearly all the agents visited.

Selection of Samples.

The samples for this year (1890) were selected by Mr. S. H. T. Hayes, an agent of the Station, who acted under instructions which it is believed were faithfully and accurately observed.

In nearly all instances the samples were drawn from four packages, mostly 100-pound bags, so that in those cases where three samples were taken they represent twelve packages.

The Trade Values of Fertilizers for 1890.

The trade values given below which are used by this Station are those "agreed upon by the experiment stations of Massachusetts, New Jersey, Pennsylvania and Connecticut for use in their respective states during 1890. The valuations obtained by use of the following figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as:"

Sulphate of Ammonia,	Azotin,
Nitrate of Soda,	Ammonite.
Dried Blood,	Dry Ground Fish,
Muriate of Potash,	Bone or Tankage,
Sulphate of Potash,	Ground So. Carolina Rock,

Plain Superphosphates.

	Cts. per lb.
Nitrogen in ammonia salts	17
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	17
in cotton seed meal and castor pomace	15
in fine bone and tankage	16½
in fine medium bone and tankage	13
in medium bone and tankage	10½
in coarser bone and tankage	8½
in hair, horn shavings and coarse fish scrap	8
Phosphoric acid, soluble in water	8
in ammonium citrate	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	6
in medium bone and tankage	5
in coarser bone and tankage	4
in fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	6
as kainite	4½
as muriate	4½

"These trade values are the average prices at which in the six months preceeding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent, in case of goods for which we have wholesale quotations."

The Valuation of Superphosphate and Mixed Goods.

These trade values are applied to the valuation of Superphos phates and all mixed goods, as follows:

It is assumed that the organic nitrogen of these goods has for its source such materials as dried blood, ground fish, or nitroge nous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like leather has been used. Organic nitrogen in mixed goods is therefore valued at seventeen cents per pound. The nitrogen present in nitrates and ammonia salts is reckoned at fourteen and one half and seventeen cents respectively.

The insoluble phosphoric acid of mixed fertilizers is considered as coming entirely from bone, and not from South Carolina rock, and is reckoned at three cents per pound.

The potash is valued at the price of that ingredient in kainite and the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned at the price of the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton. For instance the "station valuation" of the Allen Corn Fertilizer No. 549 is obtained as follows:

2.34	per cent.	Nitrogen	equal	46.8 lbs.	per ton @ 17cts..........	$7.96
5.05	"	Sol. phos. acid	"	101.0 lbs.	" " @ 8cts.........	8.08
1.48	"	Rev. " "	"	29.6 "	" " @ 7½cts..........	2.22
1.96	"	Insol. " "	"	39.2 "	" " @ 3cts..........	1.18
.12	"	Potash	"	102.4 "	" " @ 4½cts..........	4.61
Valuation..						$24.05

Change in Method.

Heretofore separate analyses have been made of the three samples representing the same fertilizer. This year equal quantities of the three samples have been mixed, and an analysis of this mixture has been assumed to give the same result as would be reached by averaging the analysis of the three samples, an assumption which must be correct.

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
549	Allen Corn Fertilizer	American Manf'g Co. Boston, Mass.	Saco	549
544 572 605	American Amm. Bone Superphosphate	Williams & Clark Co. New York, N. Y.	Portland Oxford Benton	544 572 605
565 624	Bay State Superphosphate	J. A. Tucker & Co., Boston, Mass.,	Oxford Dexter	565 624
585 590 629	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass.,	Augusta Skowhegan Belfast	585 590 629
522 631 644	Bowker's Ammo. Bone Phosphate	Bowker Fertilizer Co., Boston, Mass.,	Pittsfield Portland Unity	522 531 644
523 566 616	Bowker's Hill and Drill Phosphate	" " " " "	Pittsfield So. Paris Dexter	523 566 616
525 648	Bowker's Potato Phosphate	" " " " "	Pittsfield Richmond	525 648
545 567 650	Bowker's Square Brand Bone and Potash	" " " " "	Saco So. Paris Richmond	545 567 650
553 602 649	Bowker's Sure Crop Bone Phosphate	" " " " "	Saco Benton Richmond	553 602 649
662	Bradley's Circle Brand, Bone and Potash	Bradley Fertilizer Co., Boston, Mass.,	Lewiston	662
657 667	Bradley's Complete Manure for Potatoes and Vegetables	" " " " "	Brunswick Bangor	657 667
509 519 529	Bradley's Eureka Seeding Down Fertilizer	" " " " "	Bangor Gardiner Portland	509 519 529
528 564 586	Bradley's Potato Manure	" " " " "	Portland Mechanic Falls. Augusta	528 564 586

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture	Nitrogen	Phosphoric Acid.					Potash	Station Valuation.			
				Soluble	Reverted	Insoluble	Total	Available		Cost of nitrogen.	Cost of phosphoric acid.	Cost of potash.	Total Valuation.
		%	%	%	%	%	%	%	%	$	$	$	$
549	Allen Corn Fertilizer	18.01	2.34	5.05	1.48	1.96	8.49	6.53	5.12	7.96	11.48	4.61	24.05
544	American Amm. Bone Superphosphate	14.16	2.28	7.88	2.21	1.37	11.46	10.09	2.94	7.75	16.75	2.65	27.15
565	Bay State Superphosphate	15.75	2.49	5.20	3.14	2.62	10.96	8.34	2.38	8.47	14.60	2.14	25.21
585	B. D. Sea Fowl Guano	14.46	2.60	8.30	1.73	1.78	11.81	10.03	1.96	8.84	16.94	1.76	27.54
522	Bowker's Ammo. Bone Phosphate	9.56	2.17	4.75	2.58	6.62	13.95	7.33	2.23	7.13	15.44	2.11	24.68
523	Bowker's Hill and Drill Phosphate	10.12	2.82	5.69	2.41	5.33	13.43	8.10	2.09	9.40	15.91	1 88	27.19
525	Bowker's Potato Phosphate	9.68	2.64	5.50	2.22	6.63	14.35	7.72	3.06	8.80	16.11	2.75	27.66
545	Bowker's Square Brand Bone and Potash	3.84	1.55	.95	4.16	9.05	14.16	5.11	2.08	5.27	13.19	1.87	20.33
553	Bowker's Sure Crop Bone Phosphate	10.63	.95	2.92	5.56	6.41	14.89	8.48	.98	3.23	16.98	.88	20.97
662	Bradley's Circle Brand Bone and Potash	6.73	3.11	2.75	2.20	8.80	13.75	4.95	2.12	10.57	12.98	1.91	25.46
657	Bradley's Complete Manure for Potatoes and Vegetables	11.53	3.85	6.13	2.38	2.08	10.59	8.51	6.07	12 89	14.42	5.46	32.77
509	Bradley's Eureka Seeding Down Fertilizer	8.51	1.94	4.51	1.78	4.81	11.10	6.29	2.19	6.60	12.78	1.97	21.35
528	Bradley's Potato Manure	10.79	2.69	5.62	1.68	3.35	10.65	7.30	6.02	9.00	13.52	5.42	27.94

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
508	Bradley's X. L. Superphosphate	Bradley Fertilizer Co., Boston, Mass.,	Bangor	508
520			Gardiner	520
527			Portland	527
615	Bradley's Vegetable and Potato Fertilizer	" " " " "	Gorham	615
584	Buffalo Fertilizer	Wilson Rendering and Fertilizer Co., East Buffalo, N. Y.,	Augusta	584
606			Benton	606
612			Clinton	612
618	Buffalo Guano	" " " " " " " "	Dexter	618
625			Pittsfield	625
607	Buffalo Potato Hop and Tobacco Phosphate	" " " " " " " "	Benton	607
611			Clinton	611
512	Clark's Cove Bay State Fertilizer	John S. Reese & Co., New Bedford, Mass.	Bangor	512
516			Waterville	516
540			Portland	540
513	Clark's Cove Bay State G. G	" " " " " " "	Bangor	513
518			Gardiner	518
541			Portland	541
517	Clark's Cove Bay State Seeding Down Fertilizer	" " " " " " "	Waterville	517
538			Portland	538
647			Richmond Cor.	647
516	Cleveland Potato Phosphate	Cleveland Dryer Co., Boston, Mass.,	So. Berwick	556
582			Gardiner	582
555	Cleveland Superphosphate	" " " " "	So. Berwick	555
583			Gardiner	583
660			New Gloucester	660
526	Crocker's Amm. Corn Phosphate	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.,	Pittsfield	526
558			So. Windham	558
576			Lewiston	576
511	Cumberland Bone Superphosphate	Cumberland Bone Co., Portland, Me.,	Bangor	511
536			Portland	536
563			Mechanic Falls	563

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash. %	Station Valuation. Cost of Nitrogen. $	Cost of Phosphoric acid. $	Cost of Potash. $	Total Valuation. $
508	Bradley's X. L. Superphosphate	13.22	2.44	8.58	2.05	1.68	12.31	10.63	1.82	8.20	17.81	1.64	27.65
615	Bradley's Veg. and Potato Fertilizer	10.95	3.95	6.81	2.18	1.67	10.66	8.99	6.20	13.18	15.17	5.58	33.93
584	Buffalo Fertilizer	6.32	2.30	5.07	1.23	3.36	9.66	6.30	1.17	7.82	12.07	1.05	20.94
618	Buffalo Guano	13.13	1.05	1.96	4.66	3.66	10.28	6.62	.98	3.57	12.33	.88	16.78
607	Buffalo Potato Hop and Tobacco Phosphate	8.22	2.22	5.12	1.20	2.96	9.28	6.32	4.67	7.55	11.77	4.20	23.52
512	Clark's Cove Bay State Fertilizer	10.14	2.61	6.30	3.97	3.53	13.80	10.27	2.31	8.87	18.15	2.08	29.10
513	Clark's Cove Bay State G. G.	10.06	2.32	7.24	1.20	3.98	12.42	8.44	2.60	7.89	15.76	2.34	25.99
517	Clark's Cove Bay State Seeding Down Fertilizer	14.35	1.76	5.36	2.02	3.34	10.72	7.38	2.99	5.98	13.61	2.69	22.28
556	Cleveland Potato Phosphate	15.02	2.27	7.22	2.07	1.98	11.27	9.29	2.83	7.72	15.84	2.55	26.11
555	Cleveland Superphosphate	14.82	2.39	7.86	2.26	1.98	12.10	10.12	1.83	8.00	17.16	1.65	26.81
526	Crocker's Amm. Com. Phos.	11.08	2.29	7.51	1.50	2.22	11.23	9.01	2.95	7.79	15.60	2.65	26.04
511	Cumberland Bone Superphosphate	9.30	2.37	5.79	5.71	2.91	14.41	11.50	1.89	7.87	19.57	1.70	29.14

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
510			Bangor....	510
535	Cumberland Seeding Down Fertilizer.......	Cumberland Bone Co. Portland, Me........	Portland	535
592			Skowhegan	592
580			Bowdoinham ..	580
587	Dirigo Fertilizer...	Sagadahoc Fertilizer Co. Bowdoinham, Me.,	Augusta	587
620			Dexter	620
521			Augusta	521
623	E. F. Coe's Amm. Bone Superphos.........................	E. Frank Coe, New York, N. Y.,	Dexter	623
628			Belfast	628
560			Gray	560
588	E. F. Coe's Grass and Grain Fertilizer.......	" " " " "	Skowhegan	588
589			Waterville.	608
559			Gray..	559
589	F. F. Coe's High Grade Amm. Bone Superphosphate.......	" " " " "	Skowhegan	589
622			Dexter	622
654	E. F. Coe's Potato Fertilizer.......	" " " " "	Richmond	654
515	Farrar's Superphosphate.........	F. S. Farrar & Co., Bangor, Me.,	Bangor	515
619			Dexter	619
575	Gloucester Fish and Potash..	Bowker Fertilizer Co., Boston, Mass.,	Auburn..........	575
653	Liebig's Amm. Superphosphate.......	Flamingo Guano Co., Baltimore, Md.,	Richmond.	653
609	Original Coe's Superphosphate.......	Bradley Fertilizer Co., Boston, Mass.,	Clinton....	609
661			Lewiston.... ..	661
601			Skowhegan	601
640	Otis Superphosphate.......	S. G. Otis, Hallowell, Me.,	East Troy......	640
646			Hallowell	646
514	Pilgrim Fertilizer........	John S. Reese & Co., New Bedford, Mass.,	Bangor	514
537			Portland	537
557			So. Windham..	557
562	Potato Hop and Tobacco Phosphate......	Crocker Chem. and Fert. Co., Buffalo, N. Y.	Mechanic Falls.	562
577			Lewiston	577

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash. %	Station Valuation. Cost of nitrogen. $	Station Valuation. Cost of phosphoric acid. $	Station Valuation. Cost of Potash. $	Station Valuation. Total Valuation. $
510	Cumberland Seeding Down Fertilizer	9.95	1.97	2.73	4.94	12.90	20.57	7.67	.59	6.47	19.52	.53	26.52
580	Dirigo Fertilizer	6.97	2.82	.13	2.09	7.22	9.43	2.21	3.82	9.59	7.66	3.44	20.69
521	E. F. Coe's Amm. Bone Superphos	10.07	1.98	7.23	1.90	2.78	11.99	9.13	1.30	6.73	16 09	1.17	23.99
560	E. F. Coe's Grass and Grain Fertilizer	9.33	.82	5.54	3.78	4.73	14.05	9.32	1.37	2.79	17.37	1.39	21.55
559	F. F. Coe's High Grade Amm. Bone Superphosphate	9.42	2.31	8 15	1.59	2.62	12.36	9.74	1.93	7.85	16.99	1.98	26.82
654	E. F. Coe's Potato Fertilizer	9.45	2.06	5.72	1.57	2.87	10.16	7.29	5.41	7.00	13.22	4.87	25.09
515	Farrar's Superphosphate	15.94	2.38	8.03	2.99	1.58	12.60	11.02	1.80	8.09	18.28	1.62	27.99
575	Gloucester Fish and Potash	8.28	1.82	.70	3.61	8.66	12.97	4.31	2.15	6.19	11.73	1.93	19.85
653	Liebig's Amm. Superphosphate	12.41	2.13	.88	8.51	2.48	11.87	9.39	.80	7.24	15.66	.72	23.62
609	Original Coe's Superphosphate	13.18	2.28	7.68	2.38	2.17	12.23	10.06	1.45	7.75	17.16	1.31	26.22
601	Otis Superphosphate	14.72	2.43	7.90	1.90	2.10	11.90	9.80	1.74	8.26	16.75	1.57	26.58
514	Pilgrim Fertilizer	13.03	1.75	5.39	1.25	2.59	9.23	6.64	2.55	5.95	12.04	2.29	20.28
557	Potato Hop and Tobacco Phosphate	13.11	2.10	7.86	1.58	1.84	11.28	9.44	4.33	7.14	16.05	3.90	27.09

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
543	Potato Phosphate	Williams & Clark Co., New York, N. Y.,	Portland	543
571			Oxford	571
642			West Troy	642
533	Quinnipac Grass Fertilizer	Quinnipac Fertilizer Co., New London, Conn.,	Portland	533
599			Skowhegan	599
534	Quinnipac Phosphate	" " " " " "	Portland	534
551			Saco	551
598			Skowhegan	598
532	Quinnipac Potato Manure	" " " " " "	Portland	532
552			Saco	552
627			Pittsfield	627
531	Quinnipac Seeding Down Manure	" " " " " "	Portland	531
600			Skowhegan	600
655				655
539	Reese's Concentrated Potato and Corn Manure	John S. Reese & Co., New Bedford, Mass.	Portland	539
542	Royal Seeding Down Fertilizer	Williams & Clark Fertilizer Co., New York, N. Y.	Portland	542
570			Oxford	570
641			W. Troy	641
579	Sagadahoc Special Potato Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham, Me.,	Bowdoinham	579
578	Sagadahoc Superphosphate	" " " " "	Bowdoinham	578
617			Dexter	617
630			Belfast	630
524	Soluble Pacific Guano	W. D. Stewart & Co., Boston, Mass,	Pittsfield	524
550			Saco	550
594			Skowhegan	594
561	Standard Fertilizer	Standard Fertilizer Co., Boston, Mass.,	Mechanic Falls	561
596			Skowhegan	596
632			Belfast	632
597	Standard A Brand Seeding Down	" " " " "	Skowhegan	597
634			Belfast	634
659			Portland	639
595	Standard Guano	" " " " "	Skowhegan	595
633			Belfast	633
639			Brooks	639

In Part I, 1890, page 11, of the Experiment Station report the position of the names "Standard A Brand Seeding Down" and "Standard Fertilizer" was erroneously reversed without a corresponding change in the figures of the table. The following is a correct statement:

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid.					% Potash	Station Valuation.			
				% Soluble	% Reverted	% Insoluble	% Total	% Available		Cost of nitrogen $	Cost of phosphoric acid $	Cost of potash $	Total Valuation
561	Standard Fertilizer	14.23	1.96	7.68	1.98	2.31	11.97	9.66	2.60	6.66	16.65	2.34	25.65
597	" A Brand Seeding Down	12.11	1.41	5.80	1.25	1.20	8.25	7.05	1.25	4.79	11.87	1.13	17.79

MAINE EXPERIMENT STATION, ORONO, ME., Jan. 19, 1891.

W. H. JORDAN, Director.

542	Royal Seeding Down Fertilizer	12.16	1.02	6.67	1.65	1.82	10.14	8.32	1.69	3.47	14.23	1.52	19.22
579	Sagadahoc Special Potato Fertilizer	10.47	3.15	5.67	1.23	.97	7.87	6.90	9.22	10.71	11.49	8.30	30.50
578	" Superphosphate	8.95	3.14	6.39	1.25	1.77	9.41	7.64	1.86	10.68	13.15	1.67	25.50
524	Soluble Pacific Guano	13.92	2.38	7.70	1.95	2.41	12.06	9.65	1.90	8.09	16.72	1.71	26.52
561	Standard A Brand Seeding Down	14.23	1.96	7.68	1.98	2 31	11.97	9.66	2.60	6 66	16.65	2.34	25.65
597	" Fertilizer	12.11	1.41	5.80	1.25	1.20	8.25	7.05	1.25	4.79	11.87	1.13	17.79
595	" Guano	12.95	1.14	7.00	1.22	2.24	10.46	8.22	1.70	3.88	14.37	1.53	19.78

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
548 573 604	Stockbridge Corn and Grain Manure	Bowker Fertilizer Co., Boston, Mass.	Saco Auburn Benton	548 573 604
568 574	Stockbridge Grass Top Dressing	" " " " "	So. Paris Auburn	568 574
651	Stockbridge Pea and Bean Fertilizer	" " " " "	Richmond	651
547 554 569	Stockbridge Potato and Vegetable Manure	" " " " "	Saco Biddeford So. Paris	547 554 560
546 645 664	Stockbridge Seeding Down Fertilizer	" " " " "	Saco Unity Winthrop	546 645 664
603 652	Stockbridge Vegetable Manure	" " " " "	Benton Richmond	603 622

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture.	Nitrogen	Phosphoric Acid.					Potash.	Station Valuation.			
				Soluble	Revertted	Insoluble	Total	Available		Cost of nitrogen.	Cost of phosphoric acid.	Cost of Potash.	Total Valuation.
		%	%	%	%	%	%	%	%	$	$	$	$
548	Stockbridge Corn and Grain Manure	8.95	3.37	4.22	2.60	5.51	12.33	6.82	4.35	10.81	13.96	3.91	28.68
568	Stockbridge Grass Top Dressing	4.54	4.79	.69	3.19	5.97	9.85	3.88	6.17	14.75	9.46	5.55	29.76
651	Stockbridge Pea and Bean Fertilizer	8.65	2.82	4.64	2.54	6.50	13.68	7.18	3.09	9.28	15.13	2.78	27.19
547	Stockbridge Potato and Vegetable Manure	9.00	3.47	3.60	3.99	4.06	11.65	7.59	6.52	11.24	14.18	5.86	31.28
546	Stockbridge Seeding Down Fertilizer	11.62	3.00	6.46	1.74	4.07	12.27	8.20	3.84	9.65	15.39	3.45	28.49
603	Stockbridge Vegetable Manure	9.14	2.98	2.95	4.22	4.78	11.95	7.17	6.20	9.66	13.92	5.58	29.16

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
530	Raw Bone	Thompson & Edwards,	Portland	530
581	Bone Meal	Sagadahoc Fert. Co. Bowdoinham, Me.,	Bowdoinham	581
610 626	Cyclone Reduced Pure Bone Meal	Milsom Rendering & Fert. Co., East Buffalo, N. Y.,	Clinton Pittsfield	610 626
621	Bowker's Fresh Ground Bone	Bowker Fert. Co., Boston, Mass.,	Dexter	621
656	Bradley's Pure Fine Ground Bone	Bradley Fert. Co., Boston, Mass.,	Brunswick	656
658 665	Americus Pure Bone Meal	Williams & Clark Fert. Co., New York,	Portland Winthrop	658 665
63	Bone Meal	Maine Bone Co., Portland, Me.,	Lewiston	663

RESULTS OF ANALYSES.

	Brand.	Moisture.	Nitrogen.	Phosphoric Acid.
530	Raw Bone	6.71	2.51	22.96
581	Bone Meal	7.54	4.19	22.21
610	Cyclone Reduced Pure Bone Meal	6.76	4.19	21.68
621	Bowker's Fresh Ground Bone	5.77	3.09	17.72
656	Bradley's Pure Fine Ground Bone	5.51	3.11	23.68
658	Americus Pure Bone Meal	8.51	3.34	23.56
663	Bone Meal	4.93	2.77	23.29

The Existing Methods of Selling Fertilizing Materials.

This multiplicity of brands of fertilizers can but be regarded as unfortunate. They all contain the same valuable ingredients of plant food, and in a large percentage of the leading brands are found so nearly the same quantities of nitrogen, phosphoric acid and potash in the same forms, that it makes very little difference which the farmer buys. In spite of this fact, scores of agents are making special claims for the particular fertilizers which they represent, on the ground that they possess qualities superior to all competing goods, a claim that in most cases has not the slightest foundation in fact, and originates wholly in business zeal. Such a state of the fertilizer trade must certainly tend to confuse the farmer, and to retard his accepting the correct standards which should control the purchase of plant food.

The real object of buying a fertilizer is to secure certain elements of plant food which it contains, elements which have as definite prices as sugar, flour or iron, prices which are quoted and are authoritative in commercial circles. In other words a pound of nitrogen or potash is sold to manufacturers for so much, just as retailers buy flour or sugar at certain prices. There is no reason why the consumer should not buy his nitrogen or potash in the same way, and the time is undoubtedly coming when this will be done. Now trade names are made much of, but with a more rational method, trade names will disappear, and nitrogenous, or phosphatic or potash material will be sold as such and will be rated according to what it contains. Then the farmer will tell his neighbor that he has purchased so many pounds of nitrogen, phosphoric acid and potash, instead of so many pounds of "Blank Bros'. Lightening Crop Lifter."

An Important Consideration.

For the first time the tables showing the results of the station inspection give the market cost of the valuable ingredients separately as well as the total valuation. By consulting these figures it is possible for the farmer to determine whether in buying a particular fertilizer he is paying most for nitrogen or for some other ingredient. To illustrate this point the case of two brands of Quinnipiac goods may be taken, the Grass Fertilizer and the Seeding Down Manure. With the former the nitrogen represents thirty-seven (37) per cent. of the total cost, while with the latter it represents only fifteen (15) per cent. A study of the tables shows that in general the cost of those fertilizers receiving a high valuation comes more largely from nitrogen than is the case with the brands valued lower. It is very easy to force the valuation of a fertilizer to a high point by the use of a nitrogenous material, as the element nitrogen bears a comparatively high market price.

TESTS OF DAIRY COWS.

The Report of this Experiment Station for 1889 gives on page 106 to 134 the results of the first year's test of three breeds of dairy cows. When this work was undertaken it was the intention to continue it for two years. The second year's test has been completed and the results reached, combined with those of the first year, can be found on the following pages. The general conditions under which these trials have been conducted, the methods adopted and the objects sought to be reached are fully stated in the Report of 1889, and as that Report has been sent to all those who are likely to receive this one, or can be had upon application, a restatement of these facts is not considered necessary. There were omitted from the description of the six animals used in the test, the records of the Holstein cow, Agnes Smit.

In order to make these descriptions complete her record is inserted at this point.

Agnes Smit, Holstein, No. 4479 H. F. H. B., sire, "Barsingerhoen" (a district bull), dam "Diekje," weight 1175 lbs. Bought of William A. Russell, No. Andover, Mass., May 22d, 1889. Her first calf after coming to the Station was born on Feb. 1, 1890.

Food of the Cows.

The food of the cows for the second year has been the same as that of the first, with the exception that Agnes Smit has been fed a certain amount of middlings in addition to the regular grain ration. A statement of the rations fed and the general methods of feeding can be found in the 1889 report on page 109. During the summer of 1890 the cows were at pasture after May 30th and until October 10th, although with the exception of about two months they ate considerable hay in the barn. The grain ration was continued unchanged throughout the season. The following tables show the amounts of the different kinds of food eaten by the several animals during the years 1888-89 and 1889-90, and also the average daily ration for each animal during the time that the trials have been carried on.

Food Eaten by Cows in 1888-89.

	Jansje. (Holstein.) June 13, '88 to June 13, '89.	Nancy Avondale. (Ayrshire.) June 17, '88 to June 17, '89.	Queen Linda. (Ayrshire.) Oct. 20, '88 to Oct. 20, '89.	Agnes. (Jersey.) Sept. 13, '88 to Sept. 13, '89.	Ida. (Jersey.) Sept. 1, '88 to Sept. 1, '89.
	lbs.	lbs.	lbs.	lbs.	lbs.
Total hay eaten	6740	6375	5800	5600	5500
Total ensilage eaten	2670	1648	2540	2540	2540
Total cotton-seed meal eaten	524	250	486	459	427
Total corn meal eaten	1442	827	982	976	913
Total wheat bran eaten	724	778	748	616	605
Total food eaten in barn	12100	9878	10556	10191	9985
Days of pasturage	102	102	122	104	104
Hay eaten daily for 365 days	18.5	17.4	16.0	15.4	15.1
Ensilage eaten daily for 365 days	7.3	4.5	7.0	7.0	7.0
Grain eaten daily for 365 days	7.4	5.1	6.1	5.6	5.3
Pasturage daily for 365 days, hours	2.2	2.2	2.7	2.3	2.3

Food Eaten by Cows in 1889-90.

	Jansje. (Holstein.) June 13, '89 to June 13, '90.	Agnes Smit. (Holstein.) June 2, '89 to June 2, '90.	Nancy Avondale. (Ayrshire.) June 17, '89 to June 17, '90.	Queen Linda. (Ayrshire.) Oct. 20, '89 to Oct. 20, 90.	Agnes. (Jersey.) Sept. 18, '89 to Sept. 18, '90.	Ida. (Jersey.) Sept. 1, '89 to Sept. 1st, '90.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Hay	6643	6275	6150	6150	6000	5800
Cotton-seed meal	606	221	509	521	513	526
Corn meal	1230	1342	1123	1077	1035	1053
Wheat bran	836	1342	755	670	531	568
Middlings		170				
Total grain	2672	3075	2387	2268	2079	2147
Total food	9315	9350	8537	8418	8079	7947
Hay eaten daily, 365 days	18.2	17.2	16.9	16.9	16.4	15.9
Grain eaten daily, 365 days	7.3	8.4	6.5	6.2	5.7	5.9
Days out in pasture	132	132	132	132	132	132

Rations for Two Years.

	Jansje.	Agnes Smit. (1-year only)	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Total hay eaten	13383	6275	12525	11950	11600	11300
Hay eaten daily (730 days)	18.3	17.2	17.3	16.4	15.9	15.5
Total ensilage eaten (in 1889)	2670		1648	2540	2540	2540
Ensilage eaten daily (730 days)	3.6		2.2	3.5	3.5	3.5
Total grain eaten	5362	3075	4442	4464	4130	4093
Grain eaten daily (730 days)	7.3	8.4	6.1	6.1	5.7	5.6

NOTE. The cows were in the pasture part or all of about 120 days each year, but they probably had the equivalent of not over 90 full days of pasturage each season. In fact, there were not over two months each year when hay was not fed in the barn.

Cost of the Food.

The cost of the food is reckoned at what are assumed to be average market values. The reasons for taking such values rather than those ruling at the time work is being carried on are given in the Report for 1889. It is again remarked in this report that the figures thus reached simply show the relative expense of feeding each animal and not the actual expense for any one year, or any one period of time, or for any particular farmer. These figures may be more or less, according to the circumstances of the farmer or the ruling market prices, but whatever may be the changes in these figures, they will relatively stand the same. The table below shows the expense of each animal for each of the two years, as well as the average expense.

Cost of the Food.

	Jansje.	Agnes Smit.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
Cost of hay 2d year	$ 33.21	$ 31.37	$ 30.75	$ 30.75	$ 30.00	$ 29.00
Cost of cotton-seed meal 2d year	8.42	3.09	7.12	7.29	7.18	7.36
Cost of corn meal 2d year	12.30	13.42	11.23	10.77	10.35	10.53
Cost of wheat bran 2d year	8.36	13.42	7.55	6.70	5.31	5.68
Cost of middlings 2d year		2.12				
	62.29	63.42	56.65	55.51	52.84	52.57
Cost of pasturage	7.00	7.00	7.00	7.00	7.00	7.00
Total cost	69.29	70.42	63.65	62.51	59.84	59.57
Cost of first year	73.20		59.89	63 90	59.64	57.95
Average cost for two years	71.24	70.42	61.77	63.21	59.74	58.76

It is to be noticed that the expense of feeding a Holstein animal averaging 1,200 pounds in weight is only $11 per year more than the cost of feeding a Jersey animal, averaging in weight only about 900 pounds; or, in other words, the expense of feeding the heavier animals has been only about eighteen per cent. more than that of maintaining the lighter animals, whereas the Holsteins exceed the Jerseys in weight about thirty-three per cent. This is equivalent to saying that the quantity of food has not been in proportion to the weight of the animals, and it may be suggested by some one that this fact places the larger cows at a disadvantage as compared with the smaller. It should be remarked, however, that the Holsteins have eaten on the average a third more grain than the Jerseys, and hay has been fed to them according to their appetites. It is a well recognized fact that the food of an animal does not increase in proportion to the increase in weight, or, in other words, a small cow requires a larger maintenance ration in proportion to her weight than a large cow, consequently the food required for a given production would be relatively less in the case of the heavier animal. It is perfectly reasonable that this should be so. The large cow gives off less heat for each pound of live weight than the small cow, for the reason that two cows weighing six hundred pounds each would have much more surface exposed to the air than one cow weighing twelve hundred pounds. The loss of heat will be somewhat in proportion to the exposed surface, and so the two small cows would require more food as fuel than the one large one. A study of the figures of the two previous tables shows that only moderate rations have been fed, and it is believed that these rations have been fairly proportioned to the needs of the several animals. While the grain rations may seem to some to be small, it should be remembered that the mixture of foods has been such as to give the maximum results from the amount eaten.

The Yield of Milk, Milk Solids, Fat, Cream and Butter.

The nature of the record kept of the production of these cows is given in the Report for 1889 on page 112, to which place reference is made for those desiring information. The figures of the table which follows represents the main results of the two years' test. It is to be noticed that something more than the yield of milk and butter is given. If a cow's butter capacity is to be tested, then the total amount of fat in her milk is in general the standard by which she should be judged. If on the other hand, we wish to ascertain her capacity as a producer of human food, then it becomes a question of the total amount of milk solids which she is able to manufacture. Having kept a record with these animals, not only of the yield of milk but also of its composition in the several cases, we are able to calculate the weights of milk solids and fat which the several cows have produced. This is all shown in the following table.

TABLE SHOWING THE PRODUCTION OF THE COWS.

	Jansje. (Holstein.)	Agnes Smit. (Holstein.)	Nancy Avondale. (Ayrshire.)	Queen Linda. (Ayrshire.)	Agnes. (Jersey.)	Ida. (Jersey.)
No. of days milked 1st year..........	365		281	287	340	322
" " 2d year	308	293	294	296	357	351
Average	336	293	287	291	348	336
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Yield of milk 1st year................	9991		5948	6983	6876	4107
" " 2d year................	8362	7562	6293	7227	6204	4655
Average	9176	7562	6120	7105	6540	4381
Av. daily yield of milk for 365 days	27.	20.7	16.8	19.5	17.9	12.
Yield of milk solids 1st year	1228		751	894	1015	638
" " " 2d year....	1042	893	811	919	960	696
Average	1135	893	781	906	987	667
Yield of fat 1st year......	340		209	246	352	238
" " 2d year...	298	251	219	261	337	263
Average...	319	251	214	253	344	250
Weight of cream, fresh, 1st year....	18 9		1008	1008	1586	951
" " " 2d year.....	1377	973	1068	908	1537	1066
Average	1598	973	1038	958	1561	1008
Av. No. of inches cream........... .	799	486	519	479	780	504
Weight of butter 1st year............	349		197	188	379	238
" " 2d year	285	224	202	207	369	273
Average	317	224	199	197	374	255

NOTE. The quarts of milk can be calculated by dividing the pounds by 2 1-7.

TABLE SHOWING AVERAGE PRODUCTION OF BREEDS.

	Holstein.	Ayrshire.	Jersey.
Average yield of milk, lbs...........................	8369	6612	5460
Average yield of milk solids, lbs.	1014	848	827
Average yield of butter fat, lbs.....................	285	233	297
Average yield of cream, (inches)..................	642	499	642
Average yield of butter, lbs.........................	270	199	314

The figures given above should be carefully examined. They show that the Holsteins have produced milk solids considerably in excess of the other two breeds and that the Ayrshires and Jerseys have differed very little in this respect. This means that the Holsteins have produced considerably the larger amount of human food. When, however, we come to the consideration of the yield of fat, we find that the Jerseys excel and that the Ayrshires stand lowest in the scale. We see then, that when it becomes a question of a particular kind of production from a cow, the total solids in the milk cannot be taken as a standard any more than can the total fat. There is no question but that these two Holsteins would produce much larger weight of cheese in a year than either the Ayrshires or Jerseys, and that the Ayrshires would in this matter excel the Jerseys. On the other hand, the Jerseys plainly excel in butter production. It would be, therefore, decidedly unfair to measure the relative butter production of these animals by the solids in the milk, or the relative cheese production by the fats. This is true, because one breed of animals produces more fat in proportion to the total solids than does another breed. It is no injustice to any other breed, and is but an impartial statement of a fact, to say that the Jersey is eminently a fat producing cow.

The Relation in Quantity of Milk, Milk Solids, Fat, Cream and Butter.

The quality and value of the milk from these several animals is very clearly seen by showing its relation in quantity to the cream and butter produced. Another point that is of importance to Maine creameries, and which it seems proper to bring out in this connection, is the relative butter value of the cream. These relations are expressed in the table which follows:

	Jansje.	Agnes Smit.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Milk for each pound milk solids 1st year	8.13		7.92	7 82	6.77	6.43
Milk for each pound milk solids 2d year	8.02	8.47	7.76	7.86	6.46	6.69
Average	8.07	8.47	7.84	7.84	6.62	6.56
Milk for each pound butter fat 1st year	29.35		28.49	28.40	19.52	17.27
Milk for each pound butter fat 2d year	28.06	30.13	28.73	27.70	18.41	17.70
Average	28.70	30.13	28.61	28.05	18.96	17.48
Milk for each inch cream (average)	11.4	15.5	11.8	14.8	8.4	8.7
Milk for each pound of butter 1st year	28.59		30.19	37.13	18.12	17.26
Milk for each pound of butter 2d year	29.34	33.79	31.14	34.91	16.81	17.05
Average	28.96	33.79	30.67	36.02	17.46	17.30
Cream for each pound of butter 1st year	5.20		5.12	5.36	4.18	4.00
Cream for each pound of butter 2d year	4.83	4.34	5.28	4.38	4.17	3.90
Average	5.01	4.34	5.20	4.87	4.18	3.95
Inches of cream for 1 lb. of butter	2.52	2.17	2.61	2 43	2.06	1.98

The facts set forth in the above table forcibly illustrate the great differences that may occur in the value of certain dairy products, whether we regard them from the food standpoint or as factors in business operations. This is a matter in which the consumers of milk in our villages and cities have an interest. Milk is an important source, when healthful, of the very best quality of human food, and is so regarded especially by those who have to do with the physical welfare of children. It is evidently unfair, however, to pay the same price per quart for all kinds of milk. The food value of a quart of Jersey milk, such as that produced by the Station animals, is worth twenty-five per cent. more for purposes of nutrition, than is the Holstein milk. While it may not be possible to grade the retail price of milk according to its quality, it would be entirely just for the milk man who is selling the product of a Jersey herd to receive a larger price than that which is paid for Holstein or Ayrshire milk.

This matter of the varying value of milk according to its source is a very important one in the case of those butter factories that are purchasing milk instead of cream. When the managements of such factories pay the same price for milk containing five and one-half pounds of fat to the hundred, that they do for milk containing three and one-half pounds of fat to the hundred, they are either defrauding themselves or doing great injustice to the producers of the richer milk. Nothing can be more unbusiness-like than to purchase milk for butter making purposes at a uniform price without regard to quality. Somewhat the same considerations pertain to cream-gathering butter factories. The above table makes it very clear that cream is not of uniform value and that the individuality of animals has a very marked influence upon the cream that is produced. Taking the average of a two years' record we see that the amount of cream required for a pound of butter has varied from 5.2 pounds, in the case of the Ayrshire, Nancy Avondale, to 3.95 pounds, in the case of the Jersey, Ida. The custom so far in Maine has been to pay the same price for equal volumes of cream, without regard to its source. This may be rank injustice, as the facts show, and is excusable only on the ground that no rapid and accurate method exists for testing cream. It is true that until a comparatively recent date no such method has existed, but now we have several methods that are fairly efficient and their absence can no longer serve as an excuse for underpaying one cream producer and overpaying another.

The time has clearly come when the butter factories of Maine should deal justly with their patrons and take steps towards paying for cream according to its butter value. Apart from other considerations the two facts that the milk and cream from different breeds of animals is so greatly unlike, and that the animals now found upon a farm are very likely to be either thoroughbreds or grades of a single breed, make it imperative that we shall no longer proceed upon the old assumption that milk is milk and cream is cream. In response to a request from a gentleman in this State interested in dairy matters, the cream produced by the several Station animals has been measured in inches as well as in pounds. This was done from March 2nd to Sept. 21st, of the present year.

The quantity of cream in pounds, also in inches and the amount of butter produced during that time are given below.

Variation of Inches of Cream Required for One Pound of Butter with Different Cows.

	Jansje	Agnes Smit.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
Pounds of cream	454	347	185	492	748	506
Inches of cream	226¾	176⅛	93	256¼	378½	265½
Pounds of butter	95½	83¼	37¾	107⅔	184½	132¼
Weight of an inch of cream	2 lbs.	1.97 lbs.	2 lbs.	1.92 lbs.	1.98 lbs.	1.91 lbs.
Pounds of cream for each pound of butter	4.75	4.17	4.90	4.58	4.06	3.90
Inches of cream for each pound of butter	2.36	2.12	2.46	2.38	2.05	2.01

We see that the same varying ratios exist between the inches of cream and the pounds of butter as between the pounds of cream and the pounds of butter, the inches of cream required in the several cases to make one pound of butter varying from 2.46 inches to 2.01 inches. This demonstrates in terms that are familiar to dairy-men how unjust may be the present system of paying for cream.

Cost of Milk, Milk Solids, Fat, Cream and Butter.

The method of calculating the cost of the products from the several animals are explained in the Report for 1889 on page 115. In order that the figures may not be misunderstood, the statements referred to are repeated here.

"In computing the cost of the production of these cows, the food is alone considered. Moreover, the cost given for the butter fat and butter, represents the whole value of the food, no allowance being made for the other solids which are retained in the waste products from butter making, and which are certainly worth something. If there was a recognized market price for skimmed milk and butter milk, or if the skimmed milk of these animals was alike in value, in short, if an allowance made for the skimmed and butter milk could be anything but a purely arbitrary estimate, relatively unfair in any case unless based upon the percentage of solids, it would be possible to calculate the case of butter on a different basis. As it is, each farmer must make his own estimate of the worth to him of the waste products of the dairy.

The following table of costs is calculated from the figures given in the two preceding tables :"

Cost of Production.

	Jansje.	Agnes Smit.	Nancy Avon-dale.	Queen Linda.	Agnes.	Ida.
Cost of milk per pound 1st year.....	.7326		1.007	.9151	.8674	1.411
" " " 2d year.....	.8287	.9312	1.011	.8649	.9648	1.279
Average..................	.780	.931	1.009	.890	.916	1.345
Cost of milk per quart 1st year.....	1.56		2.16	1.96	1.86	3 02
" " " 2d year......	1.77	2.00	2.17	1.85	2.06	2.74
Average..................	1.67	2.00	2.16	1.90	1.96	2.88
Cost of milk solids per lb. 1st year..	5.96		7.97	7.15	5.87	9.08
" " " " 2d year...	6.64	7.88	7.85	6.80	6.23	8.56
Average..................	6.30	7.88	7.91	6.98	6.05	8.82
Cost of butter fat per lb. 1st year....	21.50		28.68	25.58	16.96	24.39
" " " " 2d year.....	23.26	28.06	29.07	23.96	17.76	22.65
Average..................	22.39	28.06	28.87	24.77	17.35	23.52
Cost of cream per inch 1st year.....	8.05		11.88	12.68	7.52	12.19
" " " 2d year......	10.06	14.49	11.92	13.77	7.79	11.17
Average..................	9.05	14.49	11.90	13.22	7.65	11.68
Cost of butter per lb. 1st year.......	20.94		30.40	33.99	15.72	24.35
" " " 2d year.......	24.32	31.44	31.50	30.14	16.22	21.82
Average..................	22.63	31.44	30.95	32.06	15.96	23.08

Average Food Cost of Production with Breeds.

	Holstein (cents.)	Ayrshire (cents.)	Jersey (cents.)
Average cost of milk per pound........................	.855	.949	1.130
" " " quart..........................	1.83	2.03	2.42
" " solids per pound................	7.09	7.45	7.44
" butter fat per pound....................	25.22	26.82	20.43
" cream per inch..........................	11.75	12.56	9.66
" butter per pound....................	27.03	31.50	19.52

The above results show that the Holstein milk has cost least and the Jersey milk the most, when quantity alone is considered. When we come to consider the cost of the solid matter in the milk, then the case is somewhat different. The Holsteins still show a somewhat more economical production than the others, but there is really only a small difference in the cost of a pound of milk solids as produced by each of the three breeds. As was remarked in the Report of 1889, the cost of a quart of milk depends not so much upon the volume produced, as upon the amount of solid matter that it contains. Of course the greater volume of milk a cow produces the less its quart cost, other things being eqnal, but it seems to be true that we do not find in general the production of a large volume of milk which has a high percentage of solids. If, for instance, by a process of selection, the Holsteins are bred to the production of richer milk, a decrease in the yield will undoubtedly occur.

The cost of a pound of solid matter in milk is really the true test to follow, especially if we regard the milk simply as human food. It seems that in the case of these cows a pound of Jersey milk has cost nearly a third more than a pound of Holstein milk, whereas, a pound of Jersey milk solids has cost only about one-twentieth more, or five per cent. The figures that represent the cost of the fat, cream and butter, show some very marked differences in favor of the Jersey animals. The butter fat in the milk of the Ayrshire and Holstein animals has cost from twenty to thirty per cent. more than in the case of the Jerseys, with about the same differences for the cream. The cost of a pound of butter in each of the three cases varies still more, the Ayrshire butter costing sixty per cent. more than the Jersey butter. In order to make these relations still plainer, the table below is arranged. The cost of the various products, milk, milk solids, fat, cream and butter is taken as 100 for the Holsteins.

RELATION OF FOOD COST.

	Holstein	Ayrshire	Jersey
Cost of milk	100	111	132
Cost of milk solids	100	105	105
Cost of butter fat	100	106	81
Cost of cream per inch	100	107	81
Cost of butter	100	115	72

It may not be out of place to again emphasize in this connection the great difference between the cost of a pound of edible material in milk and in beef. The Station cows have produced annually during the past two years an average of 895 pounds of milk solids, all of which is edible. This has been done at an average food cost of 7 1-4 cents per pound. It is safe to say that farmers of Maine would consider the production of a 1,400 pound steer in three years a fairly creditable performance. Such an animal, if fat, would furnish for the purpose of human food, not far from 375 pounds of edible dry matter.

No one can find fault with the assumption that it would cost as much to feed this steer for three years as it would to feed a cow giving milk for half that time, or, for a year and a half. Estimating the expense of the food on the same basis that we have for the cows, the food cost in the case of the steer three years old would be $96, making the food expense of producing a pound of edible dry matter in the butcher's meat 25.6 cents. According to these figures, the food cost of producing human food by means of the dairy cow as compared with beef production would be as 100 :353.

Composition of the Milk.

The milk of the several animals has been analyzed during the two years' test to as full an extent as it was possible. On the average, samples of milk have been taken of the night's and morning's milk for about 45 days in each year, the intention having been to take samples for five consecutive days in each month during the time the cows were giving milk. During the time from June 1888 to April 1889 the night's milk and morning's milk were analyzed separately, but since that time equaquantities of the two have been mixed and this mixture has been analyzed.

In calculating the composition of the first year's milk, the ash was assumed to be .75 per cent. Analyses made during the second year have shown that .75 per cent. for the Jersey's and .65 per cent. for the Holstein and Ayrshire milk would more accu, rately represent the amount of ash, and in the calculations of the composition of the second year's milk these figures have been used the averages for the first year being corrected to correspond.

The following tables show the averages of each cow's milk for each period of five days, and also the average for each cow for the whole year :

Tables Showing Composition of Milk of each Cow.

(Jansje.)

	Solids.	Ash.	Casein.	Sugar.	Fats.
July 15–19	14.96	.65	4.90	4.71	4.70
Sept. 30–Oct. 4	12.03	.65	2.95	5.51	2.94
Nov. 11–15	11.91	.65	2.94	5.16	3.16
Jan. 7–11	12.32	.65	2.91	5.16	3.59
Feb. 17–21	12.23	.65	3.06	5.06	3.46
March 19-23	12.35	.65	3.08	5.26	3.33
April 22–26	12.23	.65	3.04	5.01	3.52
June 10–14	12.92	.65	3.28	5.22	3.76
Average	12.62	.65	3.27	5.13	3.56

(Agnes Smit.)

	Solids.	Ash.	Casein.	Sugar.	Fats.
July 15–19	11.39	.65	2.88	4.80	3.06
September 30–October 4	12.50	.65	3.26	5.03	3.56
November 11–15	13.21	.65	3.48	4.80	4.27
February 17–21	12.68	.65	3.05	5.06	3.93
March 19–23	11.60	.65	2.79	5.20	2.96
April 22–26	11.38	.65	2.59	4.93	3.21
June 10–14	11.60	.65	2.89	4.99	3.06
Average	12.05	.65	2.99	4.97	3.44

(Nancy Avondale.)

	Solids.	Ash.	Casein.	Sugar.	Fats.
July 15–19	12.42	.65	3.36	5.20	3.20
September 30–October 4	12.60	.65	3.37	5.21	3.37
November 11–15	12.73	.65	3.54	5.06	3.48
January 7–11	14.44	.65	4.19	5.49	4.11
February 17–21	14.39	.65	4.52	4.98	4.25
June 10–14	12.61	.65	3.17	5.45	3.34
Average	13.19	.65	3.69	5.23	3.63

(Queen Linda.)

	Solids.	Ash.	Casein.	Sugar.	Fats.
January 7–11	12.55	.65	2.80	5.60	3.50
February 17–21	12.54	.65	2.99	5.36	3.54
March 19–23	12.55	.65	3.02	5.48	3.40
April 22–26	12.25	.65	3.04	5.04	3.52
June 10–14	13.21	.65	3.25	5.41	3.90
July 7–11	13.04	.65	3.22	5.44	3.73
August 11–15	13.74	.65	3.63	4.91	4.55
Average	12.84	.65	3.14	5.32	3.73

(Agnes.)

	Solids.	Ash.	Casein.	Sugar.	Fat.
September 30–October 4	15.08	.75	4.32	5.06	4.95
November 11–15	15.81	.75	4.65	4.77	5.64
January 7–11	15.52	.75	4.23	5.10	5.45
February 17–21	15.36	.75	4.38	5.06	5.17
March 19–23	15.29	.75	4.23	5.17	5.14
April 5–26	15.24	.75	4.28	4.76	5.45
June 10–14	15.55	.75	4.27	5.04	5.49
July 7–11	15.53	.75	4.12	4.95	5.71
August 11–15	16.15	.75	4.52	4.52	6.35
Average	15.50	.75	4.33	4.93	5.48

(Ida.)

	Solids.	Ash.	Casein.	Sugar.	Fat.
September 30–October 4	13.92	.75	3.34	5.13	4.70
November 11–15	14.00	.75	3.61	4.71	4.93
January 7–11	15.00	.75	3.98	4.67	5.60
February 17–21	15.12	.75	4.08	4.63	5.66
March 19–23	15.55	.75	3.95	4.99	5.86
April 22–26	15.15	.75	3.90	4.74	5.76
June 10–14	15.76	.75	3.86	4.93	6.21
July 7–11	15.76	.75	3.90	4.86	6.25
August 11–15	15.05	.75	4.02	4.51	5.76
Average	15.04	.75	3.85	4.80	5.63

AVERAGE COMPOSITION OF MILK OF EACH BREED FOR TWO YEARS.

	Total Solids.	Ash.	Casein and Albumin	Sugar.	Fat.
Average of Holstein milk	12.22	.65	3.10	5.00	3.47
Average of Ayrshire milk	12.98	.65	3.39	5.27	3.67
Average of Jersey milk	15.24	.75	4.09	4.90	5.50

The above analyses, representing as they do several animals, and extending over a period of two years, furnish information on several points that are worthy of consideration.

(1.) *The effect of breed upon the composition of milk.*

The quality of the milk as based upon the percentage of solid matter in it, is best with the Jerseys and poorest with the Holsteins. If the milk solids of the Holstein milk are represented by 100 we have as follows:

Holstein, 100; Ayrshire, 106; Jersey, 125.

It is to be observed that the relation in quantity of the various constituents of the milk solids is not the same with all the breeds.

For instance, there is very nearly the same quantity of sugar in a hundred pounds of each of the three kinds of milk. The larger quantity of solids in the Jersey milk is due to the presence of more casein, albumen and fat. Moreover, the relation existing between the nitrogenous constituents (casein and albumen) and the fat is not the same in the several cases.

Relation of Casein and Albumen to Butter Fat.

Casein and Albumen=100.

	Jansje.	Agnes Smit.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
June 1888	100 : 103		100 : 98			
July	100 : 107		100 : 94			
August	100 : 103		100 : 105			
September	100 : 107		100 : 104		100 : 110	100 : 139
October	100 : 111		100 : 101	100 : 127	100 : 128	100 : 151
November	100 : 115		100 : 100	100 : 115	100 : 130	100 : 145
December	100 : 117		100 : 99	100 : 118	100 : 128	100 : 140
January 1889	100 : 114			100 : 120	100 : 131	100 : 142
February	100 : 105			100 : 103	100 : 121	100 : 139
April	100 : 107		100 : 151	100 : 109	100 : 120	100 : 142
May	100 : 93		100 : 104	100 : 102	100 : 119	100 : 139
June	100 : 98		100 : 100	100 : 99	100 : 120	100 : 145
July	100 : 96	100 : 106	100 : 96	100 : 106	100 : 126	100 : 116
September	100 : 100	100 : 109	100 : 100		100 : 115	100 : 141
November	100 : 107	100 : 120	100 : 98		100 : 121	100 : 137
January 1890	100 : 123		100 : 98	100 : 124	100 : 129	100 : 147
February	100 : 113	100 : 129	100 : 94	100 : 119	100 : 118	100 : 137
March	100 : 108	100 : 106		100 : 112	100 : 121	100 : 149
April	100 : 116	100 : 124		100 : 112	100 : 127	100 : 148
June	100 : 115	100 : 106	100 : 105	100 : 120	100 : 128	100 : 161
July				100 : 116	100 : 138	100 : 160
August				100 : 125	100 : 140	100 : 143
Average	100 : 108	100 : 114	100 : 103	100 : 113	100 : 125	100 : 143

Note. The heavy lines indicate the times when the cows were dry.

Taking the average composition of milk for two years we have with the Holsteins the casein and albumen standing in relation to the fat as 100 :111, with the Ayrshire as 100 :108, and with the Jerseys, as 100 :134. This is a matter of considerable importance because of its bearing upon the proposal to measure the cheese value of milk by an estimation of the percentage of fat. It is very evident that a pound of fat in Jersey milk does not carry with it so large an amount of the other solids that go into the cheese as does a pound of fat in the Ayrshire milk. In other words, the cheese value of Ayrshire milk is larger in proportion to its percentage of fat than is the case with the Jersey milk, and the difference is sufficiently large to be worthy of practical consideration. The analyses of the milk of several breeds of animals at the N. J. Experiment Station, furnish similar testimony in regard to this matter.

RELATION OF CASEIN AND ALBUMEN TO BUTTER FAT.

Results at N. J. Experiment Station.

Holstein	Casein	and	Albumen	: Fat	:: 100 : 116
Ayrshire	"	"	"	"	100 : 108
Jersey	"	"	"	"	100 : 125
Guernsey	"	"	"	"	100 : 123

(2.) *Effect of certain conditions upon the relative proportion of milk solids.*

A great deal of discussion is going on at the present time in regard to the effect of certain conditions upon the composition of the milk solids. The question is, Can we increase the casein and diminish the fat, or increase the fat and diminish the casein, in a cow's milk, by changes in her food, or does the relation in quantity of the various milk solids depend upon the constitutional characteristics of the animal? Again, does the composition of the milk solids vary with the season or with the duration of the period of lactation? One of the tables just given shows the relation in quantity of the casein and albumen to the butter fat in the case of six cows for the period of two years, this relation being determined by the analysis of the milk during five days in nearly every month of the year. It is plainly seen that the composition of the milk solids is somewhat variable, that is, that the fat is sometimes more, and sometimes less, in proportion to the casein and albumen. But a very careful study of the figures fails to reveal any fixed relation between these changes and the food of the animals, the season, or the period of lactation. The change from cold weather to warm, from dry food to grass, or from a full yield of milk to the diminished yield of approaching parturition, seems to have no well defined effect upon the proportions in which the various ingredients exist in the milk solids.

Whatever changes occur seem to be due to functional causes that are hidden from ordinary observation. Whether or not radical changes in the food have the effect to increase or decrease the amount of a single ingredient of the milk without affecting other ingredients to a like degree, is still a question in dispute, although all the scientific experience of the past indicates that such is not the case. This Station is about to enter into an investigation with a view to studying this point.

(3.) *The effect of an advance in the period of lactation.* The general effect of an advance in the period of lactation seems to be to increase the solid matter in the milk. It is especially true that during the last few weeks a cow produces milk previous to the time of parturition, the percentage of solids in the milk is greatly increased. It is a question whether the somewhat uniform increase that is seen to occur in the quantity of solids, is not due to the corresponding decrease in the yield of milk. It would not be strange if extended observations finally show that any cause tending to largely augment the amount of milk produced within a given time has in general the effect of diminishing the percentage of milk solids, whether that cause be breed, food, season or any other. For this reason it is not safe to measure the value of a ration for either butter or cheese production by the increase or decrease which such ration may cause in the yield of milk.

A part of the animals have shown an increase in the relative amount of fat in the milk solids as the period of lactation has advanced, but this has not been generally true and seems therefore to be an individual matter.

(4.) *The daily variation of the composition of milk.*

There is a daily variation in the composition of milk which seems to be independent of breed, individuality, food, or any other known cause. While the milk of any given animal may have essentially the same composition during six days out of seven, there occasionally comes a day when there is suddenly an unexplainable change and which is sufficiently great to render it entirely unsafe to judge of the effect of food by the composition of a single day's milk. When, however, we take the averages of periods of four or five days each, we find that these averages compare very closely. If, for instance, the milk of a single animal were to be analyzed for every day in a month, and these analyses were to be averaged in six periods of five days each, it would be found that the six averages would give practically the same figures. Whatever permanent changes take place in the character of the milk of the individual animal are periodical in their nature and seem to be due largely to conditions over which we have no control. We must after all regard any particular cow as a machine set to a certain gauge, which is capable of producing a certain kind of product, and while we may make changes in food and surroundings which increase or decrease the amount of product, we can do but little in the way of changing its character.

Composition of Skimmed Milk, Cream and Butter Milk.

On the days that the whole milk has been analyzed samples of the skimmed milk have also been taken, as well as samples of the cream and butter milk coming from the milk during these periods. The samples were taken as follows: the skimmed milk was drawn off to within an inch or so of the cream, then stirred, and a portion taken for analysis, after which the skimming was completed. In this way the accidental presence of fat from the cream was avoided. The cream was thoroughly stirred before churning and then sampled. The samples of butter milk were taken before it was mixed with the washings from the butter. The analyses have not been complete, only the total solids and fat having been determined.

The analytical results appear below:

Tables Showing Composition of Skimmed Milk, Cream, and Butter Milk of Each Cow.

Jansje.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
July 15-19	11.58	1.03	22 76	13.77	10.58	.22
September 30,-October 4	9.35	.16	24.54	17.05	9.74	.92
November 11-15	9.49	.55	22 99	15.69	9.05	.23
January 7-11	9.79	.75	24.94	17.59	9.24	.35
February 17-21	9.52	.46	24.20	16.69	9.27	.16
March 19-23	9.52	.37	23 45	15 91	9 32	.10
April 22-26	9.31	.35	30.61	21.02	8.97	.13
June 10-14	9.81	.36	26.05	18.36	9.85	.17
Average	9.79	.50	24.94	17.01	9.50	.26

Agnes Smit.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
July 15-19	9.15	.56	26.18	19.46	9.45	.71
September 30,-October 4	9.85	.88	26.40	19.27	12.64	.43
November 11-15	10.63	1.35	25.26	17.62	9.59	.29
February 17-21	9.58	.42	28.01	21.82	9.70	.37
March 19-23	9 03	.44	26.34	19.36	9.15	
April 22-26	8.86	.48	30.48	22.89	9.05	1.10
June 10-14	9.10	.46	27.84	20.48	9.22	.39
Average	9.45	.65	27.22	20.13	9.83	.54

Nancy Avondale.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
July 15-19	9.69	.31	24.51	16.32	9.50	.35
September 30,-October 4	9.88	.40	23.88	16.15	11.02	2.07
November 11-15	10.10	.57	23.56	15.49	9.65	.22
January 7-11	11.59	.89	24.55	16.08	12.03	1.96
February 17-21	11.28	.89	25.22	16.49	11.49	.76
March 19-23						
April 22-26						
June 10-14	9.51	.22	25.05	17.56	9 49	.36
Average	10 34	.54	24.46	16.34	10 53	.62

Queen Linda.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
January 7-11	10.11	1.05	27.03	19.70	9.51	.38
February 17-21	10.39	1.12	25.71	17.77	9.79	.33
March 19-23	10.35	1.00	26.38	18 82	9 55	.19
April 22-26	10.12	1.02	26.23	18.90	9.31	.16
June 10-14	10.55	1.02	27.70	20.26	9.61	.31
July 7-11	10.43	1.08	27.27	19.80	7.96	.69
August 11-15	11.18	1.80	24.26	16.05	9.99	.27
Average	10.45	1.15	26.37	18.75	9 39	.33

Agnes.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
September 30,-October 4	10.42	.08	27.75	19.49	10.15	.10
November 11-15	10.56	.18	27.01	18.64	10.52	.12
January 7-11	10.83	.26	27.85	19.58	10.83	.09
February 17-21	10.69	.18	27.28	18.69	10.96	.35
March 19-23	10.70	.11	27.03	18 59	10.52	.09
April 22-26	10.26	.09	27.81	19.75	10.29	.08
June 10-14	10.59	.20	29.97	21.78	10.63	.18
July 7-11	10.46	.22	28,68	20.58	10.54	.28
August 11-15	10.36	.37	27.65	19.15	10.62	.25
Average	10.54	.19	27.89	19.58	10.56	.17

Ida.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
September 30,-October 4	9.55	.10	27.80	20.21	9.38	.38
November 11-15	9.58	.17	27.34	19.81	9.45	.07
January 7-11	10.34	.47	26.73	19.31	10.23	.40
February 17-21	10.20	.29	28.02	19.83	10.24	.17
March 19-23	10.28	.15	27.93	19.96	10.10	.08
April 22-26	9.98	.09	29.02	21.18	10.01	.08
June 10-14	10.49	.50	31.33	24.01	8.90	.22
July 7-11	10.69	.81	31.47	23.70	10.38	.31
August 11-15	10.53	1.08	28.85	20.74	10.22	.23
Average	10.18	.40	28.72	20.97	9.88	.22

Average Composition of Skimmed Milk, Cream and Butter Milk of the Different Breeds for Two Years.

	Skimmed Milk.		Cream.		Buttermilk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
Holstein	9.50	.52	25.80	18.30	9.70	.45
Ayrshire	10.40	.85	25.00	17.00	10.00	.44
Jersey	10.50	.37	27.90	19.80	10.30	.19

Several facts are shown in regard to the skimmed milk, cream and butter milk which are worthy of attention, partly because they stand in opposition to certain notions that are entertained by many. First of all, it does not appear to be true that the cows producing the most and the richest cream are those that furnish the poorest skimmed milk. The proportion of cream from the Jersey milk has been much larger than from either of the other two breeds, and at the same time the Jersey skimmed milk proves to be the richest of all.

The question is often asked, How do skimmed milk and butter milk compare in composition? It appears from these analyses that they are not greatly different so far as the percentage of solid matter is concerned. It is true with regard to both skimmed milk and butter milk that they follow the order of richness of the whole milk from which they come, or in other words, the poorer the whole milk, the poorer are the waste products of the dairy. In regard to the waste of fat, it appears that the Jerseys have had the advantage with both the skimmed milk and butter milk. The Ayrshire skimmed milk has contained the most fat, but with the butter milk there has been but very little difference between the Holstein and Ayrshire.

Another interesting matter is that of the composition of the cream. It is a fact that the Jerseys have uniformly produced the richest cream, while the average is lowest for the Ayrshires. In these cases, the analyses made in the laboratory are in entire accordance with the results obtained with the churn. This is equivalent to saying that all kinds of cream are not the same. The results of these analyses suggest an explanation of the fact that has been observed by creamery men, namely: that cream gathered in autumn appears to have a lower butter value than that of spring or summer. The poor feed of the pastures and other conditions have been brought forward as an explanation of this fact, but in the light of the results here shown, it seems more reasonable to suppose that this lower butter value of cream, is due to the advanced period of lactation. The practice of dairy men now is such that in the autumn the herd generally contains fewer animals fresh in milk than at any other season of the year. A careful study of the figures given in the above tables shows that while the cream from a cow that has been milked several months is as rich in solid matter as when she was "fresh," there is a marked difference in the relative amount of the different solids. It seems that without exception the cream-solids from a "fresh" cow contain a larger proportion of butter fat than is the case during the latter stages of the milking period. This fact is made evident by the figures in the succeeding table, where the relation of the fat to the other solids of the cream is numerically stated.

Relation of Other Solids in Cream to the Fat.

	Jansje.			Agnes Smit.		
	Total solids.	Solids not fat.	Ratio of other solids to fat.	Total solids.	Solids not fat.	Ratio of other solids to fat.
Cream from "fresh" cow	24.54	7.49	1 : 2.3	28.01	6.19	1 : 3.5
Cream just previous to "drying off".........	22.76	8 99	1 : 1.5	25.26	7.65	1 : 2.3
	Nancy Avondale.			Queen Linda.		
Cream from "fresh" cow	25.05	7 49	1 : 2.3	27.03	7 33	1 : 2.7
Cream just previous to "drying off"...... ...	25.22	8.73	1 : 1.9	24.26	8.21	1 : 1.9
	Agnes.			Ida.		
Cream from "fresh" cow	27.75	8.26	1 : 2,3	27,80	7.60	1 : 2.7
Cream just previous to "drying off"	27.65	8.50	1 : 2.2	28.85	8.11	1 : 2.6

As above stated, the inches of cream have not been measured during the entire two years, but only from March 2nd, 1880, to the following September. In order to furnish additional testimony for the correctness of the figures in the above table, the relation of butter to the inches of cream both in March 1890 and in September of the same year is given. It appears that without exception more inches of cream were necessary for a pound of butter in September than in March, and it is also true that at the latter time the three animals mentioned were near the time of "drying off."

	Queen Linda.	Agnes.	Ida.
Inches of cream for 1 pound of butter March 2–9	2.2	2.1	1.9
Inches of cream for 1 pound of butter August 24–31....	3.2	2.4	2.4

The Food Value of the Waste Products of the Dairy.

The food value of the skimmed milk and butter milk, which are the waste products from butter making, is not sufficiently considered in estimating the profits of dairying. The methods adopted in testing these dairy animals have made it possible to secure some very definite and reliable figures in regard to this matter. The table below shows these figures.

Table Showing the Food Material Retained in the Waste Products of the Dairy.

	Jansje.	Agnes Smit.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
Total milk solids, 1st year............	1228.		751.	893.	1015.	638.
" " 2nd year	1042.	893.	811.	919.	960.	696.
Average..................	1135.	893.	781	906.	987.	667.
Cream solids, 1st year	415.		238.8	230	415.7	253.2
" " 2nd year	335.	251.5	246	232.2	422.4	293.5
Average	375.	251.5	242.4	231.1	419.	273.3
Cream solids, per cent. of total milk solids, 1st year....................	33.8		31.8	25.7	40.9	39.7
Cream solids, per cent. of total milk solids, 2nd year.................	32.2	28.2	30.3	25.3	44.0	42.2
Average	33.	28.2	31.0	25.5	42.4	40.9
Skim-milk solids, 1st year...........	768.5		491.9	632.1	557.2	340.9
" " 2nd year...........	673.9	610.8	526	650.7	492.4	366.4
Average	721.2	610.8	508.5	641.4	524.8	353.6
Skim-milk solids, per cent. of total milk solids, 1st year...............	62.6		65.5	70.6	54.9	53.4
Skim-milk solids, per cent. of total milk solids, 2nd year	64.6	68.4	64.9	70.8	51.3	52.6
Average	63.6	68.4	65.2	70.7	53.1	53.
Butter-milk solids, 1st year	124.2		68.	64.1	104.7	59.
" " 2nd year..........	91.4	60.8	79.	57.7	106.8	65.
Average	107.8	60.8	73.5	60.9	105.7	62.
Butter-milk solids, per cent. in total milk solids, 1st year...............	10 1		9.0	7.2	10.2	9.2
Butter-milk solids, per cent. in total milk solids, 2nd year......... ...	8.8	6.8	9.7	6.3	11.1	9.3
Average	9.5	6 8	9.3	6.7	10 6	9.2

We see that the total amount of solid matter contained in a year's milk of the various animals ranged from 667 pounds up to 1135 pounds, or an average of 895 pounds per year. There was retained in the skimmed milk and butter milk from 416 up to 829 pounds of dry matter, or an average of 638 pounds of dry matter. This is seventy-one per cent. of the total yearly production, or, stated in another way, in making butter there is sent away from the farm only twenty-nine per cent. of the dry matter which the cows produce. It is worthy of note that seven-eighths of this is contained in the skimmed milk, which is equivalent to saying that the food value of the skimmed milk is seven times that of the butter milk. Now, what is the total food value of the waste products of the dairy, reckoned in dollars and cents?

At the present prices of grain it is safe to estimate the solids in the butter milk and skimmed milk at two cents per pound, which would give an average value per cow of $12.76 yearly. It should be remembered that this material is wholly edible and wholly digestible, whereas in the case of grain from fifteen to twenty-five per cent. of the dry matter is indigestible and of no use to the animal.

Loss of Fat in the Waste Products of the Dairy.

In testing the behavior of the milk of these several animals in the manufacture of butter, the various lots of milk have been treated exactly alike, that is, they have been set in the same cabinet, with water at the same temperature and for the same length of time.

In the table below can be seen the amounts of fat which the cold setting process has failed to remove from the skimmed milk, as well as the amounts of fat in the butter milk.

	Jansje.	Agnes Smit.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Total fat in milk, 1st year	340.4		208.8	245.9	352	237.8
" " " 2nd year	286.5	251.6	219.5	269.6	337 5	263.1
Average	313.4	251.6	214.1	257.7	344.7	250.4
Fat left in skimmed milk, 1st year	22.9		248.	64.	13.1	19.3
" " " " 2nd year	32.6	38.	23.6	68.3	8.5	14.2
Average	27.7	38.	24 2	66.1	10.8	16.7
Fat left in butter-milk, 1st year	6.1		3.3	2.1	1.4	1.
" " " 2nd year	2.7	3.2	7.1	2.0	1.7	1.4
Average	4.4	3.2	5.2	2.0	1.5	1.2
Total waste of fat, average	32.1	41.2	29.4	68.1	12.3	17.9
	%	%	%	%	%	%
Per cent. total fat in skimmed milk, 1st year	6.7		11.9	26.0	3.7	8.1
Per cent. total fat in skimmed milk, 2nd year	11 38	15.1	10.75	25.3	2.5	5.4
Average	9.0	15.1	11.3	25.6	3.1	6.7
Per cent. total fat in butter-milk, 1st year	1.8		1.6	0.8	0.4	0.4
Per cent. total fat in butter-milk, 2nd year	.9	1.27	3.2	0.7	0.5	0.5
Average	1.3	1.3	2.4	.75	.45	.45
Total per cent. waste of fat, average	10.3	16.4	13.7	26.3	3.5	7.10

Several facts are very plainly set forth by the above figures. The most noticeable fact is that the behavior of the milk from the various animals is greatly different. For instance, in the skimmed milk from the cow Agnes only 12.3 pounds of fat were left during the entire year, whereas the amount in the case of the cow Queen Linda is seen to be 68.1 pounds. It cannot be said that poor manipulation of the milk is the cause of the large waste in the case of the latter animal, because the milk was treated exactly alike in the two cases.

It is claimed by certain parties that where a can is only partially filled the creaming is not as perfect as with full cans, but granting that this is true, the effect of this condition should be seen to as great an extent with the two Jerseys as with the animals of the other breeds. On the contrary, we see that the creaming of the Jersey milk has been very satisfactory, notwithstanding the cans have for part of the time only contained a small amount of milk. The fact simply is that the cold setting process is able to do for one kind of milk what it cannot do for another. Where the manipulation of the milk has been entirely the same in all cases, we must look to the constitution of the milk for an explanation of this difference in behavior. A reference to the work done by Mr. Merrill in studying the milk globules of these various animals, which appears later on, seems to offer a satisfactory partial explanation of the great difference in the readiness in which the fat globules come to the surface in the two cases cited.

The loss of fat in the skimmed milk has varied from 10.8 pounds yearly to 66.1 pounds, or an average for the six cows of 30.6 pounds. By the use of a centrifuge it would be possible to remove all but about seven pounds of this fat, which would be equivalent to a gain of thirty pounds of butter per cow. This would amount to an increased income per animal of about six dollars. It remains for the farmer to determine whether with his herd of ten to twenty cows such an income would warrant either the use of a centrifuge at home, or the shipping of his milk to a factory where the cream is separated by the centrifugal process. It is fair to remark, that with a herd of Jerseys or grade Jerseys the gain made by discarding the cold setting process would undoubtedly not be as great. Another fact prominently brought to view by these figures is that the great waste of butter fat is in the skimmed milk, the waste in the butter milk being of comparatively little importance.

It is to the process of separation of cream that we must look for an improvement in dairy methods if we wish to avoid the larger wastes of butter fat, rather than to be churning. The highest average loss in the butter milk for any single cow during two years has been five pounds.

SUMMARY.

(1.) The average amount of water-free food consumed daily by the cows tested was, for each animal; Holsteins 27.4 lbs., Ayrshire 24.7 lbs., Jersey 23.2 lbs.

The weight of digestible dry matter consumed per cow, averaged daily: Holstein 17.70 lbs., Ayrshire 15.70 lbs., Jersey 15. lbs. The daily use of digestible dry matter for each 1000 lbs. of live weight has been as follows: Holstein 14.30 lbs., Ayrshire 15.2 lbs., Jersey 16.8 lbs.

(2.) It has required approximately ten pounds of dry food material, or 6.6 pounds of digestible food material, to produce one pound of milk solids. The averages for the three breeds are nearly alike in this particular.

(3.) The annual yield of milk solids has been: Holsteins 1014 lbs., Ayrshire 848 lbs., Jersey 827 lbs., or in the ratio of 122, 102 and 100 respectively. The annual yield of butter fat has been: Holsteins 285 lbs., Ayrshire 233 lbs., Jersey 297 lbs., or in the ratio of 122, 100 and 128 respectively.

(4.) The milk required for a pound of milk solids has been as follows: Holsteins 8.3 lbs., Ayrshire 7.8 lbs., Jersey 6.6 lbs. For a pound of butter fat: Holstein 29.4 lbs., Ayrshire 28.3 lbs., Jersey 18.2 lbs. The weight of cream corresponding to a pound of butter has been: Holstein 4.7 lbs., Ayrshire 5.0 lbs., Jersey 4.1 lbs.

A measurement of the cream in inches for six months, showed the relation of cream to one pound butter to be as follows: Holstein 2.24 inches, Ayrshire 2.42 inches, Jersey 2.03 inches.

(5.) The food cost of a quart of milk, reckoning the cattle foods at market prices has been: Holstein 1.83 cents, Ayrshire 2.03 cents, Jersey 2.42 cents, or in the ratio of 100: 111: 132. The food cost of a pound of milk solids has been: Holstein 7.09 cents, Ayrshire 7.45 cents, Jersey 7.44 cents, or in the ratio of 100: 105: 105. The food cost of a pound of butter fat has been: Holstein 25.22 cents, Ayrshire 26.82 cents, Jersey 20.43 cents, or in the ratio of 100: 107: 81.

A pound of milk solids has been produced by these six cows at an average food cost of 7.3 cents, which bears to the cost of a similar amount of edible material in a steer's carcass an estimated ratio of 100: 350.

(6.) The average composition of the milk for two years has been: Solids in 100 lbs., Holstein, 12.22 lbs.; Ayrshire, 12.98 lbs.; Jersey, 15.24 lbs., or in the ratio of 100: 106: 125. The pounds of fat in 100 pounds of milk have been: Holstein, 3.47 lbs.; Ayrshire, 3.67 lbs.; Jersey, 5.50 lbs., or in the ratio of 100: 106: 158. In general the milk has grown richer in solids (and fat) up to the time of "drying off."

(7.) The ratio of the quantity of nitrogenous compounds (mostly casein) to the butter fat has been subject to considerable variation but does not seem to have been controlled by changes in the food or season, or to have been modified by an advance in the period of lactation. The proportion of milk solids is affected by breed, however. The casein (and albumen) being represented by 100, its ratio to the butter fat is seen to average: Holstein, 100: 111, Ayrshire, 100: 108; Jersey, 100: 134.

(8.) The average percentages of total solids and of fat in the skimmed milk for the two years give: Solids, Holsteins, 9.50 per cent.; Ayrshire, 10.40 per cent.; Jersey, 10.50 per cent. Fat, Holstein, .52 per cent.: Ayrshire, .85 per cent. and Jersey, .37 per cent. In general the skimmed milk has grown richer in total solids and in fat as the time of parturition approached. The average composition of the butter milk has been: Solids, Holstein, 9.70 per cent; Ayrshire, 10.00 per cent.; Jersey, 10.30 per cent.; Fat, Holstein, .45 per cent.; Ayrshire, .44 per cent.; Jersey, .19 per cent. The composition of the skimmed milk and butter milk has not been greatly different.

(9.) The percentage of butter fat in the cream has averaged: Holstein, 18.30 per cent.; Ayrshire, 17.00 per cent. Jersey, 19.80 per cent. As the time of parturition has approached the amount of fat has been less in proportion to the other solids in the cream, than while the cows were "fresh."

(10.) The butter value of a given volume of cream has proved to be less in September than March, with such animals as were approaching the time of parturition.

(11. The skimmed milk has contained on the average 62 per cent. of the solid matter of the milk, and the butter milk, 9 per cent. At the present prices of cattle foods, the 639 lbs. of dry matter left in the dairy waste products from a single cow was worth for feeding purposes two cents per pound.

(12.) The annual waste of butter fat in the skimmed milk has varied with the different cows from 10.8 lbs. to 66.1 lbs., or from 3.1 per cent. to 25.6 per cent. of the total fat. The waste in the butter milk has ranged from 1.5 lbs., to 5.2 lbs., or from .45 per cent. to 2.4 per cent. of the total fat. This waste has been least with the Jerseys and greatest with the Ayrshires.

MECHANICAL LOSS OF BUTTER FAT.

It is noted in the Station Report for 1889 on pages 131 and 132 that the total amount of solids in the whole milk is not accounted for by the amount of solids in the skimmed milk and sour cream. The loss seems to have fallen especially upon the butter fat. It was found that not far from ten per cent. of the fat in the whole milk failed to appear in the skimmed milk and sour cream. A calculation based upon the second year's test shows a similar discrepancy. In a table below, which gives the results for both years, it appears that from twenty to forty-six pounds of butter fat are annually unaccounted for in the case of each of the cows.

Results for 1888-9.

	Jansje. lbs.	lbs.	Nancy Avondale. lbs.	Queen Linda. lbs.	Agnes. lbs.	Ida. lbs.
Total solids in whole milk	1222.77		751.1	893.6	1015.2	638.4
Solids in skimmed milk / Solids in sour cream	1183.7		730.7	862.1	972.9	594.1
Deficiency of milk solids	44.		20.4	31.5	42.3	44.3
Total fat in whole milk	340.4		208.8	245.9	352.	237.8
Fat in skimmed milk	22.9		24.8	64.	13.1	19.3
Fat in sour cream	285.		163 5	154.	292.9	178.5
	307.9		188.3	218.	306.	197.8
Deficiency of fat	32.5		20.5	27.9	46.	40.

Results for 1889-90.

	Jansje. lbs.	Agnes Smit. lbs.	Nancy Avondale. lbs.	Queen Linda. lbs.	Agnes. lbs.	Ida. lbs.
Total solids in whole milk	1042.1	893.	811.	918.7	960.5	696.5
Solids in skimmed milk	673.9	610.8	526.	650.7	492.4	366.4
Solids in sour cream	335.1	251.5	246.1	232.2	422.4	293.5
Total	1009.0	862.3	972.1	882.9	914.8	659.9
Deficiency of milk solids	33.1	30.7	38.9	35.8	45.7	36.6
Total fat in whole milk	286.5	251.6	219.5	261.5	337.5	263.1
Fat in skimmed milk.	32.6	38.0	23.6	68.3	8.5	14.2
Fat in sour cream	229.6	187.4	165.2	166.3	296.2	213.3
Total	262.2	225.4	188.8	234.6	304.7	227.5
Deficiency of fat	24.3	26.2	30.7	26.9	32.8	35.6

One method of explaining this loss is to say that it is due to the milk and cream that have adhered to the dairy utensils. It is true, of course, that some loss does occur in this way, but it seems hardly possible that ten per cent. of the total butter fat in the milk adheres to the milk pails and cans in which the milk is set. To be sure, the amount of waste in this way has been relatively much larger because the quantity of milk and cream handled at each time was small, and so the amount adhering to the dairy utensils was a much larger proportion of the total dry matter in the milk. The method of calculation used in securing these figures should be regarded with some suspicion, perhaps, for as has has been stated, the product for each month, not only of milk, skimmed milk, but also of cream is assumed to have the same composition that is found for five days in the month, and all the calculations are made on this basis. In this way errors may have arisen, but it is hardly probable that they would all occur on one side and uniformly cause a discrepancy in the same direction. In order to test this matter more correctly and thoroughly, calculations have been made based upon the actual yield and composition of the milk and other products during the five days on which the cows were tested. A large part of the analyses made in 1888 were made of both the night's and morning's milk, and as the records show the the weights of each mess of milk, of the skimmed milk and of the total amount of cream at the time when it was ready for the churn, it is possible to ascertain whether any loss of fat occurred. This has been done for four cows during the period of five days in June and a similar period in July. Besides these calculations, a special test has been made in which quite a large quantity of milk of known composition was taken. This latter trial was made in February, 1890. These additional results are shown below.

	Chloe.		Lois.		Jansje.		Nancy Avondale.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
June, 1888.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Total in whole milk	17.30	4.68	14.92	4.24	22.97	6.32	16.50	4.36
in skimmed milk	12.29	.73	10.36	.78	15.26	.81	11.10	.82
in sour cream	4.75	3.62	4.33	3.27	6.94	5.14	4.67	3.28
	17.04	4.35	14.69	4.05	22.20	5.95	15.77	4.10
Deficiency	.26	.33	.23	.19	.77	.37	.73	.26
Per cent. loss fat		7.00		4.5		5.8		6.00
July, 1888.								
Total in whole milk	14.29	3.79		3.10	17.05	4.40		3.71
in skimmed milk	9.67	.39		.44	10.80	.29		.51
in sour cream	4.21	3.19		2.53	5.74	3.86		3.04
	13.88	3.58		2.97	16.54	4.15		3.55
Deficiency	.41	.21		.13	.51	.25		.19
Per cent. loss fat		5.50		4.20		5.70		4.30

Special Test of Loss of Fat.

Weight of milk taken morning	125 lbs.
" " " night	83½ "
" of sweet cream, total	38½ "
" of skimmed milk, morning	103 "
" " " night	66¾ "
" of sour cream, total	37⅛ "

	Whole milk.		Skimmed milk.		Sweet Cream.	Sour Cream.
	Morn.	Night.	Morn.	Night.		
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Solids in 100 lbs	12.75	13.02	9.99	9.69	25.77	25.80
Fat in 100 lbs	3.75	4.07	.685	.478	18.19	18.17

Contained in whole milk	26.83 lbs. solids,	8.09 lbs. fat.
" in sour milk and sweet cream	26.68 "	8.02 "
" in sour milk and sour cream	26.34 "	7.77 "

Fat not accounted for in sour milk and sour cream, .32 lbs. = 4 % of total fat.

In no instance was the amount of fat in the skimmed milk and the sour cream equal to that of the whole milk, the discrepancy, or apparent loss, amounting in the several cows to from four to seven per cent. of the total fat in the milk. It should be noted that in the special trial where a large quantity of milk is used, the fat of the sweet cream plus that of the skimmed milk accounts for practically that of the whole milk. The cream was allowed to stand a longer time than usual before churning and diminished in weight from evaporation or otherwise a pound and three-eights. The percentage of fat seems to have remained unchanged, however, and the sour cream, although the weights were taken without pouring the cream from one can to another, thus avoiding any mechanical loss, contained by analysis a quarter of a pound less of fat than the sweet cream. This indicates a loss of fat not yet explained. These trials would have been repeated in a more exhaustive manner had not lack of time prevented, but this will be done, and further investigation may show that this loss has been wholly mechanical.

THE EFFECT OF A DELAY IN SETTING MILK.

It is often the case that milk is allowed to stand an hour or so after it is drawn before it is strained and set in cold water. Especially with a large herd, the milk of the first animals milked may sit some time before it is brought into contact with the cold water. Again, oftentimes the dairy-man is careless in allowing the milk to stand unnecessarily and so does not strain it into the cans nearly as soon as he might. The question arises, What is the effect of this delay in setting milk upon the amount of fat which is left in the skimmed milk? In order to secure information upon this point the matter was tested in the following manner: The milk of several animals (grades) was drawn as quickly as possible, thoroughly mixed in a large vessel, divided into two equal parts and one-half immediately submerged in water at a temperature of about 40°. The other half of the milk was allowed to stand from one-half hour to an hour, after that delay being submerged in the same cabinet with the other portion of the milk.

The following data were recorded:

The weight of milk set; the temperature of that portion of the milk which was placed in the cold water immediately; the temperature at the time of submerging of that portion of the milk which was allowed to stand some time before placing in the cold water; the composition of the milk which was used in the tests and the composition of the skimmed milk.

The first test was made from Jan. 20th to Jan. 24th, 1890, and the second test was made from Feb. 3rd to Feb. 7th, 1890. In the case of the first test, that portion of the milk which was allowed to stand some time before setting in the cold water was strained into the cans at the same time that the other portion was set in the water, and when finally placed in the water it was not stirred. During the second test that portion of the milk which was not put into cold water until after a half hour or an hour, was thoroughly stirred at the time it was submerged. This latter method of treatment would correspond entirely to the way in which milk is manipulated when it is allowed to stand some time before straining. It should be stated that the milk which was not at once placed in the cold water was in the first test allowed to stand in the dairy-room, and in the second test, in a cold walk outside of the dairy-room. The results which are shown in the tables below were a surprise. Their testimony, however, is unmistakably in one direction.

Tables Showing the Effect a Delay in Setting Milk After it is Drawn.

	Weight of each lot of milk set.	Composition of milk set.	
		Total Solids.	Fat.
	lbs.	%	%
January 20th, night	17¼	13.26	4.58
" 21st, morning	25½	12.54	3.55
" 21st, night	18¼	12.86	3.21
" 22d, morning	26	12.44	3.30
" 22d, night	18¼	12.55	3.78
" 23d, morning	24¾	12.53	3.46
" 23d, night	18	13 37	4.57
" 24th, morning	24¾	12 75	3.48
" 24th, night	20¾	12.96	4.37
February 3d, night	27½	13.30	4.22
" 4th, night	28	12.80	4.10
" 5th, night	28	13.07	4.28
" 6th, night	27	13.25	4.05
" 7th, night	35	13.49	4.50

	Milk set at once after being drawn			Milk allowed to stand before setting. Not stirred when set.				
	Temp. of milk when set.	Comp. of skim'd milk		Time milk stood before setting.	Temperature of milk when set.	Degrees cooled by standing.	Comp. of skim'd milk	
		Total sol'ds	Fat.				Total sol'ds	Fat.
	°	%	%		°	°	%	%
January 20th, night	96	9.19	.27	½ hr.	90	6	9.21	.27
" 21st, morning,	94	10.12	1.00	½ hr.	90	4	9.85	.66
" 21st, night	96	9.21	.20	½ hr.	92	4	9.27	.25
" 22d, morning	96	9.40	.25	½ hr.	90	6	9.84	.64
" 22d, night	96	9.07	.20	½ hr.	90	6	9.09	.24
" 23d, morning	96	9.59	.17	½ hr.	90	6	9.62	.22
" 23d, night	94	9.29	.17	1 hr.	86	8	9.35	.20
" 24th, morning	96	9.50	.20	1 hr.	86	10	9.51	.20
" 24th, night	94	9.41	.20	1 hr.	84	10	9.35	.24
Average			.29					.32
Average (ex. 21st morn.)			.21					.26

	Milk set at once after being drawn			Milk allowed to stand before setting. Stirred when set.				
	Temp. of milk when set.	Comp. of skim'd milk		Time milk stood before setting.	Temp. of milk when set.	Degrees cooled by standing.	Comp. of skim'd milk	
		Total sol'ds	Fat.				Total sol'ds	Fat.
	°	%	%		°	°	%	%
February 3d, night	96	9.41	.18	½ hr.	90	6	9.53	.21
" 4th, night	96	9.41	.14	½ hr.	91	5	9.51	.24
" 5th, night	95	9.46	.28	½ hr.	90	5	9.46	.29
" 6th, night	95	9.78	.32	1 hr.	84	11	9.79	.27
" 7th, night	95	9.49	.27	1 hr.	84	11	9.63	.27
Average			.24					.26

One of the important facts shown by the foregoing is the extent to which cooling took place by allowing the milk to stand from a half hour to an hour. A half hour's standing, both in the dairy-room and in the cooler walk outside, caused the temperature of the milk to lower from 4° to 6° or an average of 5.3°. An hour's standing lowered the temperature of the milk in about the same proportion for the length of time, or from 8° to 11°, the average being 10°. In no case did the temperature of the milk get below 84°, the temperature of the freshly drawn milk ranging from 94° to 96°. When we come to consider the effect of this extent of cooling upon the completeness of the separation of the fat from the skimmed milk, we find it to be slight, in fact, scarcely worth considering.

In the first test where the milk was immersed in cold water as quickly as practicable after it was drawn, the average per cent. of fat in 8 trials was .21 per cent., while the skimmed milk from the milk allowed to stand from a half hour to an hour before being placed in the cold water was found to contain on an average .26 per cent. In the first test, as has been stated, the cooled milk was not stirred at the time of placing it in the cabinet, and in the second, the cooled milk was stirred when submerged. In this latter case the milk that was placed in the ice water at once left only .24 per cent. of fat in the skimmed milk, while that which was allowed to stand left .26 per cent. These differences are insignificant and show that with herds of ordinary size, it will not be profitable to submit to any great inconvenience in order to place the milk in ice water immediately after it is drawn. In a half hour to an hour, milk does not seem to cool sufficiently to materially effect the completeness with which the cream will rise.

THE PREPARATION OF THE RATION FOR MILCH COWS.

A great deal of time is spent in discussing not so much what the ration shall be as how it shall be fed. Matters which pertain to the minor details of cattle feeding, such as the method of preparing food, number of times of feeding, the mixture of the various parts of the ration and other things of similar nature, have been given, the writer believes, undue prominence in former discussions. It is especially the case that a prominent writer for one of our leading journals has strenuously advocated the chopping of the hay and coarse fodder fed, moistening the chopped material and thoroughly mixing the grain with it before feeding. This writer has claimed that the labor necessary to do this returns large profits.

The attention of the Director of the Station has been several times called to this matter and for that reason it was decided to make a test of the method advocated in order to illustrate either its value or lack of value. Consequently in the spring of 1890 the hay fed to the Station cows was for quite a period of time chopped quite fine, moistened and the grain thoroughly mixed with the chopped material. This mixture was allowed to stand several hours before feeding. Previous to beginning the feeding of the ration in this manner the animals were receiving hay and a mixture of two parts cotton seed meal, two parts corn meal and one part bran, by weight.

During the time that the chopped and moistoned ration was fed the kind and quantity of food given remained unchanged, and at the end of the period of fifty-one days the animals were returned to the former ration, that is, unchopped hay, and grain fed dry. As the cows to which these rations were fed were those which were undergoing a two years' test, a careful record was kept of their yield and of the quality of the milk. This being done it became possible to ascertain whether chopping the hay and thoroughly mixing the grain with it after moistening, had any appreciable effect upon production. The figures which appear in the following tables form the basis of our conclusions:

The Rations Fed.

	Jansje.	Agnes Smit.	Queen Linda.	Agnes.	Ida.
	lbs.	lbs.	lbs.	lbs.	lbs.
Dry ration, unmixed (February 2d to March 4th.)					
Hay fed daily (average)	24.4	22.5	22.7	21.6	20.7
Grain fed daily	8.	8.	7.	6.	6.
Ration, chopped, wet and mixed (Mar. 5th to April 24th.)					
Hay fed daily	25.	23.	23.	22.	20.
Grain fed daily	8.	*10.	7.	6.	6.
Dry ration, unmixed (April 25th to May 24th.)					
Hay fed daily	23.5	23.2	22.	21.8	21.6
Grain fed daily	8.	10.	7.	6.	6.

* The grain ration of Agnes Smit was increased on March 8th by two pounds of middlings.

Composition of the Milk During the Three Periods.

		Total solids.	Ash.	Casein etc.	Sugar.	Fat.
		%	%	%	%	%
Jansje.	February 17–21	12.23	.65	3.06	5.06	3.46
	March 19–23	12.35	.65	3.08	5.26	3.33
	April 22–26	12.23	.65	3.04	5.07	3.52
Agnes Smit.	February 17–21	12.68	.65	3.05	5.06	3.93
	March 19–23	11.60	.65	2.79	5.20	2.96
	April 22–26	11.38	.65	2.59	4.93	3.21
Queen Linda.	February 17–21	12.54	.65	2.99	5.36	3.54
	March 19–23	12.55	.65	3.02	5.48	3.40
	April 22–26	12.25	.65	3.04	5.04	3.52
Agnes.	February 17–21	15.36	.75	4.38	5.06	5.17
	March 19–23	15.29	.75	4.23	5.17	5.14
	April 22–26	15.24	.75	4.28	4.76	5.45
Ida.	February 17–21	15.12	.75	4.08	4.63	5.66
	March 19–23	15.55	.75	3.95	4.99	5.86
	April 22–26	15.15	.75	3.90	4.74	5.76

Production of Milk and Butter During the Three Periods.

	Jansje.	Agnes Smit.	Queen Linda.	Agnes.	Ida.
Dry ration, unmixed (30 days)	lbs.	lbs.	lbs.	lbs.	lbs.
Total milk yield	896.	1108.	904.	601.	397.
Total butter yield	29.7	43.9	24.7	34.5	24.6
Average daily milk yield	29.9	36.9	30.1	20.	13.2
Average daily butter yield	1.02	1.57	.82	1.15	.82
Ration, chopped wet and mixed (51 ds.)					
Total milk yield	1342.	1712.	1225.	884.	614.
Total butter yield	47.1	51.5	33.5	51.2	38.3
Average daily milk yield	26.3	33.6	24.	17.3	12.
Average daily butter yield	83	1.00	.66	1.00	.75
Dry ration, unmixed (30 days)					
Total milk yield	720.	803.	644.	492.	357.
Total butter yield	25.	23.7	17.	27.5	21.
Average daily milk yield	24.	26.7	21.5	16.4	11.9
Average daily butter yield	.83	.79	.57	.92	.72

The records show that up to March 5th, the several cows were eating dry hay and grain, that from March 5th to April 24th, inclusive, the ration of hay and grain, without being changed in kind or quantity, was simply mixed by chopping the hay, moistening it and sprinkling the grain upon it. After April 24th, the animals were returned to the same ration that they had eaten previous to March 5th. Now how did these changes affect production? There is no evidence that they had any affect. The amount of food given, it is seen, remained practically unchanged and it does not appear that the method of preparation had any influence either upon the yield or composition of the milk. It is noticed that the yield is given for thirty days previous to March 5th, and for thirty days following April 24th. The time during which the chopped and moistened ration was fed between those dates was fifty-one days. During all this time there appears to have been very little change in the composition of the milk, as is shown by analyses made in February, March and April. There was a steady decrease in the daily yield of each animal, which seems to have been quite uniform throughout the entire time, from the first of February to the last of May. The daily weights of each mess of milk, although not recorded above, show that in changing from the dry food to the moistened or from the moistened to the dry, there was no deviation in the daily production, but that the animals behaved in every respect as though they were receiving the same amount of nutrition in the same form, which was really the case. The simple fact seems to be, that when animals are receiving palatable food that is adapted to their needs these minor differences in the method of treating the ration have very little influence. Of course it must be conceded that if steaming or chopping and wetting a coarse fodder renders palatable that which would otherwise be unpalatable and therefore useless as a cattle food, a saving is thereby made. It is, then, only a question as to whether the material thus utilized is of greater value than the cost of preparing it. But there is very little evidence that steaming, chopping, wetting or otherwise treating cattle foods that are palatable without any treatment, and of which the animals will eat a sufficient quantity in their natural condition, is good economy.

THE MINERAL INGREDIENTS OF MILK.

BY L. H. MERRILL.

Analysis of the Ash of Milk.

The milk from which the ash was obtained for these analyses was not taken at random, but represents five consecutive milkings from each cow, 50 cubic centimeters being taken from each lot of milk at each milking. The skimmed milk represents the same lots as the whole milk.

For the benefit of those who are not familiar with chemical methods, it should be stated that the potassium, sodium, iron, etc., found in the ash were calculated as oxides. It is probable, however, that all the chlorine present is combined with these elements, and that the weight of the ash as calculated is too great by the amount of oxygen which would be replaced by the chlorine found. About 71 parts by weight of chlorine would replace 16 parts of oxygen. This correction is applied in all these tables.

Composition of Milk Ash.

Holstein.

	100 parts of ash contained.					
	Jansje.		Agnes Smit.		Average.	
	Whole	Skimmed	Whole	Skimmed	Whole	Skimmed
Potash	26.49	26.67	27.23	27.12	26.86	26.89
Soda	8.88	7.35	9.37	9.19	9.12	8.27
Lime	21 94	22 70	19.65	19.93	20.79	21.31
Magnesia	3.25	2.71	2 47	2 39	2.86	2.55
Iron Oxide	.44	.52	.42	.25	.43	.39
Phosphoric Acid	26.11	26.49	29 63	29.47	27.87	27.98
Sulphuric Acid	2.43	2.50	1.41	1.79	1.92	2.14
Chlorine	13.49	14.27	12.68	12.72	13.09	13.50
	103.03	103.21	102.86	102.86	102.94	103.03
Oxygen equivalent to Chlorine	3.03	3.21	2.86	2.86	2.94	3.03
	100.00	100.00	100.00	100.00	100.00	100.00

Composition of Milk Ash.

Ayrshire.

	100 parts of ash contained.					
	Nancy Avondale.		Queen Linda.		Average.	
	Whole	Skimmed	Whole	Skimmed	Whole	Skimmed
Potash	18.80	19.08	25.97	25.79	22.38	22.43
Soda	11 72	9.90	7.62	7.72	9.67	8.81
Lime	26.85	27.13	24.05	23.98	25.45	25.55
Magnesia	3.10	2.77	2.34	2.53	2.72	2.65
Iron Oxide	.39	.59	.19	.31	.29	.45
Phosphoric Acid	25.52	26.53	30.31	29.40	27.92	27.97
Sulphuric Acid	3.21	3.26	1.38	1.76	2.29	2.51
Chlorine	13.44	13.86	10.51	10.99	11.98	12.43
	103.03	103.12	102.37	102.48	102.70	102.80
Oxygen equivalent to Chlorine	3.03	3.12	2.37	2.48	2.70	2.80
	100.00	100.00	100.00	100.00	100.00	100.00

Jersey.

	100 parts of ash contained.					
	Agnes.		Ida.		Average.	
	Whole	Skimmed	Whole	Skimmed	Whole	Skimmed
Potash	21.65	21.30	23 94	22.91	22.79	22.10
Soda	7.79	7 65	8.94	8 50	8 37	8.08
Lime	25.58	25.45	22.13	22 93	23 85	24.19
Magnesia	2.50	2.68	2.59	2.49	2.55	2.57
Iron Oxide	.46	.49	20	.19	.33	.34
Phosphoric Acid	31.41	31.75	32.97	32.46	32.19	32.11
Sulphuric Acid	2.70	2 40	.93	1.92	1.81	2.16
Chlorine	10.21	10.70	10.71	11.10	10.46	10.91
	102.30	102.42	102.41	102.50	102.35	102.46
Oxygen equivalent to Chlorine	2.30	2.42	2.41	2.50	2.35	2.46
	100.00	100.00	100.00	100.00	100.00	100.00

This work was undertaken in part to show the differences in composition which might be attributed to differences in breed. It is evident, however, that analyses from a larger number of cows would be necessary to give any conclusive results of this character. The potash and phosphoric acid seem to be the most variable constituents. It will be seen that the ash from the Holstein milk contains more potash than that from the other two breeds. On the other hand, the Jerseys show a much larger percentage of phosphoric acid than the others.

These differences are insignificant, however, when compared with the individual differences shown in the two Ayrshire cows, Nancy Avondale and Queen Linda. The small amount of potash in the case of the former seems to be compensated for in part by a correspondingly larger quantity of soda and lime. On the other hand, the ash from the milk of Queen Linda contains more phosphoric acid and less sulphuric acid and chlorine than that from the milk of Nancy Avondale.

Pounds of Ash Ingredients in 1000 lbs. of Milk.

Holstein.

	Whole milk.			Skimmed milk.		
	Jansje.	Agnes S.	Av'rage.	Jansje.	Agnes S.	Av'rage.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potash	1.79	1.59	1.69	1.86	1.67	1.76
Soda	.60	.55	.57	.51	.56	.54
Lime	1.49	1.15	1.32	1.58	1.22	1.40
Magnesia	.22	.14	.18	.19	.15	.17
Iron Oxide	.03	.02	.03	.04	.02	.03
Phosphoric Acid	1.77	1.72	1.74	1.84	1.81	1.82
Sulphuric Acid	.17	.08	.13	.17	.11	.14
Chlorine	.91	.74	.83	.99	.78	.89
	6.98	5.99	6.49	7.18	6.32	6.75
Oxygen equivalent to Chlorine	.21	.17	.19	.22	.18	.20
	6.77	5.82	6.30	6.96	6.14	6.55

Ayrshire.

	Whole milk.			Skimmed milk.		
	N. A.	Q. L.	Av'rage.	N. A.	Q. L.	Av'rage.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potash	1.33	1.61	1.47	1.37	1.68	1.52
Soda	.83	.47	.65	.71	.50	.61
Lime	1.91	1.49	1.70	1.95	1.57	1.76
Magnesia	.22	.15	.18	.20	.17	.18
Iron Oxide	.03	.01	.02	.04	.02	.03
Phosphoric Acid	1.81	1.88	1.85	1.91	1.92	1.92
Sulphuric Acid	.23	.09	.16	.24	.11	.17
Chlorine	.95	.66	.80	1.00	.72	.86
	7.31	6.36	6.83	7.42	6.69	7.05
Oxygen equivalent to Chlorine	.21	.15	.18	.22	.16	.19
	7.10	6.21	6.65	7.20	6.53	6.86

Jersey.

	Whole milk.			Skimmed milk.		
	Agnes.	Ida.	Av'rage.	Agnes.	Ida.	Av'rage.
Potash	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Soda	1.69	1.79	1.74	1.78	1.76	1.77
Lime	.61	.67	.64	.64	.65	.64
Magnesia	1.99	1.66	1.82	2.12	1.76	1.94
Iron Oxide	.19	.19	.19	.22	.19	.21
Phosphoric Acid	.04	.02	.03	.04	.02	.03
Sulphuric Acid	2.45	2.47	2.46	2.65	2.50	2.57
Chlorine	.21	.07	.14	.20	.15	.18
	.79	.80	.80	.89	.85	.87
	7.97	7.67	7.82	8.55	7.88	8.21
Oxygen equivalent to Chlorine	.18	.18	.18	.20	.19	.19
	7.79	7.49	7.64	8.35	7.69	8.02

Total Contents of Ash in the Milk of Each Cow for One Year.

Holstein.

	Whole milk.			Skimmed milk.			Cream.
	Yield milk. lbs.	Ash. %	Total Ash. lbs.	Yield milk. lbs.	Ash. %	Total Ash. lbs.	Total Ash. lbs.
Jansje..........	9176	.677	62.13	7578	.696	52.75	9.38
Agnes Smit....	7562	.582	44.00	6589	.614	40.45	3.55

Pounds of Ash Ingredients in Total Yield of Milk.

	Whole milk.			Skimmed Milk.		
	Jansje.	A. S.	Av'rage.	Jansje.	A. S.	Av'rage.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potash	16.46	11.98	14.22	14.07	10.97	12.52
Soda	5.52	4 12	4.82	3.88	3 72	3.80
Lime	13.63	8.65	11.14	11.97	8.06	10.01
Magnesia	2.02	1.09	1.55	1.43	.97	1.20
Iron Oxide	.27	.18	.23	.27	.10	.19
Phosphoric Acid..........	16.23	13.04	14.63	13.97	11.92	12.94
Sulphuric Acid...........	1.50	.62	1.06	1.32	.72	1.02
Chlorine...................	8.39	5.58	6.99	7.53	5.14	6.34
	64.02	45.26	54.64	54.44	41.60	48.02
Oxygen equivalent to Chlorine	1.89	1.26	1 57	1.69	1.15	1.42
	62.13	44.00	53.07	52.75	40.45	46.60

Ayrshire.

	Whole milk.			Skimmed milk.			Cream.
	Yield Milk. lbs.	Ash. %	Total Ash. lbs.	Yield Milk. lbs.	Ash. %	Total Ash. lbs.	Total Ash. lbs.
N. Avondale..	6120	.710	43.46	5082	.720	36.58	6.88
Queen Linda .	7105	.621	44.12	6147	.653	40.14	3.98

Pounds of Ash Ingredients in Total Yield of Milk.

	Whole milk.			Skimmed milk.		
	N. A.	Q. L.	Av'rage.	N. A.	Q. L.	Av'rage.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potash	8.17	11.46	9.81	6.98	10.35	8.66
Soda	5.09	3.36	4.23	3.62	3.10	3.36
Lime	11.67	10.61	11.14	9.92	9.63	9.78
Magnesia	1.35	1.03	1.19	1.01	1.02	1.01
Iron Oxide	.17	.08	.12	.22	12	.17
Phosphoric Acid..........	11.09	13.37	12.23	9.71	11.80	10.76
Sulphuric Acid...........	1.40	.61	1.01	1.19	.71	.95
Chlorine..................	5.84	4.64	5.24	5.07	4.41	4.74
	44.78	45.16	44.97	37.72	41.14	39.43
Oxygen equivalent to Chlorine	1.32	1.04	1.18	1.14	1.00	1.07
	43.46	44.12	43.79	36.58	40.14	38.36

Total Contents of Ash in the Milk of Each Cow for One Year.

Jersey.

	Whole milk.			Skimmed milk.			Cream.
	Yield milk, lbs.	Ash. %	Total Ash. lbs.	Yield milk. lbs.	Ash. %	Total Ash. lbs.	Ash. lbs.
Agnes.........	6540	.779	50.94	4979	.835	41.57	9.37
Ida............	4381	.749	32.83	3373	.769	25.94	6 89

Pounds of Ash Ingredients in Total Yield of Milk.

	Whole milk.			Skimmed milk.		
	Agnes.	Ida.	Av'rage.	Agnes.	Ida.	Av'rage.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potash	11.03	7.86	9.44	8 85	5.94	7.39
Soda	3.97	2.94	3.46	3 18	2 20	2.69
Lime......................	13.03	7.26	10.15	10.58	5.95	8.27
Magnesia..................	1.27	.85	1.06	1.11	.65	.88
Iron Oxide................	.23	.07	.15	.20	.05	.12
Phosphoric Acid..........	16.00	10.82	13 41	13.20	8.42	10.81
Sulphuric Acid...........	1.38	.31	.84	1.00	.50	.75
Chlorine..................	5.20	3.51	4 35	4.45	2.88	3.67
	52.11	33.62	42.87	42.57	26.59	34 58
Oxygen equivalent to Chlorine..................	1.17	.79	.98	1.00	.65	.82
	50.94	32.83	41.89	41.57	25.94	33.76

In connection with these results it may be of interest to consider the amount of fertilizing materials contained in the ash of milk. Of these, the only constituents of importance are potash and phosphoric acids. The other ingredients are usually found in sufficient quantities in the soil, or are to be obtained so cheaply that it is not necessary to notice them here. From the preceding tables we find that the average amounts of potash and phosphoric acid contained in the milk of a single cow for one year are as follows:

	Potash.		Phosphoric Acid.		Total Value.
	Pounds.	Value.	Pounds.	Value.	
Whole milk	11.16	$ .50	13.42	$ 1.07	$ 1.57
Skimmed milk	9.53	.43	11.50	.92	1.35
Cream, by difference............	1.63		1.92		$ .22

These constituents are estimated at their market values, viz.: 4 1-2 cents per pound for potash, and 8 cents per pound for phosphoric acid. If the whole milk from one of these cows were sold, it would carry from the farm potash and phosphoric acid valued at $1.57. If only the cream were sold, the skimmed milk being used upon the farm, the loss for one cow would be but 22 cents.

The average amount of manure from one cow is estimated at 9 tons, or 2 1-4 tons of dry matter. One ton contains about 15 pounds of potash and 7 pounds of phosphoric acid. The milk of a single cow, therefore, contained as much potash as three-fourths of a ton of the manure, and as much phosphoric acid as two tons.

As nitrogen is not contained in the ash, it has not been noticed here. But in view of the fact that it is found in large quantities in milk and is the most valuable ingredient of manures it should be considered. Six thousand eight hundred and fourteen pounds of milk, the average product of one cow, contains 37.48 pounds of nitrogen (.55 of one per cent.) worth at least 15 cents per pound, or $5.62 per year for the milk of a single cow. One ton of manure contains about 12 pounds of nitrogen, worth $1.80. The milk from a single cow, therefore, contains in one year as much nitrogen as three tons of manure. As in the case of the other constituents, however, the greater part of this is retained in the skimmed milk.

THE FAT GLOBULES OF MILK.

BY L. H. MERRILL.

The size of the fat globules in milk has an undoubted influence upon the completeness with which the cream separates. Prof. Babcock, in the Report of the N. Y. Expt. Station for 1885, describes a method by means of which the relative number and size of the globules in different samples of milk may be ascertained.

Omitting details, the method is briefly this: Capillary tubes of glass are filled with a very dilute sample of the milk, temporarily mounted in glycerine and placed in a horizontal position until the globules have risen to the upper sides of the tubes. The slide is then placed upon the stage of a microscope, the internal diameter of the tube measured by an eye piece micrometer, and the number of globules in a given length of the tube counted. The results of a number of observations are calculated for a tube of uniform length and diameter. The figures thus obtained serve to show the *relative number* of globules in a given quantity of the sample The *relative size* of the globules may be obtained by dividing the per cent. of fat in the milk by the number of globules.

This method was applied in the examination of the milk of five of the Station cows, representing three breeds, Holstein, Jersey and Ayrshire. Samples of the whole and skimmed milk were taken on four successive days. Considerable variation was shown from day to day, yet the individual peculiarities were well marked, as is shown in the following table, which gives the average of the results for the four days.

RELATIVE NUMBER AND SIZE OF GLOBULES IN MILK.

	Relative number of globules.	% Fat.	Relative size of globules.
Jansje, whole milk	213	3.75	182
" skimmed milk	89	.70	81
Nancy Avondale, whole milk	293	3.75	130
" " skimmed milk	79	.43	55
Queen Linda, whole milk	188	3.32	178
" " skimmed milk	75	.47	65
Agnes, whole milk	138	4.57	332
" skimmed milk	19	.10	54
Ida, whole milk	140	5.29	390
" skimmed milk	24	.18	81

As might have been expected. the larger globules have gone into the cream, leaving only the smaller ones in the skimmed milk. In no case do these average one-half the size of those in the whole milk, and in the case of Agnes they are less than one-sixth as large. It is noticeable, also, that the globules in the milk of the two Jerseys, Agnes and Ida, are double the size of those of the other breeds, a fact which must in large part account for the ready creaming of this milk.

REPORT ON TUBERCULOSIS.

BY DR. F. L. RUSSELL.

Last Fall there were discovered among the herd of cattle at the State College farm two cases of tuberculosis. One was a year old Guernsey heifer, and the other was a six year old cow, the dam of the heifer. They were both killed and buried, but the occurrence has given rise to considerable comment, and reports have been circulated that were either untruths or but half truths, so that many have gained an entirely wrong conception of the whole matter. It is the purpose of this article to briefly state the simple facts pertaining to the subject.

In the Spring of 1889, when funds became available for restocking the College farm, the trustees instructed three of their number, who constituted the Farm Committee, to make the purchases.

The Farm Committee acted upon the policy that has been adopted of having the different prominent breeds of cattle represented in the college herd, and bought two Jersey heifers, five Guernseys and three Holsteins; also six grade cows. There was already on the farm a Jersey bull belonging to the College, bred by J. R. Bremer, Hingham, Mass., (a cattle club bull), and in the Experiment Station herd two Jersey cows and a calf, two Ayrshire cows and a Holstein cow.

Four of the Guernseys, viz.: a five year old cow, Sard 4th, two two-year old heifers, Velma 2nd and Mayland Lady, and a year-old heifer, Margheita, were purchased the first of May 1889 at Wayland, Mass., of Mr. Wm. P. Perkins. About the same time, the Holsteins consisting of a six-year-old cow, Nitalia, a four-year-old heifer, Agnes Smit, and a bull calf, Archer Aberdare, were purchased of Mr. Wm. A. Russell, No. Andover, Mass. The Guernsey bull, "Jack Stately" was bought of Mr. D. M. Clark, of Portland, Me., the following December. The Jersey heifers were purchased in August, 1889, of Mr. Bailey, of Winthrop, Me., and the grade cows were bought about the same time of different parties in Kennebec Co.

After the Guernsey cow Sard 4th was purchased, but before she was moved, she dropped a heifer calf, so there were eight animals in the herd brought from Massachusetts in May, 1889, five Guernseys and three Holsteins.

When they arrived here I examined them with considerable care, and aside from Sard 4th's calf they seemed to be in excellent health. This calf was scouring badly when she came here, a natural result of the excitement and exposure to which Sard 4th was subjected in a long journey at that season of the year. With little treatment, except attention to her feed, the calf soon recovered, and although her growth was checked she soon began to gain again and continued to develop in a satisfactory manner.

When the trustees met the last of June, I made a favorable report to them on the condition of the herd. After receiving my report, the trustees instructed their secretary to request the State Veterinarian to examine the herd. The last of July, 1889, after the cattle had been here about two months, the State Veterinarian, Dr. Bailey, of Portland, came to examine them Although he informed me a few days in advance of his coming, I was away on my vacation and unable to meet him here. He pronounced the health of the herd entirely satisfactory with the exception of the temperatures of the three Guernsey heifers, Mayland Lady, Velma 2nd and Margheite, which he thought slightly elevated, and he left word with Prof. Balentine for me to take them again at different times and report to him. I took the temperatures as requested four or five times during the next three months and communicated to him the results. In December 1889, Dr. Bailey wrote to the Secretary of the Trustees that the herd was in a satisfactory condition of health, making no exceptions. In the meantime, two of the heifers had calved and were doing well, as they have continued to do up to the present time.

The first evidence that any of the stock was affected with tuberculosis was discovered Octobor 18th, 1890. The Guernsey heifer, at this time a year old, that was brought here a young calf by the side of Sard 4th, was turned out in the spring of '90 with four other heifers. She was seen frequently during the summer, and up to October 18th seemed to be doing finely. At this time she was found away from the other heifers and not feeding. She was evidently sick and was taken up to the barn. When my attention was called to her perhaps an hour later, I found her very gaunt but in good flesh.

Her temperature was 105° (F), but she had no appetite. But slight respiratory murmur could be detected on the left side and there was marked dullness on percussion. On the right side the respiratory murmur was much increased. She had a persistent hollow cough. The heifer was quarantined until October 31st, when the Farm Committee were here to attend a meeting of the

Station Council, and then she was killed. In the mean time her appetite was irregular and she continually lost flesh and became weaker. Her temperature was taken frequently and varied from 101° to 105°.

When killed, her left lung was found adherent over a large part of its area and contained a large abscess with a capacity of nearly two quarts. Attached to the surface, and particularly within the substance of this lung, were many tubercles, varying from the size of a pea to that of a large goose egg. The right lung had a few small tubercles in its substance, but no abscesses. Attached to its inferior and posterior borders, also to the walls of the thorax and the right side, were many tubercles, most of them small. In the right thoraric cavity attached to the diaphragm was a mass of tubercles weighing over a pound. Many of the thoraric lymphatic glands were enlarged, and one of them contained an abscess of considerable size. The liver contained a number of small abscesses and had a few tubercules attached to its surface.

When this heifer was found to have tuberculosis, her dam Sard 4th was carefully examined and although up to this time she was considered perfectly sound and was in apparently fine condition, the examination revealed a little trouble in the left lung. When the heifer was killed and her condition ascertained, the Cattle Commissioners were notified as required by law, and two of the commissioners, Dr. Bailey and Mr. Beal, came here. At this visit they only examined Sard 4th, and they pronounced her diseased. November 10th, they came again to examine the rest of the herd.

At this second visit they examined Sard 4th again, after she had been exercised a little, but there was no apparent change for the worse. Indeed after taking her temperature, which was slightly below the normal, and carefully examining both lungs, Dr. Bailey said, "I should not be able to condemn her from what I have seen of her to day."

Sard 4th was killed and the right lung appeared sound. The anterior lobe of the left lung was slightly adherent, contained a small tuberculous abscess, and adhering to its surface and within its substance were a number of small tubercles. The diseased portion of the lung was so far forward that the difficulty in detecting the extent of the disease in the living animal was accounted for. An examination of the rest of the herd failed to reveal any more diseased animals, although one heifer was regarded with some suspicion, which has not been confirmed by a more recent examination.

Thus it will be seen that we have had two cases of tuberculosis; Sard 4th and her calf, and the rest of the thirty animals in the herd are pronounced sound.

It may interest some to know what the cattle of the College have for feed. Sard 4th and the other mature cows giving milk have been fed two quarts of shorts and one of corn meal at a feed twice a day, and what good hay they would eat. The heifers are raised on skimmed milk and as soon as they are old enough a few shorts are given them and the amount gradually increased until it reaches two quarts when they are two years old. No corn meal or other grain than shorts is given to the heifers. In the summer all the stock is turned out to pasture and while the feed is good they get no grain.

The question very naturally arises, Where did these two animals contract tuberculosis? Were they diseased animals when they were brought here, but in so slight a degree that it could not be detected by a careful examination, or were they infected after they came?

That there is some ground for taking the latter view must be admitted. There is too much tuberculosis walking about in human form for us to be sure that any inhabited locality is free from the elements of infection, and no greater change than these animals underwent would probably render them somewhat more susceptible for a time. That there was sufficient time for these cases to develop as the result of infection after they were brought here is abundantly shown by the fact that very much the most advanced case of the two was brought here as a young calf. There is no conclusive evidence either one way or the other, so that if any one cares to think both cases were the result of accidental infection, occuring after they were brought here, there is no proof to the contrary. But much the more probable theory is that they were already infected animals when they came to Maine. Indeed, it is possible that the ultimate source of their disease is the native home of the Guernseys, as I understand that Sard 4th was imported in her dam. It is much more likely that Sard 4th conveyed the disease to her calf than that both of them contracted it independently and all the rest of the herd escaped, although exposed to the same danger.

The greater advance that the disease made in the heifer may be accounted for by her exposure to wet and cold, while her dam was housed every night. During the first part of October, before the heifer was found sick in the pasture, we had two or three long cold rains, and when the heifer was brought to the barn she was evidently suffering from a severe cold that doubtless hastened her decline.

We are frequently asked if there is danger that we will have more cases of the same kind. There can be but one answer to this question. We are liable to at any time, and the same possibility exists in relation to every herd of cattle in the State, though we do not regard this danger as very serious. But in one respect the College herd has the advantage of most other herds in the State, as these animals have been subjected to a rigid examination and pronounced sound, while a similar examination of all the cattle in the State would doubtless reveal some cases of tuberculosis that are not even suspected at present.

The idea seems to prevail that there is especial danger from tuberculous cattle, and on that account extraordinary efforts should be made to exterminate bovine tuberculosis. But the fact is we have little reason to suppose that much progress will be made in suppressing consumption and kindred tuberculous diseases so long as our efforts are confined to killing off diseased cattle. Indeed if it were possible to go through this State and all states and countries and kill all the cattle effected with any form of tuberculosis, but very little real progress would be made in stamping out the disease. If the disease were confined to cattle, this would be the very course to pursue. But this is only one of the measures to be adopted, and by no means the most important, in order to make any real progress in ridding ourselves of this deadly disease. Great stress is laid upon the fact that diseased cattle may convey tuberculosis to man; while the more important fact that consumptive men, by means of their sputum, which they spread broadcast wherever they go, may, and doubtless do, give tuberculosis to other men and cattle is often disregarded. Almost no effort is made to limit the danger from this source, which is regarded by the best informed as by far the most important means for the spread of tuberculosis.

In recent years great advance has been made in the knowledge of the cause of tuberculosis and the means by which it is spread; but it seems to me that boards of health and physicians are slow in putting this knowledge into practice in limiting the spread of disease. Persons affected with scarlet fever are kept carefully secluded with good results, while patients affected with the more surely fatal tuberculosis are permitted to live on terms of closest intimacy with their families, and to frequent public resorts without any limitations or attempt to guard others from infection. As a result we see the members of large families falling victims to this disease one after another, and about one-tenth of the whole human race dying from this one disease. If Asiatic cholera should gain as many victims in one year as tuberculosis gains *every* year, it would be regarded as an alarming condition of affairs, and every available means would be used to check it.

We do not want to take any backward steps in the matter of controlling, and so far as possible exterminating, bovine tuberculosis, but this work is rendered of almost no avail so long as scarcely any measures are taken to limit human tuberculosis. No one who is acquainted with the facts will deny that a large proportion of human tuberculosis is preventable. An extreme conservatism and disregard of the value of human life should no longer be allowed to hinder the adoption of such practical means as will save countless lives. There are evident difficulties to be encountered in carrying out any effective measures, but they are not insurmountable, and the end to be attained will justify the adoption of radical measures for the good of humanity.

RELATIVE YIELD OF DIGESTIBLE MATERIAL IN EARLY-CUT AND LATE-CUT TIMOTHY HAY.

The old discussion with regard to the best time of cutting grass for the purpose of making hay, cannot be said to have ceased, neither can it be safely asserted that the problem involved in this discussion has been solved. To be sure, quite an amount of experimental work has been done with reference to this question, but this work, much of it, has not been especially exhaustive. We have contented ourselves with measuring out plots of grass of as uniform character as possible, cutting these plots at different periods of growth and weighing the resulting hay. This is good as far as it goes, in fact, up to a certain point, is the best we can do. The true standard for judging the production with any given crop, is the resulting amount of digestible material rather than the total weight of the crop. The writer believes that in testing this matter of the economical time for cutting grass, two things are essential in order to obtain reliable results.

(1.) That a large number of tests shall be made, including a series of years.

(2.) That not the weight of the crop merely, but the amount of digestible material shall be ascertained.

Investigations of this kind are now being conducted in accordance with the above views. Whatever tests are being made of production with any crop, are being made in this way. The following experiment is the second one undertaken by this Station, that has had for its object the determination of the amount of digestible material in early-cut and in late-cut Timothy hay. The first experiment is reported in the Station Report for 1889, pages 44 to 45. In the summer of 1889, fourteen equal sized plots of very uniform grass were measured out, ten of these plots being located in one field and four in another. The size of each of the ten plots was 30x50 feet, and of each of the other four plots, 33x90 feet. One-half of these plots was cut on July 1st and the other half on July 18th. At the first cutting the Timothy was in full bloom. The hay was successfully cured and was then stored in the Station barn after careful weighing. On April 7th, the two lots of the hay were reweighed. Below can be seen the weights of the hay as put in the barn and on April 7th, together with the percentage of loss during the time of storage.

YIELD OF EARLY AND LATE-CUT TIMOTHY HAY.

	Yield of seven plots.	Yield per acre. Weight when stored.	Yield per acre. Weight dry hay April 7th.	Loss per acre by drying.	Per cent of loss after storage.
	lbs.	lbs.	lbs.	lbs.	%
Early-cut Timothy, cut J'y. 1	1560	5070	4225	845	16.6
Late-cut " " 18	1910	6208	5086	1122	18.1

This hay has not only been analyzed, but the digestibility has been determined by feeding to sheep. We have, therefore, as the total data by means of which to calculate the relative feeding value of the two lots of hay cut at different dates, its weight, composition and the digestibility of the various ingredients. All this data can be found in the following tables.

COMPOSITION OF TIMOTHY HAY.

	% Water.	% Ash.	% Protein Nx6.25.	% Fiber.	% Nitrogen-free extractive matter.	% Fat.
CXIX, Timothy hay, early-cut	10.40	4.86	7.06	32.51	41.67	3.50
CXX, Timothy hay, late-cut	9.70	4.38	6.12	30.32	46.17	3.31

COMPOSITION OF FECES.

	% Water.	% Ash.	% Protein.	% Fiber.	% Nitrogen-free extractive matter.	% Fat.
Feces, Sheep 1	8.45	6.42	7.81	33.15	40.93	3.24
" " 2	9.45	6.27	7.31	35.62	38.55	2.80
" " 3	8.70	6.49	8.19	32.31	41.19	3.12
" " 4	8.55	6.07	7.16	36.52	39.16	2.54

DIGESTIBILITY OF TIMOTHY HAY.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
CXIX, TIMOTHY HAY, early cut,							
Sheep 1.							
Fed in five days, grs.	3136	2965.	170.1	247.1	1137.8	1458.4	122.5
Excreted in five days, grs	1391.6	1293.9	97.6	118.7	503.8	622.1	49.2
Digested, grs	1744.4	1671.1	72.5	128.4	634.0	836.3	73.8
Per cent. digested	55.6	56.4	42.6	51.9	55.8	57.3	59.8
Sheep 3.							
Fed in five days, grs	3136	2965.	170.1	247.1	1137.8	1458.4	122.5
Excreted in five days, grs	1369.5	1272.1	97.3	122.8	484.6	617.8	46.8
Digested	1766.5	1692.9	72.8	124.3	653.2	840.6	75.7
Per cent. digested	56.3	57.1	42.8	50.3	57.4	57.6	61.8
Av. per cent. digested by 2 animals	**5.59**	**56.7**	**42.7**	**51.1**	**56.6**	**57.4**	**60.8**
CXX, TIMOTHY HAY, late cut							
Sheep 2.							
Fed in five days, grs	3160.5	3007.2	153.3	214.2	1061.2	1615.9	115.8
Excreted in five days, grs.	1512.2	1407.5	104.7	122.1	594.8	643.7	46.8
Digested	1648.3	1599.7	48.6	92.1	466.4	972.2	69.0
Per cent. digested	52.1	53.1	31.7	42.9	43.9	60.1	59.6
Sheep 4.							
Fed in five days, grs.	3160.5	3007.2	153.3	214.2	1061.2	1615.9	115 8
Excreted in five days, grs	1673.5	1562.4	111.1	131.0	668.3	716.6	46.5
Digested	1487.0	1444.8	42.2	83.2	392.9	899.3	69.3
Per cent. digested	47.0	48.4	27.5	38.8	37.2	55.6	59.8
Av. per cent. digested by 2 animals	**49.5**	**50.7**	**35.1**	**40.8**	**40.5**	**57.8**	**59.7**

It seems that the yield per acre of the grass cut on July 1st, was 4,225 pounds of dry hay, and of that cut July 18th, 5,086 pounds. As would be expected from all previous analyses, the early-cut hay proved to be the more nitrogenous and also the more digestible. From the early-cut hay 56.07 per cent. of the organic matter was digested and from the late-cut hay only 50.70 per cent. Of total digestible material the late-cut hay proved to contain the more, the amounts per acre being, Early cut 2,028 and Late-cut 2,212 pounds. These figures stand somewhat in opposition to those obtained from the crop of 1888, where the larger amount of digestible material was obtained from early-cut hay. It is only by repeating these tests and taking an average of a series of years that we shall obtain results that will apply to practice.

FEEDING EXPERIMENT WITH COLTS.

The object in view in conducting this experiment was to determine the relative economy of feeding oats for producing growth in colts, as compared with certain other commercial foods. The grain ration selected with which to make a comparison with oats was a mixture of pea meal and wheat middlings. The animals selected for the experiment were three grade Percheron colts of the following ages at the time the experiment was begun:

Colt No. 1, bay filly, age, 18 months.
" " 2, black gelding, age 16 months.
" " 3, gray filly, age, 9 months.

These animals were fed through three periods, during the first of which they received hay and a grain ration made up of one-third pea meal and two-thirds wheat middlings. During the second period they received hay and for the grain ration oats alone. During the third period they were returned to the mixture of pea meal and middlings, which was mixed in the proportion of one part pea meal to four of middlings. Below are given the exact weights of hay and grain fed daily during each of the three periods.

	Colt No. 1.	Colt No. 2.	Colt No. 3.
Period 1. Feb. 13 to April 2.	15 lbs. hay. 8 lbs. mixed grains.	14 lbs. hay. 7 lbs. mixed grains.	12 lbs. hay. 6 lbs. mixed grains
Period 2. Apr. 3 to May 28.	15 lbs. hay. 8 lbs oats.	14 lbs. hay. 7 lbs. oats.	12 lbs. hay. 6 lbs. oats.
Period 3. May 29 to July 2.	15 lbs. hay. 8 lbs. mixed grains.	14 lbs. hay. 7 lbs. mixed grains.	12 lbs. hay. 6 lbs. mixed grains

The weights of these colts were obtained at the beginning and end of each feeding period, and those recorded here are the average of three weighings taken on three consecutive days.

	Colt No. 1.	Colt No. 2.	Colt No. 3.
	lbs.	lbs.	lbs.
Period 1. *Hay, peas and middlings.*			
Weight February 13th to 15th	922	767	612
" March 3d to April 2nd	977	827	658
Gain in 46 days	55	60	46
Daily gain	1.19	1.30	1.00
Period 2. *Hay and oats.*			
Weight March 3d to April 2nd	977	827	658
" May 26th to 28th	1042	867	713
Gain in 56 days	65	40	55
Daily gain	1.16	.71	.98
Period 3. *Hay, peas and middlings.*			
Weight May 26th to 28th	1042	867	713
" June 30th to July 2d	1053	918	748
Gain in 35 days	11	51	35
Daily gain	.31	1.46	1.00

	Average weight of Animals.	Digestible material consumed daily.	Digestible material cons'med daily for each 1000 lbs. live weight.	Nutritive ratio.	Daily gain in weight,	Digestible material consumed for each pound of gain.
PERIOD 1. (46 days)	lbs.	lbs.	lbs.		lbs.	lbs.
Colt 1	950	12.9	13.6	1:7.2	1.19	10.9
" 2	797	11.8	14.8	1:7.3	1.30	9.0
" 3	635	10.1	15.7	1:7.3	1.00	10 1
Average	794	11.60	14.70		1.16	10.00
PERIOD 2. (56 days)						
Colt 1	1009	12.2	12.1	1:8.3	1.16	10.5
" 2	847	10.9	12.9	1:8.4	.71	15.4
" 3	685	9.4	13.7	1:8.4	.98	9.6
Average	847	10.80	12.9		.95	11.4
PERIOD 3. (35 days)						
Colt 1	1047	12.87	12.3	1:7.5	.31	41.
" 2	892	11.69	13.1	1:7.6	1.46	8.0
" 3	730	10.00	13.7	1:7.7	1.00	10.00
Average	890	11.52	13.0		.92	12.5

Unfortunately the growth of these colts was somewhat irregular, so that the results do not allow as definite conclusions as would otherwise be the case. It is especially noticeable that in the third period animal No. 1 made a very small growth, a fact which is due to some cause that is not evident. But notwithstanding this irregularity of increase in weight, the outcome of the experiment is such as to show no superiority for the oats as food for producing growth merely. In fact, if anything is indicated it is that the advantage was with the mixture of peas and middlings. A gradual decrease in the average daily growth in passing from one period to another, may be fairly charged to the increase in the weight of the animal without a corresponding increase of the amount of food. Granting that the ration of mixed grains was not inferior, at least, to the ration of oats for producing growth, the important question then becomes that of the relative cost of the two rations. Of course the peas were a costly food and were used in the case of this experiment merely because they constituted a nitrogenous food which is a perfectly safe one for horses. It is fair to assume that gluten meal would have answered the purpose equally well. Now a mixture of gluten meal and wheat middlings, if in the same proportion and quantity as were the peas and middlings in the first period, would cost about eleven cents a day, whereas an equal weight of oats would cost about sixteen cents a day, basing our estimates of course upon the present prices of grain. With different prices for grain, the relative cost of the feed rations might not be the same. The lesson of the experiment is then, if it is fair to draw any lesson from it, that unless oats are essential for producing a desired quality in the growing colt, a grain ration of any other kind is likely to be much more economical. This experiment is to be repeated with other animals, using gluten meal and middlings for the mixed grain ration.

FEEDING EXPERIMENT WITH STEERS.

In the fall of 1888, a feeding experiment was undertaken with six steers which had a two fold object.

(1.) To test the relative growth of steers of different breeds when feeding rations of the same character.

(2.) To determine the effect of two rations having quite different nutritive ratios, when these rations are fed for a long period of time or until the animal is quite fully matured.

The breeds represented in the experiment were Holstein, Shorthorn and Hereford, two animals of each being used. The history and age of the animals were as follows:

Holstein No. 1, age 6 1-2	months,	bred by Chas. H. Fitch, Pepperell, Mass.
" No. 2, " 5	"	bred by Maine State College.
Shorthorn No. 3, age, 7	"	bred by E. E. Parkhurst, Presque Isle, Me.
" No. 4, age, 7	"	bought of Howard & Ellis, Fairfield, Me.
Hereford No. 5, age, 8	"	bred by M. M. Bailey, Winthrop, Me.
" No. 6, age, 6 1-2	"	bred by A. J. Underwood, Fayette, Me.

The experiment began early in November 1888 when the animals were from five to eight months old. Three of the steers, one from each breed, were fed hay, mostly Timothy, and a grain ration consisting of equal parts of cotton seed meal, ground oats and wheat bran. The other three steers, one from each breed, were fed hay, and a grain ration consisting of equal parts of corn meal, ground oats and wheat bran. The animals were fed in this manner throughout the time the experiment was continued, excepting that in the following spring a portion of the hay was replaced by a certain amount of corn ensilage.

It would be gratifying to be able to report this experiment as having been completed in accordance with the original plans, but owing to a surprising number of accidents this cannot be done. Early in the summer of '89 one of the Holstein steers received an injury which interfered with his growth, and in the following October a workman employed in painting the new Station barn carelessly left a pot of paint sitting in the yard where the steers were running, from which two of them drank more or less, thus causing their death. For these reasons it is impossible to report the experiment later than July 27th, 1889. The results that were obtained are given here, not because of having any special value as a comparison of breeds, but because they give important testimony in regard to one of the prominent problems in animal nutrition.

The quantity and kinds of food eaten by each animal are shown in the following table:

The hay was fed according to the appetites of the steers, but of the grain a weighed quantity was given each day, the amount being three pounds daily per animal during the first five months of the experiment, and four pounds during the last three months.

It is to be noticed that the amount of food consumed by the different animals did not vary greatly.

FOOD CONSUMED BY STEERS, NOV. 7TH TO JUNE 27TH, 233 DAYS.

	Holstein.		Shorthorn.		Hereford.	
	Steer 1.	Steer 2.	Steer 3.	Steer 4.	Steer 5.	Steer 6.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Hay	2340	2220	2168	2275	2240	2235
Cotton-seed meal	272		272		272	
Ground oats	272	272	272	272	272	272
Wheat bran	273	273	273	273	273	273
Corn meal		272		272		272
Ensilage	1894	1841	1871	1878	1844	1770
Hay eaten daily (average)	10.	9.5	9.3	9.8	9.6	9.6
Grain eaten daily (average)	3.5	3.5	3.5	3.5	3.5	3.5
Ensilage eaten daily (average)	8.1	7.9	8.0	8.0	7.9	7.6

The figures of the next table show the weights of the animals at the beginning and at the end of the experiment, the total gain in weight and the average daily gain.

	Holstein.		Shorthorn.		Hereford.	
	Steer 1.	Steer 2.	Steer 3.	Steer 4.	Steer 5.	Steer 6.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Weight of steers Nov. 7-9	380	332	342	413	459	429
" " June 25-26	822	720	707	808	802	791
Gain in 233 days	442	388	365	395	343	362
Daily gain	1.90	1.66	1.57	1.70	1.47	1.55

If this experiment were to be considered as a fair trial of breeds, it would be necessary to state that the Holstein steers made the largest growth and the Hereford the least, but it would be decidedly unfair to assume that in a two years' test the relative growth would stand in the same order. The amount of growth was very satisfactory with all the animals, ranging from 1.46 pounds per day with one of the Herefords to 1.9 pounds per day with one of the Holsteins, the average for the six animals being 1.64 pounds.

The most important testimony which this experiment gives is in regard to the influence of the kind of food upon the amount of growth produced. As before stated, three of the animals, one from each breed, were fed a much more nitrogenous ration than were the other three. Those animals which ate cotton seed meal in the place of corn meal were the ones consuming the larger amount of protein, and if it were true that any deviation from the standards given in German tables is detrimental to the nutritive effect of the ration, the more highly protein fed steers should have made much the larger gain. This we do not find to be the case. The Holstein steer eating the cotton seed meal made a greater gain than the one eating corn meal, but in the case of the steers of the other two breeds this order was reversed. There are, however, no marked differences in the rates of growth, except, possibly, with the two Holstein animals. The nutritive ratio of the ration containing cotton seed meal was 1 :6.7 and of the other ration made up in part of corn meal it was 1 :10.

The figures below were reached by assuming the foods to have an average composition. The coefficients of digestibility used for the hay and bran, were those that have been found by experiments at this Station, but for the corn meal and cotton seed meal they were taken from the table of German coefficients. The hay was assumed to be all Timothy, whereas it actually contained a very small amount of Alsike clover, which would of course make the nutritive ratios slightly narrower than those given, although not affecting them relatively.

	Holstein.		Shorthorn.		Hereford.	
	Steer 1.	Steer 2.	Steer 3.	Steer 1.	Steer 5.	Steer 1.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Digestible protein consumed.	258.3	174.	252.4	176.	251.1	173.
Digestible nitrogen-free ex't consumed including fiber	1478.	1537.9	1402.9	1563.2	1434.1	1535.1
Digestible fat consumed............	100.9	77.4	98.3	78.2	99.4	77.1
Total digestible material retained..	1837.2	1789.3	1753.6	1817.4	1784.6	1785.2
Nutritive ratio..............	1 :6.7	1 :9.9	1 :6.5	1 :10	1 :6.7	1 :10
Digestible material eaten daily....	7.90	7.7	7.5	7.8	7.7	7.7
Digestible material eaten for 1000 lbs. live weight	13.2	14.6	14.3	12.8	12.2	12.6
Digestible material eaten for each pound of gain	4.16	4.61	4.80	4.60	5.2	4.9

	Pounds of nutrients fed daily for each 1000 lbs. live weight.					Daily gain.
	Protein.	Carbohydrates.	Fat.	Total nutrients.	Nutritive ratio.	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Steer No. 1...........................	1.78	10.6	.72	13.2	1 :6.7	1.90
" 2...........................	1.42	12.5	.63	14.6	1 :9.9	1.66
" 3...........................	2.06	11.4	.80	14.3	1 :6.5	1.57
" 4...........................	1.23	11.0	.55	12.8	1 :10	1.70
" 5...........................	1.71	9.8	.68	12.2	1 :6.7	1.47
" 6...........	1.21	10.8	.54	12.6	1 :10	1.55
German Standard, animals 6 to 12 months old.........................	2.50	13.5	.60	16.6	1 :6	
German Standard, animals 12 to 18 months old	2.00	13.0	.40	15.4	1 :7	

The figures in the last of the above tables were arranged so as to show clearly how the rations fed to these steers compare with the standard German rations for growing animals. In order to make this comparison easy there has been calculated the pounds of the various nutrients fed to each animal for 1,000 pounds live weight. Two things are noticeable:

(1.) That in no instance was the total amount of digestible nutrients so large as called for in the standard rations, and (2) there was no case where the proportion of digestible protein was as large. In three cases the amount of protein fell very much below the theoretical ration. Of course if the total amount of digestible material had been larger, gain would in all probability have been greater, and in this respect the German standard is very likely nearer right than the rations actually fed. However this may be, it cannot be doubted that the experiment adds much to the increasing volume of testimony that for growing animals so large an amount of digestible protein is not necessary as is called for by the German standards. While there is undoubtedly a limit which we cannot fall below without seriously affecting the efficiency of the ration, that limit is unquestionably considerably below 2 1-2 pounds of digestible protein daily for each 1,000 pounds of live weight.

Whether or not any especial care is necessary to prevent an unbalanced ration, or whether the ordinary cattle foods may be combined indifferently without regard to their composition, there being no danger of a deficiency of protein in any case provided the animals are fed generously, is a question to be settled by future careful investigation. What is found to be most economical in feeding for growth may not, and does not seem likely to be true, in feeding milch cows.

FEEDING EXPERIMENT WITH DIFFERENT BREEDS OF SWINE.

The following breeds of swine were represented in this experiment: Berkshire, Cheshire, Poland China, Chester White and Yorkshire. Two animals were used of each breed, one male and one female, both of which were from the same litter.

The persons of whom the pigs were purchased and the ages of the animals at the time of beginning to feed them, were as follows: Berkshire, bought of J. W. True, New Gloucester, Me., age, six weeks; Cheshire, bought of C. C. Phelps, Vernon, N. Y., age, eight weeks; Poland China, bought of Hon. Rufus Prince, So. Turner, Me., age, six weeks; Chester White, bought of F. J. Fogg, Dexter, Me., age, five weeks; Yorkshire, bought of B. F. Briggs, Auburn, Me., age five weeks.

As can be seen farther on, the feeding began the last of April and the first of May. The food of the pigs consisted of skimmed milk and wheat middlings throughout the entire experiment, with the exception of a small amount of Hungarian grass and corn fodder which were fed in September. On August 20th, one of the Berkshire pigs appeared to be somewhat lame, and a few days later her appetite began to diminish. Late in October, one Poland China and one Chester White began to be lame and exhibited a poor appetite. The Cheshires and Yorkshires continued to be in perfect condition throughout the entire experiment and showed greater power to withstand confinement and high feeding than did the animals of the other three breeds. It is not claimed, however, that this is a general characteristic of these breeds. This experiment was divided into three periods, the first of which ended on August 2nd, at the time when the amount of skimmed milk was considerably diminished. The second period extended from Aug. 3rd, to September 6th, at which latter date the amount of milk was again diminished. From September 7th to the end of the experiment constitutes the third period, during which time but a little milk was fed, wheat middlings constituting nearly the entire amount of feed, although during this time 150 pounds of Hungarian grass and corn fodder were given each lot of animals.

The first table which follows gives the weights of the pigs at the beginning and end of each feeding period, the increase in weight of each lot for each period, as well as the daily rate of gain. The average rate of gain throughout the entire experiment is also stated.

GROWTH OF VARIOUS BREEDS OF SWINE.

	Lot 1. Berkshire.	Lot 2. Cheshire.	Lot 3. Poland China.	Lot 4. Chester White.	Lot 5. Yorkshire.
PERIOD 1.					
Date of beginning to feed	Apr. 23	Apr. 23	May 3	May 3	May 10
	lbs.	lbs.	lbs.	lbs	lbs.
Weight of pigs at beginning	26	66	31	30	30
Weight of pigs August 2nd	232	263	211	217	197
Gain in weight	206	197	180	187	167
No. of days fed	102	102	92	92	85
Daily gain	2.02	1.93	1.95	2.03	1.97
PERIOD 2.					
Weight of pigs August 2nd		263	211	217	197
Weight of pigs September 6th		396	316	326	314
Gain in weight	76*	133	105	109	117
Daily gain (35 days)	2.2	3.8	3.0	3.1	3.3
PERIOD 3.	Nov. 15	Nov. 26	Oct. 25	Oct. 25	Nov. 20
Weight of pigs, ending September 6th	188	396	316	326	314
" " " " "	245	602	388	410	476
Gain in weight	57**	206	72	84	162
No. of days fed	70	81	49	49	75
Daily gain	.8	2.5	1.4	1.7	2.2
Total gain in 3 periods	339*	536	357	380	446
Total number days fed	207	218	176	176	195
Daily gain of one animal	1	1.23	1.01	1.08	1.14

*Only one animal after August 23d.
**Only one animal.

In the second table can be seen the weights of milk and middlings that were fed during each period.

AMOUNTS OF FOOD CONSUMED BY VARIOUS BREEDS OF SWINE.

	Lot 1. Berkshire.	Lot 2. Cheshire.	Lot 3. Poland China.	Lot 4. Chester White.	Lot 5. Yorkshire.
PERIOD 1.	lbs.	lbs.	lbs.	lbs.	lbs.
Total milk fed	1286	1286	1186	1186	1116
Total middlings fed	376	459	366	362	353
PERIOD 2.					
Total milk fed	396	438	438	438	438
Total middlings fed	238	415	320	320	320
PERIOD 3.					
Total milk fed	91	182	182	182	182
Total middlings fed	337	1087	455	427	721
Hungarian grass	60	90	90	90	90
Fodder corn	30	60	60	60	60
Milk fed in 3 periods	1773	1906	1806	1806	1736
Middlings fed in 3 periods	951	1961	1141	1109	1394

In the third table we have given the total amount of digestible food consumed by each lot of animals, and also the amount of digestible food required in each case to produce one pound of growth.

RELATION OF GROWTH TO FOOD WITH VARIOUS BREEDS OF SWINE.

	Lot 1. Berkshire.	Lot 2. Cheshire.	Lot 3. Poland China.	Lot 4. Chester White.	Lot 5. Yorkshire.
PERIOD 1. (To Aug. 2d)	lbs.	lbs.	lbs.	lbs.	lbs.
Gain in weight	206.	197.	180.	187.	167.
Total digestible material eaten	378.	435.2	361.9	359.1	346.4
Pounds digestible food for each lb. gain	1.83	2.21	2.01	1.98	2.08
PERIOD 2. (Aug. 3d to Sept. 6th)					
Gain in weight	76.	133.	105.	109.	117.
Total digestible material eaten	200.6	326.4	261.	261.	261.
Pounds digestible food for each lb. gain	2.64	2.46	2.48	2.40	2.23
PERIOD 3. (Sept. 6th to completion)					
Gain in weight	57.	206.	72.	84.	162.
Total digestible material eaten	252.6	785.1	349.7	330.4	532.97
Pounds digestible food for each lb. gain	4.43	3.81	4.85	3.93	3.29
Total gain in weight	339.	536.	357.	380.	446.
Total digestible food eaten	831.2	1546.7	972.6	950.5	1140.4
Digestible food consumed for each lb. gain	2.45	2.88	2.73	2.50	2.5

In commenting upon these results it should be remarked in genral, that no striking differences are observed in the rate of growth, or in the relation of the amount of food to growth, with these several breeds of swine.

(1.) The daily rate and growth of our animal is seen to have been: Cheshires, 1.23 pounds; Yorkshire, 1.14 pounds; Chester White, 1.08 pounds; Poland China, 1.01 pounds; Berkshire 1. pound.

(2.) It does not appear that the animals growing most rapidly required the least food for a pound of growth. The weights of digestible foods consumed for each pound of growth made are the following: Cheshire, 2.88 pounds; Poland China, 2.73 pounds; Yorkshire, 2.55 pounds; Chester White, 2.5 pounds; Berkshire, 2.45 pounds. Although the Berkshire pigs made the smallest gain they required the least food for each pound of growth, and the Cheshire making the largest gain consumed the most food for each pound of increase of weight.

(3.) A careful study of the first of the above tables shows plainly that the ratio of food to growth was very different during the early part of the experiment from what it was the latter part. In Period 1, including approximately the first one hundred days of the experiment, not far from two pounds of digestible food produced one pound of growth, while during the last fifty days, or thereabouts, the ratio was four pounds of digestible food to one of growth. The ratio of the second period stands between those of the first and third.

(4.) It is worth remarking that certain of the animals, notably the Berkshires and Chester Whites, made during the first three months a larger percentage of their entire growth than did the other breeds. The difference, however, is not very marked.

FERTILIZER EXPERIMENTS.

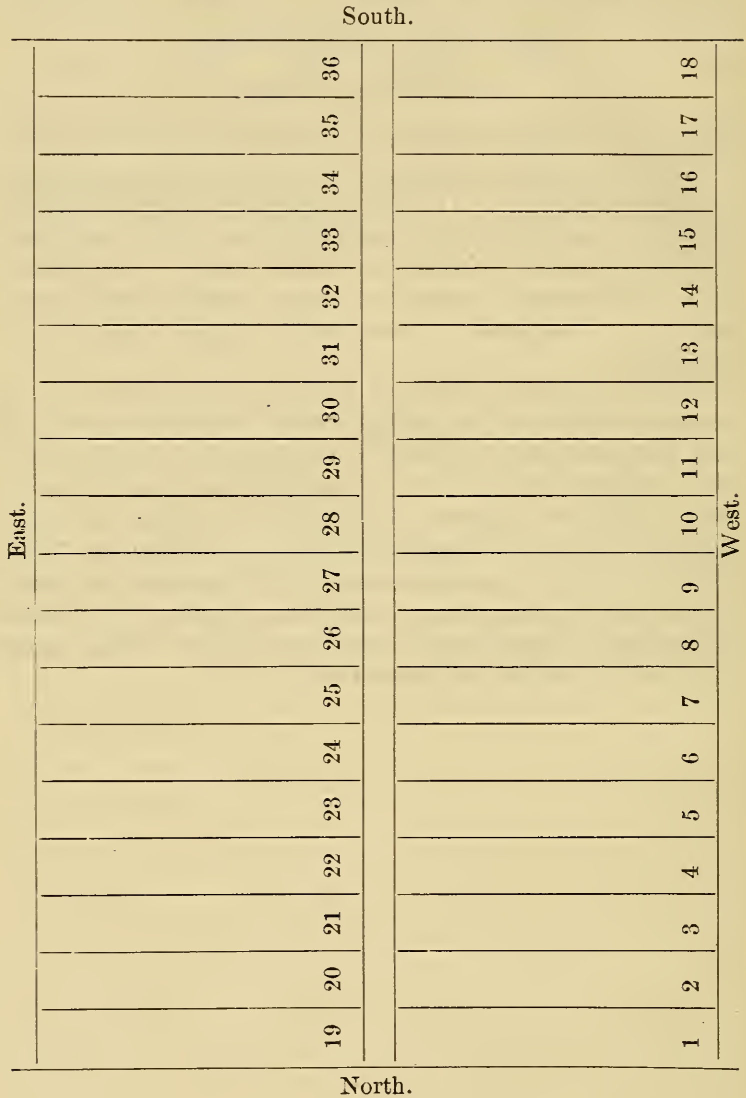
Prof. Walter Balentine.

Effect of Different Forms and Mixtures of Fertilizers.

In 1886 the Station commenced a series of plot experiments, having for their object: (1) The comparative effect of different forms of phosphoric acid in manuring crops; (2) A comparison between commercial fertilizers and stable manure in crop production; (3) The effect of partial as compared with complete fertilizers; (4) A comparison of the effect of different quantities of fertilizers.

The soil selected for this work is a clay loam situated near the southern boundary of the college farm. This field was laid off into thirty-six plots, as shown in the diagram. Each plot contains one-twentieth of an acre, being eight rods long by one rod wide. They are separated by strips of land eight feet wide, through which runs a ditch sufficiently deep to take off all surface water. At the commencement of the experiment the ground was in condition to produce a fair crop of grain. For further information in regard to the state of cultivation of this field at that time, see Station Report for 1886.

DIAGRAM OF EXPERIMENTAL FIELD No. 1.



On the first year of the experiment the plots were manured as indicated in the following table, three plots in each case receiving the same treatment as to fertilizers. The entire field was seeded to oats, the plots receiving the same cultivation.

Plot 1, 7, 13	Received no fertilizer.
Plot 2, 8, 14	Dissolved bone black, 400 lbs. per acre. Muriate of potash, 100 " " " Sulphate of ammonia, 200 " " "
Plot 3, 9, 15	Fine ground bone, 360 lbs. per acre. Muriate of potash, 100 " " " Sulphate of ammonia, 140 lbs. per acre.
Plot 4, 10, 16	Fine ground South Carolina rock, 300 lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.
Plot 5, 11, 17	Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.
Plot 6, 12, 18	Stable manure, 40,000 lbs. per acre.
Plot 19, 25, 31	Received no fertilizer.
Plot 20, 26, 32	Dissolved bone black, 400 lbs. per acre.
Plot 21, 27, 33	Dissolved bone black, 400 lbs. per acre. Muriate of potash, 100 " " "
Plot 22, 28, 34	Dissolved bone black, 200 lbs. per acre. Muriate of potash. 50 " " " Sulphate of ammonia, 60 " " "
Plot 23, 29, 35	Dissolved bone black, 300 lbs. per acre. Muriate of potash, 100 " " " Sulphate of ammonia, 120 " " "
Plot 24, 30, 36	Dissolved bone black, 400 lbs. per acre. Muriate of potash, 150 " " " Sulphate of ammonia, 180 " " "

On the second year of the experiment the same kinds of fertilizers were applied and again a crop of oats was raised. With the oats, the second year, grass seed was sown, so that in 1888 or the third year, the field was in grass and no fertilizers were used.

The results of these three seasons of cropping are to be found in the Station Reports for the corresponding years. In 1889, the fourth year of the experiment, fertilizers were applied again as in the years 1886 and 1887, and the field was planted to corn, but the season was such as to render it apparent that the crop would not be a success, hence the land was summer tilled.

The fifth year (1890) a crop of peas was grown on the field without the further addition of fertilizers.

In table A are given the results obtained from the first tier of plots. These furnish data on the comparative value of soluble phosphoric acid in Dissolved Bone black and the insoluble phosphoric acid in fine ground bone and fine ground South Carolina rock, also on the comparative value of commercial fertilizers and stable manure.

Both of these points are of great practical importance. The phosphoric acid of dissolved Bone black is soluble but more expensive than the insoluble phosphoric acid of fine ground bone and South Carolina rock. It is believed that a large portion of the soluble phosphoric acid becomes insoluble in water soon after application to the soil On the other hand, it is believed that there are agencies at work in the soil which make the phosphoric acid of the mineral phosphate more available for plants as time goes on.

The question naturally arises whether manuring continuously with insoluble mineral phosphate might not from a financial standpoint prove more advantageous.

It often happens that a farmer finds it desirable to cultivate more land than he can manure well with the farm manures he has at hand, and the question arises whether it will be better to purchase stable manure at a neighboring village, or to make up the deficiency with commercial fertilizers.

TABLE A.

	No Manure.		Dissolved Bone Black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre.		Fine Ground Bone 360 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 140 lbs. per acre.		Fine Ground South Carolina Rock 300 lbs., Muriate of Potash 100 lbs. and Sulphate of Ammonia 200 lbs. per acre.		Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre.		Stable Manure 40,000 lbs. per acre.	
	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.
Plot 1	38.0 lbs.	38.0 lbs.										
" 7	35.5 "	33.5 "										
" 13	38.0 "	28.0 "										
" 2			47.0 lbs.	42.0 lbs.								
" 8			43.0 "	37.0 "								
" 14			45.5 "	48.3 "								
" 3					47.5 lbs.	48.7 lbs.						
" 9					46.0 "	45.0 "						
" 15					48 3 "	52 7 "						
" 4							35.5 lbs.	39.0 lbs.				
" 10							53.3 "	46.7 "				
" 15							40.0 "	51.5 "				
" 5									36.3 lbs.	34.3 lbs.		
" 11									37.0 "	18.0 "		
" 17									41.0 "	46.7 "		
" 6											74.0 lbs.	58.5 lbs.
" 12											69.0 "	62.0 "
" 18											61.0 "	71.9 "
Average	37.11 bs.	33.2 lbs.	45.1 lbs.	47.4 lbs.	47.3 lbs.	48.8 lbs.	42.4 lbs.	45.7 lbs.	38 1 lbs.	33.0 lbs.	68.0 lbs.	64.1 lbs.

Table A shows, that of the phosphates applied to this field with this crop, fine ground bone gave the highest yield of peas, while dissolved bone black stood next, the lowest yield being with the South Carolina rock. The table also shows that muriate of potash and sulphate of ammonia have little or no effect when applied alone, and that by far the largest yield of peas was obtained from the plots manured with stable manure.

Table B gives the average yield in bushels of the sets of three plots subjected to the different methods of manuring, and also shows the cost of the gains due to the phosphates and the stable manure.

TABLE B.

Kinds of Fertilizers.	Fertilizers per acre, in lbs.	Average yield of peas per acre in bush.	Average yield of straw per acre in lbs.	Aver. increase of peas per acre in bush.	Aver. increase of straw per acre in lbs.	Cost of increase due to phos. acid.	Cost of increase per bush.
Nothing		12.3	660				
Dissolved bone-black..	400						
Muriate of potash	100	15.0	840	2.3	180	$ 5.20	$ 2.26
Sulphate of ammonia ..	200						
Fine ground bone	360						
Muriate of potash......	100	15.7	980	3.00	320	5.04	1.68
Sulphate of ammonia..	140						
Fine ground S. C. rock	300						
Muriate of potash	100	14.3	840	1.60	180	2.40	1.50
Sulphate of ammonia..	200						
Muriate of potash	100	12.7	660	——	——	——	——
Sulphate of ammonia..	200						
Stable manure............	40000	22.7	1280	10.0	620	20.00	1.87

In table B it has been assumed that all gains on the plots to which phosphates were applied, above what was produced on the plots manured with sulphate of ammonia and muriate of potash, were due to the phosphates, and that the increase on the stable manure plots over the unmanured plots was due to stable manure. Practically the entire gain of the plots to which phosphates were applied was due to phosphoric acid, as the plots receiving no fertilizers produced as great a yield of peas as the plots receiving muriate of potash and sulphate of ammonia.

The cost of gain is based on the following prices: $26.00 per ton for dissolved bone black, $28.00 per ton for fine ground bone and $16.00 per ton for fine ground South Carolina rock. The price of the South Carolina rock is much too high in comparison to the other phosphates but is what was actually paid in this case.

The cost of the increase produced by the stable manure is reckoned on a basis of one dollar per ton for the manure.

The crop of peas on these plots would probably have been much larger had it not been for the severe cold rains in the early part of the season, which proved damaging to most crops during the year 1890.

Table C shows the method of manuring and the crop produced in studying the question of partial and complete fertilization, *i. e.*, in studying the question whether in all cases it will be more profitable to apply nitrogen, phosphoric acid and potash or to omit one or two of these substances.

This question is one into which every farmer in the State who uses commercial fertilizer should inquire. The standard brands of commercial fertilizers contain all three of the above named substances, and it may happen that only one of them is of use to him In such a case the cost of the crop has been unnecessarily increased by what he has paid for the fertilizing elements that have not materially added to the yield of his land.

TABLE C.

	No Manure.		Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per care.		Dissolved Bone-black 400 lbs. per acre.		Dissolved Bone-black 400 lbs., and Muriate of Potash 100 lbs. per acre.		Dissolved Boneb-lack 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre.		Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 150 lbs. per acre.	
	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.
Plot 1	38.0 lbs.	38.0 lbs.										
" 7	35.5 "	33.5 "										
" 13	38.0 "	28.0 "										
" 19	47.5 "	50.3 "										
" 25	38.0 "	38.5 "										
" 31	29.0 "	39.5 "										
" 5			36.2 lbs.	34.2 lbs.								
" 11			37.0 "	18.0 "								
" 17			41.0 "	46.7 "								
" 20					52.2 lbs.	51.2 lbs.						
" 26					43.0 "	52.7 "						
" 32					32.5 "	34.5 "						
" 21							52.7 lbs.	53.5 lbs.				
" 27							48.0 "	53.0 "				
" 33							43.0 "	46.5 "				
" 2									47.0 lbs.	42.0 lbs.		
" 8									43.0 "	37.0 "		
" 14									45.5 "	40.0 "		
" 24											56.5 lbs.	37.5 lbs.
" 30											37.3 "	43.7 "
" 36											49.5 "	42.5 "
Average	37.6 lbs.	37.9 lbs.	38.1 lbs.	33.0 lbs.	42.6 lbs.	46.1 lbs.	47.9 lbs.	50.7 lbs.	45.2 lbs.	42.0 lbs.	47.8 lbs.	41.2 lbs.

It is seen in table C that the average yield of the plots to which no manure was applied is practically the same as the average yield of those plots which were manured with muriate of potash and sulphate of ammonia. The plots manured with dissolved bone black show a decided increase over the unmanured plots. The highest yield is given with dissolved bone black and muriate of potash.

The following table (D) shows the average yield per acre under the various methods of fertilization, the gains on the manured plots over the unmanured plots and the cost of same.

This experiment shows quite clearly that for the soil on which the experiment was carried, out and for this crop, the nitrogenous manure was not needed, and that it only served to increase the cost of the crop.

TABLE D.

	Fertilizer per acre.	Average yield of peas per acre, in bushels.	Average yield of straw per acre, in lbs.	Average gain per acre of peas, in bush.	Average gain per acre of straw, in lbs.	Cost of gain per bushel.
Nothing	——	12.7	854	——	——	
Dissolved bone-black	400 lbs.	14.2	924	1.5	70	$2.40
Dissolved bone-black Muriate of potash	400 " 100 "	15.9	1020	3.2	166	1.79
Dissolved bone-black Muriate of potash Sulphate of ammonia	200 " 50 " 60 "	14.9	844	2.2	—10	2.29
Dissolved bone-black Muriate of potash Sulphate of ammonia	300 " 100 " 120 "	13.7	872	1.0	18	9.18
Dissolved bone-black Muriate of potash Sulphate of ammonia	400 " 150 " 180 "	15.9	824	3.2	—30	4.16

The amount of commercial fertilizers that can profitably be used in growing the staple agricultural products is a question that every farmer must settle for himself, because of the varying conditions under which farmers are working. But the experiments at the Station present matter that is worthy of consideration.

Table E shows the crop producing power of the field without fertilizers in the results obtained from the unmanured plots, together with the results obtained from the use of different amounts of commercial fertilizers.

In table F are shown the gains per acre and the cost of the fertilizers producing them.

TABLE E.

	No Manure.		Dissolved bone-black 200 lbs., muriate of potash 50 lbs. sulphate of ammonia 60 lbs. per acre.		Dissolved bone-black 300 lbs., muriate of potash 100 lbs., sulphate of ammonia 120 lbs. per acre.		Dissolved bone-black 400 lbs., muriate of potash 150 lbs., sulphate of ammonia 180 lbs. per acre.	
	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.	Peas.	Straw.
Plot 1	38.0 lbs.	38.0 lbs.						
" 7	35.5 "	33.5 "						
" 13	38.0 "	28.0 "						
" 19	47.5 "	50.3 "						
" 25	38.0 "	38.5 "						
" 31	29.0 "	39.5 "						
" 22			45.3 lbs.	40.8 lbs.				
" 28			52.5 "	44.5 "				
" 34			36.3 "	41.5 "				
" 23					45.0 lbs.	45.0 lbs.		
" 29					34.3 "	38.7 "		
" 35					44.0 "	47.0 "		
" 24							56 5 lbs.	37.5 lbs.
" 30							37.3 "	44.7 "
" 36							49.5 "	42.5 "
Average	37.66 "	37.96 "	44.7 "	42.26 "	41.1 "	43.56 "	47.76 "	41.56 "

TABLE F.

Quantity of Fertilizer per Acre.	Average yield per acre. Peas.	Average yield per acre. Straw.	Gain per acre. Peas.	Gain per acre. Straw.	Cost of Grain per bushel.
No manure	12.7 bush.	854 lbs.			
Diss'lved bone-black 200 lbs; Muriate of potash, 50 lbs; Sulphate of ammonia, 60 lbs	14.9 "	846 "	2.2 bush.	—8 lbs.	$2.64
Diss'lved bone-black 300 lbs; Muriate of potash, 100 lbs; Sulphate of ammonia, 120 lbs	13.7 "	872 "	1.0 "	18 "	10.36
Diss'lved bone-black 400 lbs; Muriate of potash, 150 lbs; Sulphate of ammonia, 180 lbs	15.9 "	824 "	3.2 "	—30 "	4.35

From the results given in table F it would seem that for peas, on the land on which this experiment was carried out, the smallest quantity of fertilizers applied produced the best results financially; and that in no case was the increased yield produced by the fertilizers sufficient to pay for the cost of the fertilizers.

Systems of Manuring.

The object of this experiment is to compare a system of manuring with stable manure and systems of manuring with commercial fertilizers, and of cropping without manuring.

In 1888, a ten acre field of grass land located south of the college farm stables was carefully surveyed and divided into four plots extending nearly east and west, each plot being 177 5-10 feet wide by 613 52-100 feet long, and containing two and one-half acres. This land is a clay loam and excellent grass land.

For two years no fertilizers were applied to any of the plots, the grass being cut and weighed carefully to determine the relative conditiion of the plots as to fertility. The plots are numbered 1, 2, 3 and 4, commencing with the plot on the north side. Their yield of hay for the two years is shown in the following tables:

TABLE SHOWING YIELDS OF HAY PER PLOT AND PER ACRE FOR THE YEAR 1888.

	Per Plot.	Per Acre.
Plot 1	7.380 lbs.	2.952 lbs.
" 2	6.460 "	2.584 "
" 3	5.930 "	2.372 "
" 4	7.055 "	2.822 "

TABLE SHOWING YIELDS OF HAY PER PLOT AND PER ACRE FOR THE YEAR 1889.

	Per Plot.	Per Acre.
Plot 1	5.320 lbs.	2.158 lbs.
" 2	5.625 "	2.250 "
" 3	4.485 "	1.792 "
" 4	5.485 "	2.194 "

TABLE SHOWING TOTAL YIELDS OF HAY PER ACRE AND PER PLOT FOR THE YEARS 1888 AND 1889.

	Per Plot.	Per Acre.
Plot 1	12.710 lbs.	5.084 lbs.
" 2	12.080 "	4.832 "
" 3	10.415 "	4.164 "
" 4	12.530 "	5,010 "

TABLE SHOWING THE AVERAGE YIELD OF HAY PER PLOT AND PER ACRE FOR THE TWO YEARS.

	Per Plot.	Per Acre.
Plot 1	6.355 lbs.	2.542 lbs.
" 2	6.040 "	2.416 "
" 3	5.207 "	2.082 "
" 4	6.265 "	2.510 "

Taking Plot 4, which is the plot under cultivation without manure, as the standard from which to reckon the productiveness of the other plots from time to time had they been cropped without manuring, and representing the yield of Plot 4 by the number 100, the following table shows the yields of the different plots that might be expected without the adddition of fertilizers, in per cent. of the yield of Plot 4.

The figures below show the average yield of hay for the years of 1888 and 1889 in per cent. of Plot 4.

Plot 1, 101 per cent.
" 2, 96 " "
" 3, 80 " "
" 4, 100 " "

In the spring of 1890 the entire ten acres were plowed and the plots treated as follows as to fertilizers.

Plot 1	Received 50 loads of manure from the cow stables, or at the rate of 20 loads to the acre, requiring 3 loads to the cord.
Plot 2	Received 2.500 lbs. of finely ground South Carolina rock, 250 lbs. of muriate of potash, 165 lbs. nitrate of soda and 40 lbs. sulphate of ammonia.

Plot 3 { Received 1250 lbs. of acid South Carolina rock, 250 lbs. of muriate of potash, 165 lbs. of nitrate of soda and 40 lbs. sulphate of ammonia.

Plot 4 { Received no fertilizers.

At the time of planting it was thought desirable to couple with this experiment one to determine the comparative amounts of barley and peas that could be produced on the same area under the same system of manuring and cultivation, and also to determine which of the two varieties of peas, the Black-eyed Marrowfat or the small Canada, would give the largest yield.

With the above named objects in view one-half of each plot (1 1-4 acres) was sowed broadcast to barley. The remaining half plots (1 1-4 acres) were each divided into two parts of five-eighths acres, one part of which was in each case planted to the small Canada pea, in drills with a Eureka Corn Planter at the rate of two bushels per acre. The other five-eighths acre was drilled to Black-eyed peas.

The peas were cultivated twice between rows to keep down grass and weeds.

The following diagram shows the field and manner of seeding.

EXPERIMENTAL FIELD NO. 2.

No. 1. 20 Loads (6⅝ Cords Stable Mauure per Acre. 2½ Acres.	⅝ Acres.	........Black-eyed Peas.
	⅝ Acres.	........Canada Peas.
	1¼ Acres.	........Barley.
No. 2. 1000 lbs. South Carolina Rock, 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia, and 100 lbs. muriate of potash per acre. 2½ Acres.	⅝ Acres.	........Black-eyed Peas.
	⅝ Acres.	........Canada Peas.
	1¼ Acres.	........Barley.
No. 3. 500 lbs. Acid South Carolina Rock, 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia and 100 lbs. muriate of potash per acre. 2½ Acres.	⅝ Acres.	........Black-eyed Peas.
	⅝ Acres.	........Canada Peas.
	1¼ Acres.	........Barley.
No. 4. No. Manure. 2½ Acres.	⅝ Acres.	........Black-eyed Peas.
	⅝ Acres.	........Canada Peas.
	1¼ Acres.	........Barley.

The season was very unsatisfactory for experimental work both at the opening and at the close, on account of heavy rains. This work was carefully carried through however, and though the crops were much less than would have been the case in an ordinary season, they will serve to show the comparative effect of the fertilizers used in growing them and the comparative yield of stock food produced by the different crops under the conditions of the experiment.

Below is given a table showing the combined yield of barley and peas on each plot and the amount per acre, together with calculated yields of Plot 1, 2 and 3 had no fertilizers been applied, the average yield for the two years that the field was in grass, calculated in per cent. of Plot 4, being taken as a basis.

Amounts of fertilizer applied per acre.		Total yield per plot of 2½ acres.	Total yield per acre.	Calculated yield per acre without fertilizer.	Calculated gain per acre due to fertilizers.
Plot 1.	20 loads stable manure.....	5520 lbs.	2208 lbs.	1129 lbs.	1079 lbs.
Plot 2.	1000 lbs. S. C. rock. .... 66 lbs. nitrate of soda...... 16 lbs. sulphate of ammonia .... 100 lbs. muriate of potash..	4280 lbs.	1712 lbs.	1062 lbs.	640 lbs.
Plot 3.	500 lbs. acid S. C. rock..... 66 lbs. nitrate of soda...... 16 lbs. sulphate of ammonia .... 100 lbs. muriate of potash..	3555 lbs.	1422 lbs.	894 lbs.	528 lbs.
Plot 4.	No fertilizer	2795 lbs.	1118 lbs.	—	—

The highest yield is given here with stable manure. Then follows the plot to which the finely ground South Carolina rock was applied. Next in order comes the plot receiving acid South Carolina rock, while the lowest in the scale is the unmanured plot. There is nothing remarkable in the yield of Plots 1 and 4. They produced relatively about what was expected of them. Plots 2 and 3 were treated alike as to fertilizers, excepting in the amount and condition of phosphoric acid. Plot 2 received about 200 lbs. of insoluble phosphoric acid per acre, while Plot 3 received 70 lbs. of soluble phosphoric acid per acre. It would seem from these results that the 200 lbs. of insoluble phosphoric acid was more effective in producing an increase in the total weight of the crop than the 70 lbs. of soluble phosphoric acid.

In order to study the effect of the fertilizers on the relative yield of barley and peas separately, and the comparative amount of stock food produced by the barley and the two varieties of peas, the following diagramatic table of the experimental field is presented.

Plot 1. Stable manure, 20 loads per acre. (2½ acres.)	Black-eyed Peas, 405 lbs., (⅝ acres.)	Straw, 585 lbs.
	Canada Peas, 199 lbs., (⅝ acres.)	Straw, 821 lbs.
	Barley, 552 lbs., (1¼ acres.)	Straw, 2958 lbs.
Plot 2. 1000 lbs. South Carolina Rock; 100 lbs. muriate of potash; 66 lbs. nitrate of soda, and 16 lbs. sulphate of ammonia, per acre. (2½ acres.)	Black-eyed Peas, 326 lbs., (⅝ acres.)	Straw, 325 lbs.
	Canada Peas, 127 lbs., (⅝ acres.)	Straw, 433 lbs.
	Barley, 553 lbs., (1¼ acres.)	Straw, 2527 lbs.
Plot 3. 500 lbs. acid S. Carolina Rock; 100 lbs. muriate of potash; 66 lbs. nitrate of soda; and 16 lbs. sulphate of ammonia, per acre. (2½ acres.)	Black-eyed Peas, 251 lbs., (⅝ acres.)	Straw, 450 lbs.
	Canada Peas, 122 lbs., (⅝ acres.)	Straw, 393 lbs.
	Barley, 542 lbs., (1¼ acres.)	Straw, 1799 lbs.
Plot 4. No manure. (2½ acres.)	Black-eyed Peas, 257 lbs., (⅝ acres.)	Straw, 418 lbs.
	Canada Peas, 160 lbs., (⅝ acres.)	Straw, 430 lbs.
	Barley, 220 lbs., (1¼ acres.)	Straw, 1310 lbs.

In order to study the relative effects of the fertilizers on the crops of peas and barley, the following tables have been made showing the yields per acre of Barley, Black-eyed Peas and Canada Peas, on the different plots, together with the calculated yields had no fertilizers been applied, and the calculated gains due to fertilizers.

BARLEY.

Amount of fertilizers applied per acre.		Yield of Barley per acre.		Calculated yield per acre without fertilizers.		Calculated gain per acre.	
		Barley.	Straw.	Barley.	Straw.	Barley.	Straw.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Plot 1.	20 loads of stable manure	441	2766	178	1058	263	1708
Plot 2.	1000 lbs. S. C. rock 66 lbs. nitrate of soda 16 lbs. sulphate of ammonia 100 lbs. muriate of potash	442	2216	169	1006	273	1210
Plot 3.	500 lbs. acid S. C. rock 66 lbs. nitrate of soda 16 lbs. sulphate of ammonia 100 lbs. muriate of potash	434	1438	141	834	293	604
Plot 4.	No manure	176	1048				

BLACK-EYED PEAS.

Amount of fertilizers applied per acre.		Yield of Peas per acre.		Calculated yield per acre without fertilizers.		Calculated gain per acre.	
		Peas.	Straw.	Peas.	Straw.	Peas.	Straw.
Plot 1.	20 loads of stable manure.....	lbs. 648	lbs. 920	lbs. 425	lbs. 665	lbs. 223	lbs. 255
Plot 2.	1000 lbs. S. C. rock............ 66 lbs. nitrate of soda.......... 16 lbs. sulphate of ammonia... 100 lbs. muriate of potash.....	522	520	375	652	147	132
Plot 3.	500 lbs. acid S. C. rock......... 66 lbs. nitrate of soda.......... 16 lbs. sulphate of ammonia... 100 lbs. muriate of potash.....	402	720	329	526	73	194
Plot 4.	No manure.....................	411	658				

CANADA PEAS.

Amount of fertilizers applied per acre.		Yield per acre.		Calculated yield per acre without fertilizers.		Calculated gain per acre.	
		Peas.	Straw.	Peas.	Straw.	Peas.	Straw.
Plot 1.	20 loads of stable manure.....	lbs. 318	lbs. 1314	lbs. 259	lbs. 695	lbs. 59	lbs. 619
Plot 2.	1000 lbs. S. C rock.............. 66 lbs. nitrate of soda ... 16 lbs. sulphate of ammonia... 100 lbs. muriate of potash.....	203	697	245	660	42	37
Plot 3.	500 lbs. acid S. C. rock......... 66 lbs. nitrate of soda .... 16 lbs. sulphate of ammonia... 100 lbs. muriate of potash.....	195	596	204	550	9	46
Plot 4.	No manure.....................	256	688				

Considering first the effect of the fertilizers on the barley, it will be seen that the calculated gain of grain is largest with the acid South Carolina rock and least with the stable manure, while the fine ground South Carolina rock is mid way between the two.

With the calculated gain of straw the order is reversed, the stable manure giving the highest gain of straw, fine ground South Carolina rock ranking next, while the acid South Carolina rock stands lowest.

But in whatever light the figures be examined we can but come to the conclusion that the South Carolina rock has assissted in increasing the crop of barley to an extent nearly equal to, if not greater than, acid South Carolina rock.

With the Black-eyed peas the stable manure gives the best results, South Carolina rock standing next in order, and the acid South Carolina rock at the foot of the list, so far as the yield of peas is concerned. But with pea straw the South Carolina rock gives the lowest returns. The effect of the phosphatic manures on the yield of the Canada peas was but slight, and the greatest effect of stable manure was in increasing the straw. The gain in this direction was 619 lbs. per acre while the yield of peas was only increased by 59 lbs.

There is no way of accounting for the failure of the manures to increase the yield of this crop in proportion to that of the Black-eyed Marrowfat peas.

In considering the yields of the crops grown on this field from the standpoint of the amount of stock food produced by each under like condition of fertilization it is but fair to state that the peas possess about twice the value of the barley as a source of albumnoids. The following table shows the yield per acre of Barley, Black-eyed Peas and Canada Peas.

	Barley.	Black-eyed Peas.	Canada Peas.
Plot 1	441 lbs.	648 lbs.	318 lbs.
" 2	442 "	522 "	203 "
" 3	434 "	402 "	195 "
" 4	176 "	411 "	256 "

The conclusions to be drawn from these figures are obvious. Under the conditions of this experiment the growing of peas for stock purposes is to be preferred to growing barley. The Black-eyed Marrowfat pea yields double the amount of the Canada pea.

Fertilizer Experiments by Farmers.

In 1889 the Station sent out sets of experimental fertilizers to several farmers designed to test the availability of insoluble phosphates.

Two of these sets fell into the hands of farmers whose land evidently needed phosphoric acid more than anything else. One of them, Mr. H. L. Leland, has kindly consented to continue his experiment this year without further manuring.

This experiment was conducted on a dry, slaty loam, which previous to 1889, had received no manure for thirty years and had been subjected to continuous cropping. At the time it was plowed up it was cutting only half a ton of hay per acre. The experiment was conducted on one-tenth acre plots, and the amounts of phosphates applied were such that the plots receiving crude phosphates obtained four times as much insoluble phosphoric acid as was received of soluble phosphoric acid by the plots to which the acid phosphate was applied.

Mr. Leland writes that the bad weather seriously interfered with the experiment for this year.

The results are valuable, however, as showing the relative effect of the phosphoric acid from the various sources.

In 1889 the average increase of the plots receiving phosphoric acid with sulphate of ammonia and muriate of potash over the plots receiving only sulphate of ammonia and muriate of potash was for

Acid South Carolina Rock, 194 per cent.,
Fine Ground South Carolina Rock, 113 per cent.,
Fine Ground Caribbean Sea Guano, 62 per cent.

In 1890 the gains were for

Acid South Carolina Rock, 124 per cent.,
Fine Ground South Carolina Rock, 65 per cent.,
Fine Ground Caribbean Sea Guano, 42 per cent.

The following tables show the results obtained by Mr. Leland for the years 1889 and 1890.

EXPERIMENT OF H. L. LELAND FOR 1889.

Crop Potatoes.

No. of Plot.	Name of fertilizer.	Amount per acre.	Yield* per acre of potatoes.
1.	Acid S. C. Rock Sulphate of ammonia Muriate of potash	500 150 lbs. 100	68⅓ bush.
2.	Fine ground S. C. Rock Sulphate of ammonia Muriate of potash	1000 150 " 100	50 "
3.	Caribbean Sea Guano Sulphate of ammonia Muriate of potash	725 150 " 100	40 "
4.	Sulphate of ammonia Muriate of potash	150 " 100	22 "
5.	No fertilizer		30 "
1a.	Acid S. C. Rock Sulphate of ammonia Muriate of potash	500 150 " 100	65 "
2a.	Fine ground S. C. Rock Sulphate of ammonia Muriate of potash	1000 150 " 100	48⅓ "
3a.	Caribbean Sea Guano Sulphate of ammonia Muriate of potash	725 150 " 100	33⅓ "
4a.	Sulphate of ammonia Muriate of potash	150 " 100	21⅓ "
5a.	No fertilizer		29⅓ "

*Rust killed potato vines about August 15th, or the yield would probably have been greater.

EXPERIMENT OF H. L. LELAND FOR 1890.

Crop Beans.

No. of Plot.	Name of Fertilizer.	Amount per acre in lbs.	Yield of beans per acre in bush.
	Acid S. C. Rock	500	
1	Sulphate of ammonia	150	9.7
	Muriate of potash	100	
	Fine ground S. C. Rock	1000	
2	Sulphate of ammonia	150	8.7
	Muriate of potash	100	
	Caribbean Sea Guano	725	
3	Sulphate of ammonia	150	6.3
	Muriate of potash	100	
	Sulphate of ammonia	150	
4	Muriate of potash	100	4.0
5	No fertilizer		4.6
	Acid S. C. Rock	500	
1a.	Sulphate of ammonia	150	10.5
	Muriate of potash	100	
	Fine ground S. C. Rock	1000	
2a.	Sulphate of ammonia	150	6.4
	Muriate of potash	100	
	Caribbean Sea Guano	725	
3a.	Sulphate of ammonia	150	6 4
	Muriate of potash	100	
	Sulphate of ammonia	150	
4a.	Muriate of potash	100	4.9
5a.	No fertilizer		3.7

Five sets of experimental fertilizers were sent out to farmers last spring having the same general object as those that were sent out in 1889, namely, the determination of the availability of phosphoric acid in crude phosphates. These sets were arranged for tenth acre plots like those in the preceding year. The phosphates used for crude material were South Carolina rock and Thomas' Slag.

The latter is a fertilizing material that has come into notice within a few years. It is a by-product resulting from the manufacture of a certain grade of steel and contains a considerable quantity of free lime, together with a varying amount of phosphoric acid. The lot purchased by the Station carried twenty per cent. of phosphoric acid, of which six per cent. was soluble in ammonium citrate.

Rather remarkable results have been obtained by the use of this material in experimental work, and the question has arisen, in the minds of some, whether the favorable action of this phosphate was not in part due to the free lime it contains. Hence two plots have been arranged which receive an equal amount of phosphoric acid in South Carolina Rock, to which is added an amount of free lime equal to that contained in the Thomas' Slag. The nitrogen in this set was furnished in the form of nitrate of soda and the potash as muriate of potash.

EXPERIMENT BY J. P. MOULTON, OF SPRINGVALE.

Mr. Moulton reports as follows:

"The soil is a heavy, rocky loam, yellow sub-soil with a hard pan from two and a half to three feet below the surface; land inclining gradually to the south-west. It was seeded seven years ago and cut three-fourths of a ton of hay per acre in 1889. The ground was plowed the first of May, 1890, and planted from the twelfth to the fifteenth of the same month. Fertilizers applied as directed. Seed was a small eight rowed corn and the hills were two feet eight inches apart each way.

The following table shows the kind and quantity of fertilizers used and amount of crop produced on the several plots.

No. of Plot.	Name of Fertilizer.	Amount per acre in lbs.	Total yield per plot in lbs.	Yield of No. 1 husked corn per plot in lbs.	Yield of No. 2 husked corn per plot in lbs.
1	Acid S. C. Rock Muriate of potash Nitrate of soda	500 100 150	705	233	103
2	Fine ground S. C. Rock Lime Muriate of potash Nitrate of soda	1000 200 100 150	705	112.5	175
3	Thomas' Slag Muriate of potash Nitrate of soda	1000 100 150	712.5	269.5	108
4	Fine ground S. C. Rock Muriate of potash Nitrate of soda	1000 100 150	820	192.5	100
5	Muriate of potash Nitrate of soda	100 150	825	173.5	88
6	No fertilizers	———	706.5	107.5	134
1a.	Acid S. C. Rock Muriate of potash Nitrate of soda	500 100 150	987.5	279	90
2a.	Fine ground S. C. Rock Lime Muriate of potash Nitrate of soda	1000 200 100 150	1082.5	225	90
3a.	Thomas' Slag Muriate of potash Nitrate of soda	1000 100 150	1094.	270	115
4a.	Fine ground S. C. Rock Muriate of potash Nitrate of soda	1000 100 150	735	239	97
5a.	Muriate of potash Nitrate of soda	100 150	560	171	88
6a.	No fertilizer	———	457.5	143.5	82

Observations and remarks of Mr. Moulton in regard to the crop.

"The corn was harvested the first of October. Plots 1, and 1a, were very dry and ripe when harvested.

These plots were more forward than any of the others through the entire season and in ripening were two weeks ahead, but the kernels were not as plump or the ears as well filled.

The fertilizers applied to plots 2 and 2a, seemed to have a bad influence on the germination of the seed. The corn on these plots had a backward appearance through the season.

Plots 3 and 3a gave the best and largest yields of corn, though the fodder on 3 was not as much as in some other cases.

Plots 4 and 4a were an average pair.

The fertilizer applied to plots 5 and 5a seemed to effect the seed in the same way as on 2 and 2a. Only about half of the seed germinated.

Plots 6 and 6a surprised me more than all the others. No one supposed that the corn would mature."

In Mr. Moulton's experiment all of the phosphates seem to increase the crop over muriate of potash and nitrate of soda. Slightly more corn was produced by the Thomas Slag than with Acid South Carolina Rock. The experiment gives no evidence that the superior effect of the Thomas Slag over Fine Ground South Carolina Rock is due to the free lime contained in the slag.

EXPERIMENT OF MR. O. B. KEENE, EASTON, AROOSTOOK COUNTY.

No description of soil accompanied this report. The results obtained are quite remarkable, though they show little evidence of any benefit to the crop from the use of crude phosphates.

The plots in this case as in the experiment by Mr. Moulton and Mr. Leland were one-tenth acre plots.

The crop cultivated was potatoes. The number of hills per plot 870. Mr. Keene reports many missing hills which might have been due to bad seed.

In the following table are given the quantities of fertilizers used; the number of missing hills; the actual yield per acre and the calculated yield per acre had all of the hills on the plots yielded as did those producing potatoes.

No. of Plot.	Kind of Fertilizer.	Amount per acre in lbs.	No. missing hills.	Total yield per acre in bush.	Yield per acre in bush., comput'd for 870 hills per plot.
1	Acid S. C. Rock Muriate of potash Nitrate of soda	500 100 150	220	218	292
3	Thomas' Slag Muriate of potash Nitrate of soda	1000 100 150	301	182	278
4	Fine ground S. C. Rock Muriate of potash Nitrate of soda	1000 100 150	458	134	281
5	Muriate of potash Nitrate of soda	100 150	576	104	255
6	No fertilizers	———	434	128	155
1a.	Acid S. C. Rock Muriate of potash Nitrate of soda	500 100 150	327	213	344
3a.	Thomas' Slag Muriate of potash Nitrate of soda	1000 100 150	251	192	270
4a.	Fine ground S. C. Rock Muriate of potash Nitrate of soda	1000 100 150	221	151	203
5a.	Muriate of potash Nitrate of soda	100 150	230	202	276
6a.	No fertilizer	———		84	109

This experiment is interesting in showing the remarkable effect of commercial fertilizers on some soils. The average of the plots receiving no fertilizers was 132 bush. per acre. The average of the plots receiving nitrate of soda and muriate of potash was 262 bush per acre. Here the crop was doubled by adding 150 lbs. of nitrate of soda and 100 lbs. of muriate of potash.

The cost of the chemicals in this case was $5.50.

The extra cost of 130 bush. of potatoes was about 4.2 cents per bushel.

No addition to this crop was produced by using South Carolina Rock or Thomas Slag. But the use of 500 lbs. of Acid South Carolina Rock, costing $4.50, caused an additional gain to that made by the nitrate of soda and muriate of potash of 56 bush. at a cost of 8 cents per bush.

This experiment has a local value, if Mr. Keene and his neighbors have much soil of this character, as indicating what they shall use for fertilizers in growing potatoes.

TESTS OF VARIETIES.

Prof. Walter Balentine.

For several years the Station has grown a large number of varieties of potatoes, oats, barley and peas to test their comparative value, each year cultivating the varieties produced the preceding year and adding new varieties.

The present year the old varieties have been dropped and only a few varieties of garden vegetables that have been advertised as novelties have been tested. The season has been unfavorable for giving these varieties a fair trial, being cold and wet both in the first and last part leaving only a few weeks in the middle portion of really favorable weather for producing such crops.

Quite a number are not reported on as it was quite evident that the fault was more with the weather than the variety.

Below are given the results of these trials:

BEANS.

Early Golden-Eyed Wax Bush Bean.

Planted May 24th, blossomed July 18th.

Large enough for string beans, July 31st.

Ripe September 20th. Quality medium.

Yosemite Mammoth Wax Bush Bean.

Planted May 24th. Blossomed July 24th.

Large enough for string beans, August 4th.

Ripe October 1st. This variety rusted so badly as to be worthless.

Henderson's New Bush Lima Bean.

Planted May 24th. Blossomed August 4th.

Large enough to shell Sept. 25th. This bean is too late for profitable culture in this section of the State.

Early Golden Cluster Wax Pole Bean.

Planted May 24th. Blossomed Aug. 2d.

Large enough for string beans, Aug. 18th. Quality good.

Failed to ripen on account of wet weather.

Black-Eyed Wax Bush Bean.

Planted June 9th. Blossomed July 30th.

Large enough for string beans Aug. 8th.

Ripe Sept. 20th. Quality good.

Champion Bush Bean.

Planted June 9th. Blossomed July 30th.

Ripe Sept. 29th. Quality good. Fairly prolific.

SWEET CORN.

The following varieties of sweet corn were tested:

Burbank's Early Maine Sweet Corn.

Planted May 24th. Spindled July 26th. Silked Aug. 4th.

Ears large enough to boil Aug. 30th. Quality inferior.

New Gold Coin Sweet Corn.

Planted May 24th. Spindled Aug. 13th. Silked Aug. 27th.

This variety was very late. The kernels did not arrive at the milky stage before the frost killed the crop.

Ne Plus Ultra Sugar Corn.

Planted May 26th. Spindled Aug. 13th. Silked Aug. 25th.

Failed to produce ears far enough advanced for boiling before the frost killed the crop. The variety is too late for this climate.

PEAS.

But one variety of pea was planted, the Dwarf Champion. Planted June 9th. Blossomed July 20th. Large enough to shell Aug. 4th. This variety is fairly prolific and of good quality.

BEETS.

Mitchell's Perfected Earliest Turnip Beet proved to be of superior quality.

SQUASH AND PUMPKINS.

Four varieties of squash were planted for testing and one variety of pumpkin. The season proved so unfavorable that none ripened before the frost killed the vines on Sept. 25th.

Report of Botanist and Entomologist.

PROF. F. L. HARVEY.

Below is given an outline of the subjects considered by the division of Botany and Entomology during the past season.

BOTANY.

1. Germination Experiments.
2. Testing varieties of grasses.
3. Spraying Experiments for Apple Scab and Codling Moth.
4. Spraying Experiments to determine minimum amount of Paris Green for Potato Beetles.
5. Causes of Potato Scab. Consideration of investigations by Messrs. Bolley and Thaxter.
6. Correspondence about Strawberries.
7. *Plantago lanceolata*, Linn. Rib Grass or English Plantain described and Illustrated.
8. *Leontodon autumnalis*, Linn. Fall Dandelion considered and illustrated.

ENTOMOLOGY.

9. *Platysamia Cecropia*, (Linn.). Cecropia Emperor-moth.
10. *Orgyia leucostigma*, (Sm. & Abb.). White-marked Tussock-moth.
11. *Hyphantria cunea*, Drury. Fall Web-worm.
12. *Tmetocera ocellana*, (Schiff.). Eye-spotted Bud-moth.
13. *Schizoneura lanigera*, (Hausm). Woolly-louse of the Apple.
14. *Œdemasia concinna*, (Sm. & Abb.). Red-humped Apple-tree Caterpillar.
15. *Anisopteryx pometaria*, Harris. Fall Canker-worm.
16. *Clisiocampa sylvatica*, Harris. Forest Tent-caterpillar.

PLANTS OF ECONOMIC IMPORTANCE RECEIVED FOR EXAMINATION IN 1890.

No.	Common Name	Scientific Name.	From Whom.	Depredations, &c.
1	Orange Hawk weed.	Hieracium aurantiacum.	Geo. S. Paine, Winslow, Me.	Weed in meadows.
2	Field Sow Thistle.	Sonchus arvensis, L.	H. H. Cook, Presque Isle.	Weed in grain fields.
3	Reed.	Phragmites communis, Trin.	M. F. Reed, East Bradford.	Growing in low ground.
4	Black Knot.	Plowrightia morbosa, Saco.	J. Q. A. Butts, Canaan.	Parasitic on cherry trees.
5	Oats.	Avena sativa.	Joel Richardson, N. Newport, Me.	Specimens turned yellow by wet weather. No parasite.
6	Rib Grass or Eng. Plantain.	Plantago lanceolola, L.	Various Parties.	A weed in fields and meadows.
7	Fall Dandelion.	Leontodon. autumnalis.	Various Parties.	Weed in fields, meadows and along roadsides.

INSECTS REPORTED AND EXAMINED—1890.

No.	Common Name.	Scientific Name.	Depredations.
1	Cecropia Emperor-moth.	Platysamia Cecropia, (Linn.).	The cocoon was received.
2	White-marked Tussock-moth.	Orgyia leucostigma, (Sm. & Abb.).	On apple trees and rose bushes.
3	Fall Web-worm.	Hyphantria textor, Harris.	On apple trees.
4	Eye-spotted Bud-moth.	Tmetocera ocellana, (Schiff.).	In blackberry buds.
5	Woolly-louse of the Apple.	Schizoneura lanigera, (Hausm).	On leaves and twigs of apple trees.
6	Red-Humped Apple-tree Caterpillar.	Œdemasia concinna, (Sm. & Abb.).	On leaves of apple trees.
7	Fall Canker-worm.	Anisopteryx pometaria, Harris.	On shade and apple trees.
8	Forest Tent-caterpillar.	Clisiocampa sylvatica, Harris.	On forest, shade and fruit trees.
9	The May-beetle.	Lachnosterna fusca, (Frohl.).	Feeding in larval state on grass roots.

Remarks.

Those of the above named plants and insects that have been studied and are of sufficient importance are considered below. The fine plates illustrating Rib Grass and Fall Dandelion were prepared by Miss Kate Furbish, Brunswick, Me. The cuts illustrating insects were obtained from J. B. Lippincott & Co., and are after cuts in Saunder's Insects Injurious to Fruits.

Mr. F. P. Briggs, as Assistant, has rendered efficient aid in conducting germination tests, looking after the grass plots, conducting spraying experiments and collecting material for the herbarium. Hereafter the experiments with insecticides will be under the direction of Prof. Munson and any one wishing information on spraying apparatus or insecticides should address their letters to him. Those who wish information regarding plants or insects, especially injurious fungi or insects are requested to sent specimens to the writer. Directions for sending specimens may be found in Station Report, 1888, p. 194, or in Maine Agricultural Report, 1888, p. 158.

We invite correspondence. It is to the interest of farmers to cultivate the habit of noticing insects and fungi when they first make their appearance and not wait until pests are beyond control before reporting them. It will be largely through correspondence that the Station learns of insects doing damage in the State.

GERMINATION EXPERIMENTS.

The seeds tested during the year were germinated as in previous years, in pockets or folds of cloth, which were kept moist by a flap of the cloth dipping into water. The entire apparatus was described in the Annual Report for 1888. The conditions, it is believed, were as favorable as possible, and the results obtained seem to prove that such was the case, for in many instances every seed sprouted.

The material for this year's work was obtained from James J. H. Gregory, Marblehead, Mass., and E. W. Burbank, Fryeburg, Me. Following are tables showing the results of the experiments :

RESULTS OF GERMINATION TESTS.

Serial number.	Station number.	DESCRIPTION.	Weight of 100 seeds in grams.	Number of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Per cent. Sprouted.	No. of days required for one-half to sprout.
		GREGORY.																	
310	324	Refugee Bean	31.770	0	0	10	40	27	2	0	0	0	0	0	0	0	0	79	4
311	325	Marrowfat Pea	38.706	0	0	9	60	31	0	0	0	0	0	0	0	0	0	100	4
312	326	Field Corn	30.676	0	3	22	52	16	1	0	0	0	0	0	0	0	0	94	4
313	327	Sugar Pumpkin	15.173	0	0	0	12	18	8	2	0	1	0	1	0	0	0	42	
314	328	Imperial Barley	2.962	75	15	5	0	0	1	0	0	0	0	0	0	0	0	96	1
315	329	Saskatchewan Wheat	2.892	40	40	9	2	2	0	1	0	0	0	0	0	0	0	94	2
316	330	Race horse Oats	2.672	10	67	19	0	0	1	0	0	0	0	0	0	0	0	97	2
317	331	Spring Rye	2 094	90	3	1	0	0	0	0	0	0	0	0	0	0	0	94	1
318	332	German Millet	.210	86	3	3	1	1	1	0	0	0	0	0	0	0	0	95	1
319	333	Eclipse Turnip Beet	1.427	5	17	11	1	3	2	0	0	0	0	1	0	0	0	40	
320	334	Hollow Crown Parsnip	.435	0	0	0	1	9	7	8	0	2	3	2	3	0	0	35	
321	335	All Seasons Cabbage	.394	3	23	9	3	1	2	2	1	0	1	0	1	0	0	46	
322	336	White spine Cucumber	2.808	25	65	3	2	0	2	0	0	1	1	1	0	0	0	100	2
323	337	Danvers Carrot	.122	0	5	16	12	5	0	2	2	0	1	0	0	0	0	43	
324	338	Long Scarlet Radish	1.362	31	24	5	4	7	1	1	0	1	1	0	0	0	0	75	2
325	339	Paragon Tomato	.335	0	2	40	20	10	4	0	0	0	0	0	0	0	0	76	4
326	340	Hanson Lettuce	.127	72	18	10	0	0	0	0	0	0	0	0	0	0	0	100	1
327	341	White Dutch Turnip	.213	97	0	0	1	0	0	0	0	0	0	0	0	0	0	98	1
328	342	Yellow Danvers Onion	.345	8	40	17	3	5	3	0	0	0	2	0	0	0	0	78	3
329	343	White Solid Celery	.046	0	0	0	0	3	8	5	2	5	2	1	1	0	0	27	
330	344	Alfalfa	.202	35	10	5	1	1	0	1	0	0	0	0	0	0	0	53	3
331	345	Red Clover	.156	62	20	3	1	1	0	0	0	0	0	0	0	0	0	87	1
332	346	White Clover	.061	25	20	3	18	1	0	0	0	0	0	0	0	0	0	67	4
333	347	Orchard Grass	.075	0	1	10	11	11	10	4	3	4	3	1	2	0	0	60	8
334	348	Timothy	.037	0	70	19	3	0	0	0	0	0	0	0	0	0	0	92	2

RESULTS OF GERMINATION TESTS.—(Continued.)

Serial number.	Station number.	DESCRIPTION.	Weight of 100 seeds in grams.	Number of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Per cent. sprouted.	No. of days required for one-half to sprout.
		BURBANK.																	
335	349	Sweet Corn	24.248	0	0	0	4	9	24	40	12	1	1	0	1	0	0	92	7
336	350	Turnip Beet	2.240	0	0	0	7	30	15	8	6	3	1	1	0	0	0	71	6
337	351	Sibley Squash	14.415	0	0	5	32	3	0	0	2	1	0	0	0	0	0	43	
338	352	Long Green Cucumber	2.705	0	0	17	20	32	1	0	2	0	0	0	0	0	0	72	5
339	353	Phinney's Watermelon	9.214	0	0	0	0	2	6	60	10	0	0	0	0	0	0	78	7
340	354	Fottler's Cabbage	.412	0	30	56	2	1	0	0	0	0	0	0	0	0	0	89	3
341	355	Improved Carrot	.123	0	0	3	8	32	8	4	0	0	0	0	1	0	0	56	6
342	356	Purple Top Turnip	.312	9	90	1	0	0	0	0	0	0	0	0	0	0	0	100	2
333	357	Hollow Crown Parsnip	.442	0	0	0	0	1	4	10	6	1	3	5	0	0	0	30	

Comparison of Seeds Tested.

During the years 1888, 1889 and 1890, we have tested seeds grown and sold in the State, and also some of those sold in Maine on commission, which are grown in other states. The results have been published in the Reports for these years respectively, but for the purpose of comparison we give below a rèsumè of the larger part of the work. The seeds tested were put up by the following parties: Lewis Atwood, Winterport, Me.; E. W. Burbank, Fryeburg, Me.; Edwin Chick & Co., Bangor, Me.; Department Agriculture, Washington, D. C.; A. H. Dunlap & Sons, Nashua, N. H.; R. B. Dunning & Co., Bangor, Me.; Thos. W. Emerson & Co., Boston, Mass.; D. M. Ferry & Co., Detroit, Mich.; James J. H. Gregory, Marblehead, Mass.; Kendall & Whitney, Portland, Me.; David Landreth & Sons, Philadelphia, Pa.; E. W. Lyman, Springfield, Mass.; Delano Moore, Presque Isle, Me.; J. B. Rice, Cambridge, N. Y.; James M. Thorburn & Co., New York, N. Y.

Put up by	Varieties tested.	Average % sprouted.	Put up by	Varieties tested.	Average % sprouted
Lettuce.			*Lettuce.*		
Atwood.	2	63	Emerson.	1	10
Chick.	1	99	Ferry.	2	90
Dept. Agr.	2	90	Gregory.	1	100
Dunlap.	3	83	Lyman.	1	0
Dunning.	1	77	Rice.	3	71
Turnip.			*Turnip.*		
Atwood.	3	73	Ferry.	5	83
Burbank.	1	100	Gregory.	1	98
Chick.	1	76	Lyman.	1	4
Dunlap.	3	29	Moore.	1	99
Dunning.	1	29	Rice.	2	73
Emerson.	1	97			
Cabbage.			*Cabbage.*		
Atwood.	1	48	Emerson.	1	92
Burbank.	1	89	Ferry.	4	85
Chick.	1	69	Gregory.	1	46
Dept. Agr.	4	80	Lyman.	1	91
Dunlap.	3	49	Rice.	3	77
Dunning.	1	88			
Parsnip.			*Parsnip.*		
Atwood.	2	22	Ferry.	3	55
Burbank.	1	30	Gregory.	1	35
Chick.	1	44	Lyman.	1	0
Dunlap.	5	36	Moore.	1	82
Dunning.	1	34	Rice.	2	58
Emerson.	1	49			

Put up by	Varieties tested.	Average % sprouted.	Put up by	Varieties tested.	Average % sprouted.
Celery.			*Celery.*		
Atwood.	1	58	Ferry.	2	35
Chick.	1	27	Gregory.	1	27
Dunlap.	1	10	Lyman.	1	33
Dunning.	1	62	Rice.	2	45
Onion.			*Onion.*		
Atwood.	1	73	Ferry.	1	67
Chick.	1	74	Gregory.	1	78
Dept. Agr.	10	83	Lyman.	1	0
Dunlap.	4	34	Rice.	2	87
Emerson.	1	95	Dunning.	1	62
Beet.			*Beet.*		
Atwood.	2	52	Emerson.	1	77
Burbank.	1	71	Ferry.	3	83
Chick.	1	63	Gregory.	2	60
Dept. Agr.	6	76	Lyman.	1	48
Dunlap.	4	79	Moore.	1	84
Dunning.	1	18	Rice.	4	72
Carrot.			*Carrot.*		
Atwood.	1	57	Ferry.	2	58
Burbank.	1	56	Gregory.	1	43
Dunlap.	2	56	Moore.	2	82
Dunning.	1	51	Lyman.	1	22
Emerson.	1	48	Rice.	2	45
Tomato.			*Tomato.*		
Atwood.	2	52	Gregory.	1	76
Dept. Agr.	4	58	Lyman.	1	57
Dunlap.	1	78	Rice.	3	91
Ferry.	2	81			
Radish.			*Radish.*		
Atwood.	2	4	Gregory.	1	75
Dunlap,	2	79	Lyman.	1	80
Ferry.	2	69	Rice.	3	84
Sweet Corn.			*Sweet Corn.*		
Burbank.	2	95	Gregory.	1	94
Dept. Agr.	2	82	Moore.	1	90
Ferry.	1	99	Rice.	3	86
Clover.			*Clover.*		
Chick.	3	86	Landreth.	1	78
Dunning.	4	88	Moore.	1	81
Gregory.	2	77	Thorburn.	5	86
Kend. & Whit.	5	83			

Experiments with Corrosive Sublimate.

In all of the germination experiments care has been taken to destroy all fungoid germs by boiling the cloths used, for about thirty minutes, and thoroughly scalding the tray and everything connected with it. Yet the seeds have moulded more or less during the two weeks they remained in the germinator. Those that sprouted in a few days moulded but little, or not at all, while those that sprouted slowly, or failed to germinate moulded considerably, and sometimes very badly. The germs of the mould must in these cases have been on or in the seeds themselves. The question arose whether the mould interfered in any way with the sprouting of the seeds. As was stated in last year's report, a weak solution of corrosive sublimate, (mercuric chloride) one part to ten thousand parts of water was used, in which the seeds were dipped, after which they were washed in water that had been boiled, and then placed in the germinator. Only a few were tried in this way and no conclusions could be safely drawn from the results. This year more experiments were made, in about the same way. Two solutions were used each stronger than the first, one having one part of the corrosive sublimate to one thousand parts water, and the other, one part to five hundred parts water. Below are tables showing the per cent. sprouted, with and without being dipped in the solutions.

Corrosive sublimate 1 part to 1000 water			Corrosive sublimate 1 part to 500 parts water.		
Kind of seed.	Not treated.	Dipped in solution.	Kind of seed.	Not treated.	Dipped in solution.
Bean.	79	79	Corn.	92	88
Parsnip.	35	37	Beet.	71	31
Cabbage.	46	43	Squash.	43	25
Carrot.	43	50	Cucumber.	72	67
Radish.	75	78	Watermelon.	78	78
Tomato.	76	82	Cabbage.	89	82
Celery.	27	7	Carrot.	47	56
Alfalfa.	53	58	Turnip.	100	100
Red Clover.	87	89	Parsnip.	30	3

One thing is proven by these experiments, that in some cases at least, the sublimate did not injure the vitality of the seeds, and in no case did it destroy *all* of the seeds, if it affected them in any way. The average of the two columns is nearly the same. Those that vary the most have the lowest percentage, while those that average above seventy-five per cent. differ but little. Another thing is sure, that the sublimate destroys the germs of the fungus. None moulded after being treated, except the squash, and that but little, while before being dipped it was completely covered with a dense forest of fungus. And yet, more squash seeds sprouted when they were not treated with the solution. This makes it impossible to say at present whether it is of any advantage to use the sublimate solution. In seven cases out of the eighteen, more germinated when it was used. In eight cases, more when it was not used, and in three instances there was no difference. Till more data is obtained all we can assert is that a solution of corrosive sublimate of proper strength will destroy the germs of mould without destroying the vitality of the seeds, and probably without injuring them.

Experiments with Grasses.

In Experiment Station Report, 1889, p. 161, will be found a consideration of forage plants tested on small plots to determine their adaptability to the soil and climate of Maine. On page 169 of the same Report is a table of the most promising ones. Of these, eleven kinds were selected the past season and grown in one-eight acre plots, and next season a record will be kept regarding them.

SPRAYING EXPERIMENTS.

Apple Scab.

It was intended to conduct some spraying experiments the past season with copper compounds, to determine their value in preventing or checking apple scab. For various reasons mentioned below the work was abandoned. Arrangements were made with Mr. F. M. Woodward, Winthrop; Mr. Chas. S. Pope, Manchester, and Mr. E. F. Purrington, Farmington, to conduct these experiments. The material for the work at Winthrop was ordered early, but by delay in transportation did not reach its destination in time to make the first application before the leaves started. The bloom was so light and the rains so heavy and frequent it was thought best to abandon the work for the season. Mr. Pope writes that he made the first application but a heavy shower washed it off almost immediately, and as the rainy weather continued he did not spray again. One of the difficulties in using these compounds is that they are washed off by rains and the disease is always worse in rainy seasons. The copper compounds are quite rapid in their action upon vegetable spores and would destroy them in a few days. Much good would therefore be done if the compounds remained only a few days before being washed off. Care should be taken to make the applications immediately after showers. These experiments will be conducted another season if possible. The experiments conducted by Prof. Taft in Michigan, and Prof. Goff in Wisconsin, in 1890, and considered in Me. Expt. Sta. Rept., 1889, p. 182, indicate that the copper compounds will materially check this disease and at a very small cost. We would like to see the method carefully tested in Maine and hope many will spray for the scab another season and report the results. Directions for spraying and apparatus were considered in the Station Report for 1889. Additional information if needed will be given by correspondence.

Codling Moths.

Complaints of Codling Moth ravages continue to be reported to the Station. It is a surprise that the arsenic compounds are not used to check this pest. It is conceded by many fruit growers in other states, who have tried spraying with Paris Green and London Purple for codling moths, that they are effective remedies. Why do not the orchardists of Maine avail themselves of this remedy? The process is simple, free from danger, effective and the materials and apparatus inexpensive in relation to the benefits received. In the interests of successful orcharding in Maine may we not strongly urge the great importance of spraying? In our Report for 1889 it was suggested that perhaps the first application should not be made until the apples are larger then peas. This is based upon the belief that the moths come out later in Maine, than has been supposed. We hope those who spray will watch the first appearance of the moths about the trees and report the same to the Station.

EXPERIMENT WITH PARIS GREEN UPON POTATO BEETLES.

It is well known by those who use Paris Green to destroy Potato Beetles, that there is more or less difficulty in obtaining a mixture of the right strength to kill all the insects, without "scorching" the leaves.

In order to determine the least amount of Paris Green required to do effectual work, four different strengths were used. The amounts taken were one and one-half, one, one-half and one-fourth teaspoonful to two gallons of water. As a teaspoonful weighs very nearly 8 grams, and there are 454 grams in 1 pound avoirdupois it would be at the rate of 1 pound Paris Green to about 75, 112, 125, and 250 gallons of water respectively. The poison was applied to four adjacent rows, all being badly infested with young beetles. There was no rain at the time, or any thing to interfere with the experiments so far as is known. After thirty-six hours the results were noted as follows:

First row, one and one-half teaspoonfuls to 2 gallons water, nearly all the insects killed.

Second row, one teaspoonful to 2 gallons water, same as first, so far as one could perceive.

Third row, one-half teaspoonful to 2 gallons water, perhaps one-half the beetles dead.

Fourth row, one-fourth teaspoonful to 2 gallons water, could only find an occasional one dead.

The leaves were not scorched in any of the rows.

From these experiments we see that one teaspoonful of Paris Green to 2 gallons of water, or at the rate of 1 pound to 112 gallons, did as effectual work as the stronger mixture, while the lesser amounts were not sufficient. This is perhaps as good a rule as can be given, and the amount may be varied more or less, if the strength of the Paris Green is found to vary.

CAUSES OF POTATO SCAB.

Since my last Report some very important investigations into the cause of Potato Scab have been made at the Indiana Experiment Station by Mr. H. L. Bolley and at the Connecticut Station by Dr. Roland Thaxter. Though there were differences of opinion, botanists had about concluded that this disease was due to chemical or mechanical conditions and not to a vegetable or animal parasite, but the investigations of these gentlemen have opened the question anew. They claim to have discovered specific forms of organisms that will when introduced into healthy potato tubers produce the scab, and wherever the disease occurs these organisms are present. It is exceedingly interesting to know that the species of bacterium found by Mr. Bolley, and regarded by him as the cause of the disease, is entirely different from the filamentous fungus found by Dr. Thaxter. It is reasonable to conclude as is done by Dr. Thaxter that there are two kinds of Potato Scab, the organism studied by Mr. Bolley producing what is called *shallow* or *surface scab* and the one found by Dr. Thaxter causing the *deep scab*. The investigations of these gentlemen seem so thorough it is hard to find any errors in their work and the conclusions reached seem inevitable. Now that the parasitic nature of the disease is established the theories of mechanical and chemical irritation, insect depredations. excess of moisture in the soil, and the attacks of larger fungi must be discarded as *primary* causes. It is well established by many observers and many experiments, that rubbish, garbage, excess of vegetable matter, fresh stable manure, saw dust, chip manure, ashes and lime, excessive moisture in the soil and growing potatoes from year to year on the same field aggravate the disease. It is therefore certain, that the agents and conditions before regarded as *primary* causes are secondary, aggravating the disease by producing conditions favorable to the growth of the parasites. The investigations of Dr. Thaxter indicate that the fungus causing the disease may be a form common in manure and other fermenting organic matter and would be transferred to the soil in such material and reach the potato tubers. Should this prove to be true it would open the question how far diseases affecting farm crops are due to the germs carried to the field in infested fertilizers and lead to the necessity of adopting means to sterilize fertilizers. Certainly it would do but little good to select clean potatoes for seed and plant them in a soil fertilized by material teeming with the organism that causes potato scab. If the disease is caused by vegetable parasites, as seems quite probable, then scabby seed and infested fertilizers are the sources of the disease, or the germs may live in the soil over winter. By selecting clean seed and not planting successive seasons on the same ground, two of the sources would be eliminated. This would leave the fertilizing material as the remaining source of infection.

It would also be necessary to avoid all general conditions as poorly drained soil, etc., that are known to favor the development of fungi.

Although neither Mr. Bolley nor Dr. Thaxter have suggested any definite remedies, it is a long stride in the right direction to know the cause of a disease. and as Mr. Bolley says, "The facts secured must of necessity affect the future investigations in the line of prevention; and the indications are very favorable to the belief that results in that direction may be reached which will have a financial value to the potato grower." Those who wish to read the investigations of Mr. Bolley and Dr. Thaxter will find articles by the former in Agric. Science, Knoxville, Tenn., September and October, 1890 and by the latter in Conn. Exp't. Station Bull. No. 105. Dec. 1890.

Since the above was written Prof. Thaxter has been successful in producing the scab disease by inoculating healthy tubers with the fungus, but thinks the similar fungus found in horse dung will not produce it.

STRAWBERRIES.

The following correspondence regarding strawberries may be of sufficient interest to place on record.

After receiving Mr. Fowler's letter the writer asked Prof. Maynard, of Amherst, Mass., some questions regarding strawberries and below his answer is given, also Mr. Fowler's letters. The facts contained therein may be suggestive to others who are growing strawberries. The Station is testing varieties of strawberries (see Ex. Sta. Rept. 1889, p. 256) which will be reported upon in the future.

SEARSMONT, ME., Aug. 27, 1890.

PROF. F. L. HARVEY:

Dear Sir:—I wish some information in regard to strawberries. My patch looks very nice and I expected a nice yield but they were small and *ill shaped*. I think the most of them are Crescent seedlings and am afraid there are not enough Wilsons. What I wish to know is this, will natives do to set out with the Crescent seedlings next spring?

Very truly,

M. A. FOWLER.

AMHERST, MASS., Sept. 22, 1890.

PROF. F. L. HARVEY:

We have discarded both the Crescent and Wilson, but they are suitable to grow together as the one is about as poor as the other. I do not know how the last succeeds with you, but with us it is worthless on account of its lack of vigor. The Crescent is vigorous and productive but poor quality. Would advise the trial of Bubach No. 5 in place of the Wilson, and if you find the Crescent valuable perhaps the May King, Warfield or Haviland would please you as a fertilizer for both. It would be far more profitable to set some other variety than the wild seedling to fertilize the Crescent unless you wish to save the seed, in which case it might give some interesting crosses.

Very truly yours,

S. T. MAYNARD.

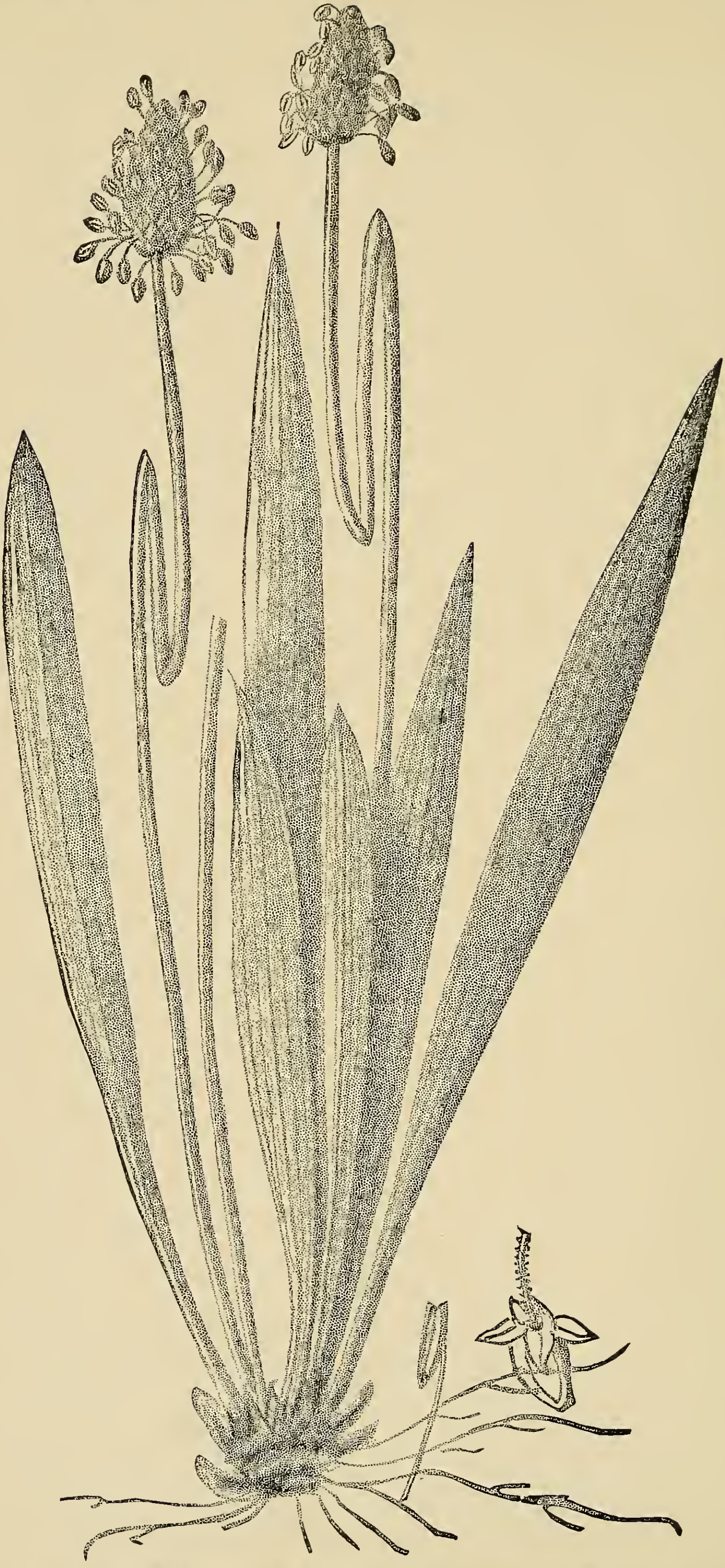
SEARSMONT, ME., Oct. 28th, 1890.

PROF. F. L. HARVEY:

Dear Sir:—As to my strawberries I am in a fix. I must have some 15,000 plants and I can't get enough of any variety but natives to set out, so shall be compelled to set them or none. The berries formed this year and some grew well, also had some Wilson berries among them, but most of the berries were ill shaped, small and did not ripen good or refused to grow larger than a Champion of England pea. I gave them a heavy coating of manure in August and cultivated it in with spring tooth cultivator and now have an abundance of nice plants. Expect to get some Haviland or some other variety in the Spring to set out for sets the next year. My plants were hurt last winter and spring by ice and rain.

Very truly,

M. A. FOWLER.



Rib Grass or English Plantain. (*Plantago lanceolata, L.*)

KATE FURBISH, Del.

RIB GRASS, OR ENGLISH PLAINTAIN.

Plantago lanceolata, L.

This weed belongs to the Order *Plantaginaceæ* (Plantain Family) and was introduced from Europe. *Plantago* comes from the Latin and means *sole of the foot.* It was originally applied to the door yard plantain, which grows in foot paths. *Lanceolata* refers to the lance shaped leaves. It may be known by the following description :

Root living from year to year, stem grooved, angular, nine inches to two feet high; leaves hairy, narrow, three to five ribbed and in a cluster at the root. The flowers small, whitish, borne in a thick short spike at the end of the long flower scape. The pod opens at the top by means of a lid and allows the two oblong boat shaped seeds to escape. These seeds are smaller than clover seed and may be distinguished by the brownish color, oblong shape and hollow or groove on the inner face. They look like a diminutive boat. Attention is especially directed to this weed, as it is being introduced into the State in clover seed. Complaints have been received about fields over run with it, that were seeded to clover. The seeds of the plaintain being smaller and duller colored are liable to escape notice, being hidden by the bright yellow color of the clover seed. Great care should be exercised by farmers in purchasing clover seed, so as not to introduce this detestable weed. We hear complaints of its occurrence in other States. Being a perennial it is a hard weed to exterminate. It is hardy and will cover the ground with a mat of leaves. Cultivation in a hoed crop would be the best way to control it.

Accompanying the Report for 1889 was an envelope containing New York Red Clover seed, adulterated with about ten per cent. of Rib Grass seed, (*Plantago lanceolata, L.*) This seed was purchased at a prominent seed store in Maine and was highly recommended. It was distribubted that farmers might learn to distinguish the seed of Rib Grass and avoid it.

That farmers may recognize this weed when they see it growing, we publish on the opposite page a fine crayon drawing made by Miss Kate Furbish, Brunswick, Me. The plate also shows one of the flowers, and one of the stamens enlarged.

FALL DANDELION.

Leontodon autumnalis. L.

This plant belongs to the Order *Compositæ* or Sunflower Family and was introduced from Europe. The genus name *Leontodon* comes from two Greek words and means lion-toothed, referring to the toothed leaves. The specific name *autumnalis*, means blooming in the autumn, but is hardly applicable to this plant as it blooms from June to November. This weed can be readily determined by the following description: the plant from five inches to two feet high; branched and bearing heads at the ends of the scaly thickened branches, which are composed of many yellow strap shaped flowers. Leaves clustered at the root, lance shaped, hairy and cut toothed. Perennial, growing in meadows and along roadsides, and blooming from June to November. It has spread from New England to Arkansas. Where found along roadsides it should be dug up. The seeds, which bear at one end a row of tawny brittles, (*pappus*) are easily carried by the wind to cultivated grounds. When introduced, cultivation in a hoed crop is the best way to kill it.

On the opposite page is shown a fine cut of this weed made from a crayon drawing executed by Miss Kate Furbish, Brunswick, Me. This will enable farmers to tell the plant when they see it. The plate shows the plant natural size and also one of the seeds magnified and with the bristles (pappus) attached at the end.

KATE FURBISH, Del. FALL DANDELION. *(Leontodon autumnalis, L.)*

THE CECROPIA EMPEROR MOTH.

Platysamia Cecropia, (*Linn.*)

We received a cocoon of the above insect from Mr. R. C. Higgins, attached to a Juniper twig. The cocoon was put away and on June 10th the moth came forth, and essentially the following letter was sent to Mr. Higgins, which may be of interest to others:

"Dear Sir:—The cocoon you sent some weeks ago produced to-day a beautiful moth (five and a half inches spread of wing) known as the Cecropia Emperor Moth. This insect belongs to the *Bombycidæ* which embraces the Chinese silk worm *Bomby mori.* It is the largest species of moth found in the United States. It usually feeds upon the apple, plum and cherry and a variety of other shrubs and trees. Taking it upon a Juniper is novel to me, and I find no record of it feeding upon coniferous plants. The caterpillar probably wandered to the Juniper tree to spin its cocoon. This insect is not abundant in nature and though classed as one of the pests of the orchard does but little damage. It is kept in check by ichneumons, other insect parasites and birds.

The moth, caterpillar and cocoon of this insect all being so large and conspicuous they attract attention and specimens are frequently sent. The *moths* may be known by their large size, the rich brown color of the wings, each bearing near the middle a kidney shaped white spot usually shaded with red and edged with black. The *caterpillars* are three or four inches long and nearly as thick as a man's thumb; pale green with carrot red warts on the third and fourth segments of the body, yellow warts upon the back of the other segments, excepting the second and last, on which they are blue, as well as the smaller warts along the sides.

The *cocoons* are about three inches long, pod shaped, rusty gray or brown, and firmly attached by one side to a limb. They are composed of two layers of silk, an outer papery and loose fibrous one and an inner densely woven oval one containing the chrysalis. The moths come from the cocoons in June. The eggs are soon laid and in a week or ten days the caterpillars appear. They are voracious feeders. When full grown in the fall they spin their cocoons and remain in this state until the following spring. The cocoons are frequently found in the orchard or woods after the leaves have fallen, attached to the branches.

This moth is considered in Saunder's *Insects Injurious to Fruits*, p. 73, and all the stages figured. It is also considered in *Insects Injurious to Vegetation*, Harris, pp. 385-388.

THE WHITE-MARKED TUSSOCK-MOTH.

Orgyia leucostigma, (Sm. & Abb.).

During the past two years specimens of the above insect, in the egg, larval and wingless female stages of its life history have been received at the Station from various parts of the State. Being apparently widely distributed and having attracted considerable attention we give below an account of its habits.

Eggs, three or four hundred in a mass attached to the empty grayish cocoon previously occupied by the female moth. Egg mass convex, smooth, grayish white; composed of several layers of eggs with a frothy, gelatinous material between them.

Larva, when mature, over one inch long; bright yellow; head and two small protuberances on the back carrot red; back ornamented with four cream colored brush like tufts; two long black plumes near the head and one near the posterior end of the body; sides clothed with yellow hairs; brown or black stripe on the back, and a dusky stripe on each side. See Figure 1.

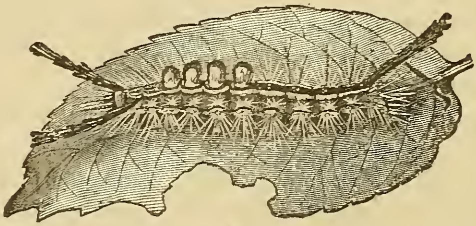


Fig. 1.

Cocoon, gray, spun on the inside of a leaf. Texture loose and the silk interwoven with numerous hairs from the caterpillar.

Chrysalis, enclosed in the cocoon, oval, brown or sometimes whitish below, covered with whitish hairs or down. Figure 2 d. shows the male chrysalis and Figure 2 c. the female chrysalis.

Perfect Insect (female) wingless or wings mere rudiments, light gray, oblong oval, body distended with eggs; legs long. Figure 3 represents the female resting upon the empty cocoon from which she emerged.

Perfect Insect (male) winged, expands an inch and a quarter, fore wings crossed by wavy bands of darker shade; a small black spot on the outer edge of the wing toward the tip, beyond it an oblique blackish stripe, near the outer hind angle a minute white crescent. Body gray with a small black tuft near the base of the abdomen, antennæ feathered. Figure 4 represents the male moth natural size.

Fig. 2.

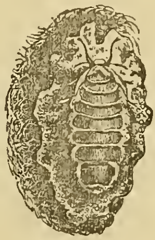


Fig. 3.

Fig. 4.

LIFE HISTORY.

During the winter months there will be found occasionally in the orchard, dead leaves attached to the branches of the trees. Upon examination these will usually be found to contain an empty, gray cocoon with a mass of eggs attached to it, as described above. These eggs hatch in Maine about the first of June or earlier farther south. The young larvæ at once begin to devour the leaves of the tree. When disturbed they lower themselves by means of a silken thread which they climb when danger is past. The beautiful caterpillars described above feed about two months and then spin their cocoons. The moths soon emerge and the females being little more than animated masses of eggs are sluggish. The males having wings are able to fly and they meet the females while resting upon the empty cocoon to which the mass of eggs is finally attached. The eggs soon hatch, producing the *second* brood of caterpillars which complete their growth late in the season and enter the chrysalis state. The moths soon emerge, mate and the eggs are deposited and remain on the trees during the winter.

REMEDIES.

The female is wingless and always attaches her eggs to her empty cocoon, hence the insect does not readily spread from tree to tree. The caterpillars sometimes wander when their food supply is gone, or are accidently carried from tree to tree, or eggs are introduced on young trees. From the nature of the insect it it is not usually very injurious but sometimes does great damage to the leaves of apple trees and also gnaws the surface of the fruit. Though partial to the apple tree it also feeds on the plum, pear cherry, rose, and occasionally on the elm, maple, horse chestnut, linden, oak, locust, butternut, black walnut, hickory, spruce, fir, larch and other plants. The orchard should be examined during the winter months for leaves attached to the branches and if they contain egg clusters collect and *burn* them. Any cocoons without egg clusters should not be molested, as they probably contain parasites of this pest and should be protected. Mr. Saunders says that nine different species of parasites, four and two winged flies, are known to prey upon this insect in the caterpillar state.

THE FALL WEB-WORM.

Hyphantria cunea, *Drury*. (*H. textor*, *Harris.*)

While in Cumberland County, Me. last season attention was directed to an orchard badly infested by this insect. Though it was only July 5th, the webs were already quite conspicuous. In *Forest Insects*, just issued from the Dept. of Agric., Dr. Packard, on p. 244 says: "The name *Fall Web-Worm* is most expressive for New England and other northern states where the insect is single brooded, appearing there during August and September, while in more southern regions it is double brooded." Though we have not traced this insect through its life history in Maine and cannot *positively* say there are two broods, yet the fact that the webs were conspicuous and the larvæ fully three-fourths of an inch long early in July would indicate two broods in western Maine. A few webs were observed about Orono during the fall months, probably those of the second brood or late single brood.

This is a native insect which has from time to time done great damage to forest and fruit trees. It is a general feeder, having been observed to feed upon over one hundred different species of trees, shrubs and herbs. This species makes a web which is sometimes very conspicuous, attaining dimensions of several feet. The web can readily be told from that of the Apple-tree Tent-caterpillar. The *former* insect does not leave the nest to feed. As soon as hatched the young larvæ spin a small web for themselves. Under the shelter of this they feed in company upon the upper portions of the leaf, leaving the veins and lower surface. As they grow they connect their web to adjoining twigs and leaves until finally a whole branch several feet long may be inclosed. The web of the *latter* is more frequently made in the fork and is not usually extended along the branches and the caterpillars leave the nest to feed, returning for the night and to rest. Below is given an account of the insect in all the stages of its life history.

Egg 4 mm. (.16 in.) in length, bright golden yellow, globular, ornamented with numerous regular pits, which according to Packard give it under the magnifying lens the appearance of a beautiful golden thimble.

Larva (young) pale yellow with two rows of black marks along the body, a black head and sparse hairs.

Fig. 5.

Full grown larva usually pale yellowish or greenish with a broad, dark stripe along the back and a yellowish stripe along the side, covered with whitish hairs that spring from black and orange yellow warts. The caterpillars are somewhat variable as to depth of color and marking, even on the same tree. The fall brood is generally darker colored than the spring brood. The larva is shown in Fig. 5.

Cocoon, thin, almost transparent, composed of a slight web of silk intermixed with a few hairs from the caterpillar, or sometimes mixed with sand when the cocoon is spun in the soil.

Pupa, length 0.60 in.; breadth in the middle at the bulge, 0.23 in.; dark brown, smooth, polished, faintly punctate, and bulged in the middle a little all round.

Fig. 6.

Perfect insect, a moth which varies greatly in size and color. These color varieties have received different names by entomologists but are now reduced to H. cunea, Drury. The most common form is white or slightly fulvous with white wings, but the wings show variations from pure white to those profusely dotted with black and brown; front thighs tawny yellow, sometimes marked with a large black spot; feet blackish; expanse of wings 1 1-4 to 1 2-3 inches; male moth usually smaller with the antennæ doubly feathered beneath. The antennæ of the female possess two rows of minute teeth. The moth is shown natural size in Fig. 6.

Life History.

The female deposits her eggs in a cluster on the upper or under side of a leaf, usually near the end of a branch. The clusters consist of many eggs laid in regular rows, if the surface of the leaf admits. Sometimes the eggs are laid in smaller irregular patches. Each female lays on an average about five hundred eggs. The eggs for the first brood are deposited by the last of May or during June, and the time required for them to hatch depends upon the weather. Under favorable circumstances they mature in about ten days, or those of the second brood in eight days. As soon as the caterpillars hatch they spin a small silken web which soon becomes conspicuous. Under this they feed together upon the upper surface of the leaves. As they grow other leaves and branches are included until the web reaches considerable size and contains dead leaves and the molt skins of the larvæ. If their food supply gives out they quit the web and drop to the ground and crawl directly toward other trees with almost unerring instinct, or when disturbed let themselves down by a thread and by this regain the tree when the danger is past.

When full grown they are 1.11 inches long and leave the web and wander about for suitable places to spin their cocoons. They select crevices in bark, the angles of tree boxes, rubbish about the base of trees, and other similar situations, while the fall brood prefer to bury themselves in the earth if possible, but adapt themselves to circumstances. They soon spin their cocoons. The pupæ contained in these hatch into the second brood of moths about the first of August, and the moths lay eggs which hatch into caterpillars that feed, mature and spin their cocoons during August and September. The insects invariably spend the winter in the chrysalis state in the cocoon and the following spring the moths emerge and lay their eggs, thus completing the life history.

Remedies.

As these insects do not leave the web to feed and are protected by it, spraying to kill them would do no good. The best way is to strip the webs from the extremities of the branches with the hand as soon as they appear, and destroy them with the included young caterpillars. The twigs bearing the small webs should be cut off with a knife when on the low branches, or with long handled pruning shears if on high branches and burned. These insects should be destroyed while the webs are small. There is no excuse for allowing them to remain until large branches are involved in the web. The webs are unsightly and even when the insects are not abundant enough to do serious damage they should be destroyed.

The natural enemies of this insect are many. Outside of insect parasites and predacious insect enemies, screech owls, cuckoos, the common toad and several species of spiders feed upon them. They have but few bird enemies, being so hairy birds will not eat them. Those mentioned above and the common toad eat the whole insect, while the spiders suck the soft parts out and leave the shell.

Among the predacious insects, the Mantis or rear horse in the south, and the wheel bug and other hemipterous insects in other parts of the country help to hold them in check. The true parasites are those that lay their eggs in the eggs or caterpillars of the web-worm and destroy them. They consist of hymenopterous or ichneumon like insects and tachina flies. Of the former one species infests the eggs, and two others lay their eggs in the caterpillars. One species of tachina at least is known to imfest the larvae of the web-worm. The eggs of the parasites hatch and their larvae destroy the web-worm, and from their chrysalids or cocoons the parasites come forth.

THE EYE-SPOTTED BUD-MOTH.

Tmetocera ocellana, (Schiff.).

Fig. 7.

The following letter was received last May:

ROCKLAND, ME., May 20, 1891.

ENTOMOLOGIST EXPERIMENT STATION.

SIR:—I send you some blackberry buds that are infested with maggots. I have about one-fourth of an acre and I think three-fourths of the buds on the piece contain one or more of these maggots. I noticed them for the first time last year, when I found a few of them. When the buds are small they eat into the heart of them and spoil them. The eggs are deposited in the buds early in the spring or in the fall. I have found some of them on rose bushes and also on a peach tree standing near the blackberries. My family and I have killed a great many of them but still they will injure the bushes very much.

Yours respectfully,

JOHN N. INGRAHAM.

The specimens sent by Mr. Ingraham were put into a breeding cage to transform and proved to be the Eye-spotted Bud-moth. This species was considered and figured in the Annual Report of the Experiment Station, 1888, p. 169 and in the Maine Report of Agriculture, 1888 p. 133 as a pest upon apple trees. We find no record of this species attacking blackberries, therefore the habit is new. The observations of Mr. Ingraham would indicate that this species also feeds upon the peach tree and roses. As there are several *bud-moths* that infest our fruit trees and shrubs it is not safe to conclude that this species did the injury on the peach trees and roses, though they were near the blackberries, until the insect has been reared from them. It is not improbable that the Eye-spotted Bud-moth feeds upon peaches and roses, as it is known to feed upon plums and cherries, plants belonging to the same family.

The larvæ we transformed went into the pupa state the last of June and the moths appeared in July. As the moths are on the wing in July the eggs must be laid in the summer or fall, and as the larvæ are apparently nearly grown and have done much damage early in June the eggs must hatch very early or else the larva hybernate. When this insect was considered in 1888 we did not have the writings of Mr. James Fletcher, who expresses the opinion in his Report for 1885, p. 24, as Entomologist to the Dept. of Agric. of Canada, that it passes the winter in the larva state on the branches of apple trees, protected by a covering of silk. Since the above was written there has appeared from the pen of Prof. Fernald in Bull. No. 12, April, 1890, Mass. Expt. Station an interesting article upon this insect.

This article contains such an exhaustive and careful study of the egg and larval stages we quote that portion of it *verbatim.*

"The fore wings expand about three-fifths of an inch. The head, thorax, and basal third of the fore wings, and also the outer edge and fringe are dark ash gray, the middle of the fore wings is cream white, marked more or less with costal streaks of gray, and in some specimens this part is ashy gray, but little lighter than the base. Just before the anal angle are two short horizontal black dashes followed by a vertical streak of lead-blue, and there are three or four similar black dashes before the apex, also followed by a streak of lead-blue.

The hind wings above and below and the abdomen are ashy gray. The under side of the fore wings is darker, and has a series of light costal streaks on the outer part.

The moths pair and the female lays her eggs, when in confinement, in clusters of from four to ten or eleven, often overlapping each other. They are oval, flattened, four-fifths of a millimeter long, and half as wide, sordid white, with a narrow border of clear and transparent white, while the center of the eggs is one complete mass of minute granules. In about three days the center of the egg has grown darker, and the granules larger; and on either side there is a clear, white, oval space about one-third the length of the egg. In about two days more the outer edge of the center is the same color as in the last stage, and inside this is a narrow, lighter band, while in the center is seen the form of a cylindrical larva larger at one end, and both ends slightly curved towards each other; and in one or two days more the whole form of the larva is visible, the head, thoracic and anal shields being black. The egg stage lasts from eight to eleven days.

When the young larva hatches it does not eat the shell of its egg, but goes on to the tenderest leaves and almost immediately begins spinning a microscopic layer of silk, under which it eats the outer layer or epidermis of the leaf. The larva is then about three millimeters in length, of a creamy white color, with head, thoracic and anal shields blackish brown, and a few minute pale hairs on the body; the head is very large for the rest of the body. In a week the larva is nearly four millimeters long, light yellowish brown, with the head, thoracic and anal shields dark brown, and it eats minute holes through the leaf, its silken web now being visible to the naked eye. The larva gradually becomes a trifle more brownish, increases in size and enlarges its web along the side of the midrib.

Late in the fall the silken web is quite heavy and thick, and the larva deposits its excrements in little black pellets in the form of a tube, under the web, within which it hibernates during the winter. Not unfrequently two leaves are fastened together by the silk of the web, and sometimes a leaf is secured to a branch of the tree in the same manner.

About the first of May the larva measures seven millimeters when resting, and eight when in motion. It is cylindrical in form, with the head dark brown and of medium size. The body is dark yellowish brown, and the head, thoracic and anal shields very dark, polished brown. There are ten lighter brown protuberances on each segment, from each of which arises one pale hair. On the upper surface of the ninth segment is seen the double undeveloped reproductive organ of a light brown color. The legs are dark brown and the prolegs yellowish brown. About the first of June the larva is from ten to twelve millimeters in length, and the body has changed to a cinnamon rufous color. From the middle to the last of June it curls or draws together several leaves which it lines with silk, and in which it transforms to a pupa."

We show in Figure 7, Page 128, a cut of the larva and moth.

Since the above was written Mr. Ingraham writes that though nearly all the buds were infested and badly eaten, the flower buds were not molested and he had a good crop of blackberries. This may have been due to the well known law, that the last effort of nature is to reproduce, and the diminished leaf surface may show itself next season in a loss of vigor of the new canes. He also writes that this insect was noticed in 1889, but did not do enough damage to attract much attention or require remedial measures. In 1890 it had so much increased as to affect most of the leaf buds. This teaches the important lesson, that orchardists and farmers would save themselves much trouble and expense by carefully watching their orchards and crops to detect new insects when they appear in small numbers, apply remedial measures *at once* and not wait until the entire crop is endangered before active measures are taken. For this reason we urge the importance of sending to the Station for identification insects not known, to learn whether they are friends or foes.

Remedies.

Pick and burn the infested buds while the caterpillars are still in them.

Spray the bushes or trees, about the time the buds are opening, with Paris green, one pound to two hundred gallons of water. London purple could be used instead of Paris green and in the same way. There would be no danger of poisoning the fruit as the application is made so long before the berries are formed it would all be washed off.

If this insect hybernates in its silken web attached to leaves as stated by Prof. Fernald, then to gather the fallen leaves of infested trees or bushes and burn them would seem a good remedy.

THE WOOLLY-LOUSE OF THE APPLE.

Schizoneura lanigera, (Hausm.).

The following letters were received during the fall of 1890:

WAYNE, ME., Oct 8, 1890.

PROF. HARVEY:

Dear Sir—I send you by to-day's mail a box containing two twigs covered with some kind of a fungous growth. The twigs were taken from a seedling tree set out in the spring of '89, and from the nursery of F. Bowman & Bro., Sidney. The whole top of the tree is affected but otherwise seems healthy. I first discovered it about one week ago. I think I have seen the same growth on black alders. What is it? Is it injurious? If injurious what is the remedy?

Truly yours,

W. A. BURGESS.

FAIRFIELD, ME., Sept. 12, 1890.

F. L. HARVEY:

Sir—I can find no more of the worms like those you already have, but I send a specimen which I have lately discovered on a tree which came from Homer N. Chase, Geneva, N. Y. Will write you more at length about them soon.

W. J. HIGGINS.

The specimens accompany the above letters were the "Woolly-louse of the Apple." and as this is quite an injurious insect we consider it at length and illustrate it.

Two forms of this insect are recognized by entomologists. One known as the Apple-root Plant-louse which attacks the roots, producing wart-like excresences or swellings. The other form known as the Wooly-louse of the apple was the one we received. It feeds upon the sap of the trunk and branches. They are regarded as the same species living under different conditions. We do not know which was the original form and which the variety, whether it was a northern species feeding upon the trunk and branches and adapted itself to a southern life by seeking a habitat on the roots, or whether it is naturally a root species seeking the trunk and branches in a cool, moist, northern climate. Its more frequent occurrence on the roots would suggest the latter. The above ground form occurs most abundantly in this country in New England. This insect is more common in Europe and Australia than in America, where it is more destructive, and is called the "American Blight." Entomologists differ in their opinions regarding its nativity, some accredit it to America, most are inclined to think it originated in Europe. It would not be much honor to either country to produce such a pest.

This insect in the root form was noticed in this country as early as 1848, when thousands of trees were found so badly infested that they had to be destroyed. Since then the insect has been reported as doing more or less damage in every section of the country. The above letters indicate that this pest was distributed upon nursery stock, and gives us another opportunity to reiterate the importance of carefully examining nursery stock before setting it.

DESCRIPTION AND HABITS.

Eggs—Minute, requiring a magnifying glass to see them. They are laid in the crevices of the bark at or near the surface of the ground.

The young when first hatched appear like specks of mold, being covered with fine white down. As they get older the cottony covering becomes more distinct, apparently issuing from the pores of the skin of the abdomen and attaining considerable length. The young have beaks longer than the body and when grown this organ is fully two-thirds the length of the body. By means of the beak they attach themselves to the root or branches, and when abundant, draw heavily upon the vitality of the tree, or may even kill it.

When full grown the females are about one-tenth of an inch long, oval, head and feet black, legs and antennæ dusky, abdomen yellowish, body covered with white mealy powder, a tuft of long, easily detached down upon the hinder part. Under each patch of down is usually found a female and her young. During the summer the females are wingless and the young are produced alive. Toward fall the broods contain both winged females and winged males, which have not much down on them and are nearly black and plump. The fore wings are about twice as long as the narrow hind ones. These winged females fly to other trees and lay eggs, establishing new colonies. During the early part of the season this form of the insect is found in clusters about the base of the trunk, upon suckers or twigs springing from the trunk, but in autumn they commonly affect the axils of the leaves and sometimes cover the whole under surface of the limbs and trunk, making the tree look as though whitewashed.

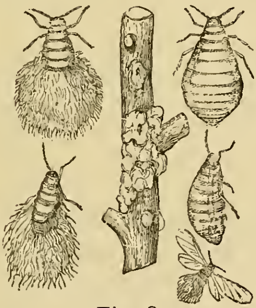


Fig. 8.

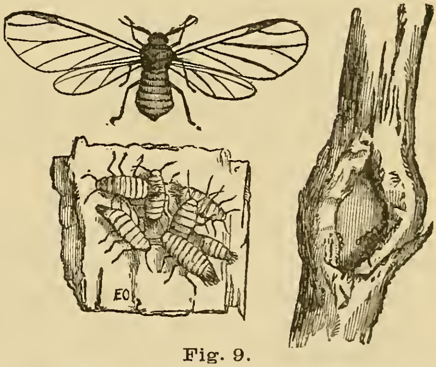


Fig. 9.

Figure 8 shows the insect magnified. The centre of the figure represents a portion of a twig showing how the lice collect about the axils of the leaves.

Figure 9 shows the winged insect much enlarged, a cluster of the young enlarged and an apple twig natural size, showing an opening in the bark caused by the puncture of this insect.

REMEDIES.

Fig. 10.

Natural remedies.—This louse is preyed upon by a small chalcid fly known as *Aphelinus mali*, Hold, and shown much enlarged in Figure 10. The real size is shown by the crossed lines below. The lady birds and their larvæ, also the larvæ of the lace-wing flies and syrphus flies, which feed upon plant lice, also hold this species in check. (A consideration of these useful parasites will be found in Station Report, 1888, under the head of the *Apple-tree Aphis.)* Spiders devour large numbers. They spin their webs over the colonies entrapping them and then devour them at their leisure. We find no record of birds feeding upon them.

Artificial remedies.—The presence of this insect can be readily detected by the moldy or whitewashed appearance of the trunk or branches where the colonies are located. If a tree seems sickly and the leaves turn yellowish, it would be well enough to examine the roots, by laying them bare, to ascertain whether the root form of this species is present. If the lice are found in the crevices, they can be killed by scalding water freely poured upon the roots. If the trees are in the ground the water can be applied nearly boiling without injury. If nursery stock, taken up to transplant, the water should not be hotter than 150° Fahrenheit. The roots may be drenched with strong soapsuds followed by a dressing of ashes on the surface of the ground.

It is said that mulching should precede the treatment, as it causes the lice to come near the surface of the ground where they can be more easily reached. When the lice are on the branches strong soapsuds, kerosene emulsion, or Paris green in water applied in the usual way would prove effective. As the winged females no doubt fly to other trees, more or less, and start new colonies, the lice should be treated before the fall broods appear. It would always be well to carefully examine nursery stock before setting it. At least it should be carefully watched the first season for any new pest that might appear in few numbers, so as to destroy them.

THE RED-HUMPED APPLE-TREE CATERPILLAR.

Œdemasia concinna, (Sm. & Abb.).

This pest of the apple tree has made its appearance in Maine, as shown by the correspondence given below, which is perhaps important enough for permanent record. That the insect may be more easily recognized by orchardists we give Figure 11 an illustration of the moth life size, Figure 12 the full grown larva and Figure 13 the pupa.

Fig. 11.

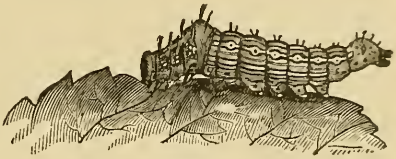


Fig. 12.

Fig. 13

(For the Maine Farmer.)

Pest of the Apple Trees.

[The following note, together with the box of insects, was sent to Prof. Harvey, of the State College, for his investigation. We give his clear and very satisfactory reply. Ed.]

Mr. Editor:—Please give, through your columns, the history and habits of the pests I send you. I find them stripping the leaves off my apple trees, leaving nothing but the main stem of the leaf. I never saw anything like them before, as I can recollect. Yours truly,

Fairfield, Me. Wm. J. Higgins.

Editor Maine Farmer:—The insects which you forwarded by express came to hand in good condition. They are the half grown larvæ of the Red-humped Apple-tree Caterpillar; *Œdemasia concinna*, (Sm. & Abb.).

The perfect insect is a moth which measures from an inch to an inch and a quarter across the wings. The fore wings are dark brown on the inner, and grayish on the outer margin. There is a dot near the middle, a spot near the angle and several longitudinal streaks along the hind margin, all dark brown. The body is light brown, and the thorax of a darker shade. These moths are on the wing late in June or July. The female deposits her eggs on the under side of a leaf in a cluster, usually during July. They soon hatch into small caterpillars. These caterpillars, while young, feed upon the tender tissues of the under side of the leaf, leaving the upper surface unbroken, but when large they devour greedily the whole leaf. They reach maturity during August or September. The specimens sent were about half grown, and were about three-fourths of an inch long. When full grown they are often an inch and a quarter long. The full grown larvæ may be known by the coral-red head and a hump of the same color on the fourth ring or segment from the head. The body is striped lengthwise with narrow yellow, white and black lines. There are two rows of black spines along the back, and rows of shorter black spines on the sides. Each spine bears a fine hair. The spines on the coral-red hump are more prominent than the others. The hinder end of the caterpillar tapers and is usually elevated when the insect is at rest. When handled, a fluid with a strong acid smell is emitted. When mature they descend to the ground and hide under leaves or rubbish, or sometimes burrow a little into the ground and slowly change to the chrysalis state, where they remain until the following spring, when the moths appear, completing the life history. At the north there is only one brood during the summer, but in the south two broods appear.

The species is widely distributed, though not usually abundant. It prefers the apple, but will feed upon the plum, cherry, rose, thorn and pear, plants belonging to the *Rose* family.

As these caterpillars go in flocks, and when not feeding remain close together, they could easily be destroyed by cutting off the branch on which they appear and burning it. They might be destroyed by jarring the limb, and when they fall to the ground trample them with the foot. If the trees are not in bearing, the insects could be destroyed by spraying with Paris green in suspension in water, 1 pound to 150 gallons. They emit such an odor birds do not eat them. It is said that Ichneumons are parasetic upon them and help hold them in check.

This is the first complaint we have had of this insect in Maine. It may have been introduced on nursery stock from farther south. The history of its appearance and the extent of its depredations at Fairfield would be interesting, and we hope Mr. Higgins will tell us more about it. Those who have a copy of "Saunders" Insect Injurious to Fruits," will find this pest figured and considered on pages 63 and 64.

F. L. HARVEY,

ORONO. Entomologist for the Station.

THE FALL CANKER-WORM.

Anisopteryx pometaria, (Harris.).

This species was considered and illustrated in Station Report, 1888, to which the reader is referred for an account of the life history and remedies. We expressed there a want of information regarding its distribution in the State and damages. Since then we learn it is widely distributed and does considerable damage to the foliage of orchard and shade trees. About Orono it has steadily increased for the past two years and this season did considerable damage. We think that by spraying with Paris green or London purple in the usual way, when the worms are small, they could be readily destroyed. This worm is known by the farmers about Orono as the "Green Inch-worm." Last November we received the following letter, which with the answer, we place on record.

BELFAST, ME., 11, 10, 1890.

F. L. HARVEY:

Enclosed find specimens of Lepidoptera, *Anisopteryx*, I think female, with eggs accompanying. They are to-day found in large numbers on the outside of the front door of my dwelling house in this city.

Are they A. *eseularia* or A. *pometaria*? I was not aware before that they deposited their eggs on buildings. Perhaps they are a new insect. Can you tell?

Haste,

GEO. E. BRACKETT.

MR. GEO. E. BRACKETT:

Dear Sir:—Your letter containing insect specimens was received during my absence from home. It now claims attention. The specimens enclosed are the females and eggs of *Anisopteryx pometaria*, Harris, the Fall Canker-worm. This species usually deposits its eggs upon the branches or twigs of trees. The females being wingless, when they emerge from the ground, crawl to the base of trees, which they climb. The tendency to climb is so strong in these insects they blindly ascend fences and houses, as well as trees, and deposit their eggs. The eggs thus laid would hatch, but the young larvæ would perish. This shows that the instinct of insects is not the infallible guide claimed by some. They make mistakes in judgment, like us mortals. This species has been abundant here this season. My boys had quite a box of females and eggs which they took upon fence posts during my absence. So this blind habit of laying the eggs seems common, though I have never seen it recorded in any of the entomological works. Will make note of it some time in the future, and give you credit for the observation. Will be pleased to answer questions about insects any time.

Yours truly,

ORONO. F. L. HARVEY.

THE FOREST TENT-CATERPILLAR.

Clisiocampa sylvatica, Harris.

The Forest Tent-caterpillar was so abundant the past season in several localities in the Penobscot Valley that it caused serious alarm upon the part of many, as to the safety of our forests and orchards. Several articles bearing upon the subject appeared in the local papers. It is no doubt TRUE THAT IT IS a great drain upon the vitality of forest trees to lose their leaves and have to replace them. They probably do not regain their normal vigor for several years and many die from this cause. There is however no need of serious alarm, as the history of this insect shows it does not continue to increase many years in succession, but generally disappears almost entirely after the second season. To ascertain how far parasites were destroying this pest the writer took 135 cocoons last fall and from them was able to rear only twenty moths.

This shows that only about fifteen per cent. survived the attacks of parasites and other mishaps. From the cocoons came forth about ninety parasites; two species of Ichneumons and two species of Tachina flies. As only twenty moths came forth this leaves about twenty-five deaths to be accounted for in some other way. Some of the cocoons seemed affected by a disease, probably bacterial, that may account for part of the mortality. This spring, 1891 and previously, we have bred a Chalcid fly from the eggs of this species. Thus the efforts of fungi, larval and egg parasites combined aid in holding them in check. The parasites have increased rapidly the past season and there will be comparatively few caterpillars in 1891. The parasites bred were *Pimpla conquisitor*, (Say), *Anomolon* near *exile*, Prov., *Tachina clisiocampa*, Townsend and *Phorocera promiscua*, Townsend.

The Tachinas were new to entomologists and were named and described by Prof. C. H. Tyler Townsend in Psyche for May, 1891. The *Phorocera* was very abundant. Eighty of the one hundred and thirty-five cocoons collected at random were infested by it. This spring we bred from the eggs of this species as stated above, a minute four-winged fly which we sent to Prof. C. V. Riley for identification and received the following reply, which we record for the benefit of entomologists, it being too technical for the comprehension of those not versed in entomology. "The specimen is a species of *Tetrastichus*, a genus in which we have an indefinite number of undescribed species in this country, which are very difficult to separate. Your species is probably undescribed. *Tetrastichus* is invariably, so far as we know, hyper-parasitic and the primary parasite, is, in your case, probably, a Telenomus or a Trichogramma."

FRUIT TESTS.

With few exceptions the plants set in 1889 lived and made a vigorous growth during the season of 1890. In accordance with the purpose noted last year, cions of the most promising varieties of apples were sent to some of the leading orchardists in various parts of the State, for the purpose of determining the adaptability of these varieties to the widely varying conditions existing in different localities. A blank form was sent with all cions that the system of records may be uniform.

The following fruits were added to the experimental plantations in 1890:

APPLES.

Excelsior.
Fall Pippin.
Golden Russet.
Gideon.
Martha.
Mann.
Munson's Sweet.
October.
Peter.
Primate.
Red Russet.
Tallman Sweet.
Vandevere.
Wealthy.
William's Favorite.
White Pippin.
Antononka.
Aport.
Arabskoe.
Bogdanoff.
Early Sweet.
Golden Reinette.
Mallet.
Romna.
Striped Winter.
Table Apple.
Tetofsky.
Titvoka.
Titus Riga.

PEARS.

Anjou.
Angouleme.
Bartlett.
Clairgeau.
Clapp.
Flemish Beauty.
Hardy.
Howell.
Keiffer.
Lawrence.
Le Coute.
Louise Bonne.
Seckel.
Sheldon.
Souvenir des Congres.
Superfine.
Winter Nellis.

PLUMS.

Green Gage.
McLaughlin.
Moore's Arctic.
Quackenbos.
Pond's Seedling.
Prunus Simoni.
Smith's Orleans.
Washington.
Weaver.
Wild Goose.

CHERRIES.

Yellow Spanish.
Black Tartarian.
Belle Magnifique.

GRAPE.

Lindley.

REPORT OF METEOROLOGIST.

President Fernald, Meteorologist To The Station.

MAINE EXPERIMENT STATION.

Lat. 44°, 54', 2'', N. Long. 68°, 40', 11'', W.

Following the purpose indicated in the last report, the Experiment Station seeks not to duplicate the meteorological work of the College, but rather to study carefully certain meteorological conditions which are more or less intimately connected with practical agriculture.

It therefore addresses itself to an examination of the meteorological phenomena regarded of greatest interest to the cultivator of the soil.

The most of the instruments employed have been manufactured by H. J. Green of Brooklyn, N. Y. Mr. Robert H. Fernald of Orono, has been observer during the two years that this work has been carried on. In this report the results of observations made during the years 1889 and 1890 are combined. The instruments have remained unchanged in position during the two years.

The several problems considered will appear in the following pages. The first to which attention has been given, is a determination of the percentage of moisture in forest as compared with that in open field.

The arrangement of instruments for this investigation is herewith submitted.

Hygrometer No. 1 is placed in a wooden stand constructed for thermometrical instruments and located in the open field remote from buildings. Hygrometer No. 2 also is enclosed in a wooden box, perforated to allow a free circulation of air, and located also in the open field. Hygrometer No. 3 is also enclosed in a perforated box attached to a tree in a moderately dense forest. Hygrometer No. 4 is placed in a similar box attached to a tree in a portion of the forest a little more open than that in which No.

3 is located, but near which is a running brook except during the driest part of the summer.

Each hygrometer is about four feet above the surface of the ground. Readings are taken three times daily, at 7 A. M., at 1 P. M., and at 7 P. M., local time.

Observations were commenced April 5, 1889 and they have been continued through the growing seasons of 1889 and 1890.

The monthly averages are given in the following tables on the scale of 100.

PERCENTAGES OF MOISTURE.

HYGROMETER NO. 1.—IN OPEN FIELD.

	1889. 7 A. M.	1890. 7 A. M.	1889. 1 P. M.	1890. 1 P. M.	1889. 7 P. M.	1890. 7 P. M.	Mean.
April,	81	74	53	50	66	58	64
May,	84	81	60	62	71	74	72
June,	88	83	67	72	81	75	78
July,	85	85	65	74	75	79	77
August,	95	90	70	63	80	77	79
September,	93	93	68	76	83	85	83
October,	94	90	66	62	79	79	78
Mean results.	89	85	64	66	76	75	76

HYGROMETER NO. 2.—IN OPEN FIELD.

	1889. 7 A. M.	1890. 7 A. M.	1889. 1 P. M.	1890. 1 P. M.	1889. 7 P. M.	1890. 7 P. M.	Mean.
April,	78	70	52	46	65	56	61
May,	80	78	53	61	68	74	69
June,	84	78	66	68	74	75	74
July,	79	80	60	63	69	71	70
August,	87	88	67	62	75	73	75
September,	91	91	60	67	81	83	79
October,	93	91	66	62	81	79	79
Mean results.	85	82	61	61	72	73	72

HYGROMETER NO 3.—IN FOREST.

	1889. 7 A. M.	1890. 7 A. M.	1889. 1 P. M.	1890. 1 P. M.	1889. 7 P. M.	1890. 7 P. M.	Mean.
April,	81	78	62	61	69	69	70
May,	83	87	63	74	73	81	77
June,	89	87	80	77	84	82	83
July,	94	93	86	85	91	83	89
August.	91	94	89	80	93	84	88
September,	96	96	88	87	92	92	92
October,	96	96	90	86	90	90	91
Mean results,	90	90	80	79	85	83	84

HYGROMETER NO. 4.—IN FOREST.

	1889. 7 A. M.	1890. 7 A. M.	1889. 1 P. M.	1890. 1 P. M.	1889. 7 P. M.	1890. 7 P. M.	Mean.
April,	83	79	65	60	77	71	72
May,	89	88	66	73	80	84	80
June,	92	89	81	77	86	84	85
July,	93	91	79	79	87	85	86
August,	95	91	86	78	91	85	88
September,	96	97	83	86	90	92	91
October,	96	94	80	80	90	89	88
Mean results,	92	90	77	76	86	84	84

Percentages of Moisture.

RESULTS FOR 1889 AND 1890 COMBINED.

	7 A. M.	1 P. M.	7 P. M.	Mean
Hygrometer No. 1, in open field,	87	65	76	76
" " 2, " " "	83	61	72	72
" " 3, in forest,	90	79	84	84
" " 4, " "	91	76	85	84

Regarding the mean results from hygrometers Nos. 1 and 2 as indicating percentages for the open field, we have the following summary of results:

	7 A. M.	1 P. M.	7 P. M.	Mean.
Percentages of moisture, open field,	85	63	74	74

Regarding the mean results from hygrometers No. 3 and 4 as indicating percentages for forests only moderately dense, we have the following summary results:

	7 A. M.	1 P. M.	7 P. M.	Mean.
Percentages of moisture, forest,	90	78	84	84

Comparing results, open field and forest, we have excess of moisture in forest above that in open field expressed in percentages.

7 A. M.	1 P. M.	7 P. M.	Mean.
5	15	10	10

It thus appears that from observations covering the period of growth of two years, that the excess of moisture in forest above that of open field in the morning, amounts to but 5 per cent., while in the middle of the day it rises to 15 per cent., and at night-fall drops down to 10 per cent., and that the mean excess for the day is 10 per cent. In a very dense forest the percentage of excess would undoubtedly rise much higher. The presence of patches of forest in any region exerts a marked influence on the hygroscopic conditions of the atmosphere, and this condition, in turn, is an important factor in the growth of vegetation.

It was noticeable in the investigation made that proximity to running water during two-thirds of the period of experiment only compensated for the loss of moisture resulting from the more open character of the forest where hygrometer No. 4 was situated as compared with No. 3.

It is designed that this examination of the effect of forests on the moisture of the atmosphere shall be continued.

Soil Temperatures.

In this investigation a knowledge of the temperature of the soil at different depths, during the growing season, is sought.

The periods covered by the experiment are from May 1 to Nov. 1, 1889 and from April 1 to Nov. 1, 1890, with thermometers placed in the soil to the depths of 1, 3, 6, 9, 12, 24 and 36 inches.

The thermometers were allowed to remain in place during the winter intervening between the two periods of observation.

Their location is in the open field, near hygrometer No. 2, in the tract of land assigned to the Station for experimental purposes and devoted to farm experiments. The character of the soil is regarded, therefore, as representative of that on which the field experiments by the Station are carried on.

A summary of results for the two seasons by monthly averages is given in the annexed tables.

SOIL THERMOMETERS—1889.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
May..........	51.77	62.92	59.20	51.50	60.33	59.70	52.92	55.21	57.04	53.49	53.31	55.44	52.46	52.15	53.21	48.84	49.06	49.01	46.28	46.42	46.48
June..........	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52
July..........	63.41	72.10	68.89	63.10	70.86	69.54	64.25	66.51	67.48	64.93	65.15	66.27	64.30	64.02	64.29	60.99	61.14	61.03	58.50	58.62	58.57
August..........	61.18	69.59	66.90	61.75	68.91	68.01	62.90	64.83	66.01	59.82	63.88	65.01	63.31	63.10	63.31	60.96	61.10	60.97	59.16	59.31	59.23
September......	57.11	61.56	61.45	57.74	63.01	62.89	59.47	60.25	61.29	60.29	60.20	60.93	60.30	60.21	60.04	59.42	59.51	59.36	58.40	58.51	58.37
October........	42.80	43.59	45.50	43.80	47.31	46.72	46.06	46.48	47.12	47.21	46.97	47.32	48.17	47.83	47.85	50.63	50.65	50.54	51.66	51.66	51.61
Mean...........	56.37	63.55	61.58	56.54	63.34	62 44	57.91	60.28	60.71	57.97	58.63	59.75	58.30	58.06	58.41	56.34	56.48	56.39	54.73	54.84	54.79
	°			°			°			°			°			°			°		
Mean temperature for six months	60.50			60.77			59.63			58.78			58.26			56.40			54.79		

SOIL THERMOMETERS—1890.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April...........	33.74	40.35	36.89	36.53	38.12	37.11	34.32	34.55	35.13	33.56	34.09	34.29	34.57	34.55	34.75	34.81	34.83	34.95	35.31	35.39	35.37
May...........	50.38	54.80	51.53	47.63	54.67	53.40	49.40	50.26	51.49	49.29	49.27	49.72	48.80	48.68	48.82	45.72	45.55	45.84	43.27	43.72	43.77
June...........	56.06	60.05	59.68	55.91	60.44	60.07	56.11	56.78	57.55	55.85	55.95	56.32	55.99	55.95	55.82	53.52	53.18	53.27	50.85	50.94	50.96
July...........	62.82	64.69	64.03	62.06	66.93	66.81	65.91	64.11	64.87	62.85	62.95	63.88	62.70	62.60	62.78	58.77	58.84	58.77	56.25	56.28	56.34
August...........	61.80	68.20	67.28	62.15	67.60	67.41	63.69	65.08	66.26	63.91	64.16	64.83	63.87	63.84	63.91	61.72	62.09	61.34	59.43	59.40	59.39
September......	56.51	59.83	59.43	57.44	58.93	59.62	58.21	58.56	59.34	58.36	58.30	58.59	58.73	58.58	58.56	58.15	58.43	58.37	57.73	58.05	57.65
October...........	45.37	47.17	46.67	45.77	47.16	46.76	47.00	47.10	47.23	47.40	47.32	47.06	48.81	48.72	48.50	51.08	50.97	50.86	52.07	52.04	52.00
Mean...........	52.38	56.44	55.07	52.58	56.29	55.88	53.54	53.78	54.55	53.08	53.15	53.61	53.35	53.27	53.32	51.07	51.99	51.93	50.70	50.83	50.78
	°			°			°			°			°			°			°		
Mean temperature for seven months...	51.63			54.92			53.96			53.20			53.31			51.96			50.77		

In order that comparisons may be made between soil temperatures at different depths and the air temperatures during the same months and in the same locality, the following tables are added.

Thermometer in the Open Air.

(Locality the same as that of the soil thermometers.)

1889.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
May,	52.95	68.30	59.47	60.24
June,	63.36	74.27	68.07	68.57
July,	65.12	75.75	70.86	70.58
August,	59.97	74.20	66.81	66.99
September,	54.39	70.86	61.55	62.27
October,	37.41	52.80	44.05	44.75
Mean,	55.53	69.36	61.80	62.23

1890.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
April,	35.76	49.02	42.55	42.44
May,	49.16	60.60	53.58	54.45
June,	57.95	67.64	62.76	62.78
July,	67.10	76.19	71.85	71.71
August.	61.50	73.78	68.84	68.04
September,	52.04	66.16	58.52	58.91
October,	37.70	53.19	45.63	45.51
Mean,	51.60	63.80	57.68	57.69

Tables Showing Changes of Temperature in the Soil for Increased Depths.

1889.

Depth of Thermometer.	Mean temperature for six months, May to Oct. inclusive.	Difference in mean temperature.	Changes in temperature for one inch.
	°	°	°
1 inch	60.50		
3 inches	60.77	+0.27	+0.13
6 inches	59.63	—1.14	—0.38
9 inches	58.78	—0.85	—0.28
12 inches	58.26	—0.52	—0.17
24 inches	56.40	—1.86	—0.15
36 inches	54.79	—1.61	—0.13

1890.

Depth of Thermometer.	Mean temperature for seven months. April to Oct. inclusive.	Difference in mean temperature.	Changes in temperature for one inch.
	°	°	°
1 inch	54.63	+0.29	+0.14
3 inches	54.92	—0.96	—0.32
6 inches	53.96	—0 70	—0.23
9 inches	53.26	+0.05	+0.02
12 inches	53.31	—1.35	—0.11
24 inches	51.96	—1.19	—0.10
36 inches	50.77		

An examination of the tables shows that the soil responds readily to the daily heat of the sun to the depth of three inches, less readily to the depth of six inches, in a moderate degree only to the depth of nine inches, and very slightly below twelve inches. To the depth of three inches the range between the morning and the midday observations has been as high as fifteen degrees. The mean daily range at the depth of 1 inch during the period of observations was 5°.62 ; at the depth of three inches, 5°.26 ; at the depth 6 inches, 1°.90 ; at the depth of 9 inches, 1°.18, and below 12 inches, very slight.

At the depth of 3 inches, the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about five degrees warmer than the soil 36 inches below the surface.

The rate of reduction of temperature with depth below the layer three inches from the surface is clearly shown in the foregoing tables.

Comparing soil temperatures with air temperatures during the two seasons under notice, the following mean results appear. At the depth of 1 inch, the temperature of the soil was lower than that of the air by 2°.40 ; at the depth of 3 inches, by 2°.11 ; 6 inches, by 3°.16 ; 9 inches, by 3°.94 ; 12 inches, by 4°.18 ; 24 inches, by 5°.78, and at the depth of 36 inches, by 7°.18.

Terrestrial Radiation.

The heat radiated from the surface of the earth during the night reduces its temperature several degrees below that of the surrounding atmosphere. The amount of this radiation or the consequent reduction of temperature is approximately shown by comparing the readings of a terrestrial radiation thermometer with those of a minimum thermometer. In obtaining data for the comparison given below, the minimum thermometer was four feet above the ground and the terrestrial radiation thermometer was within six inches of its surface. The results are based on monthly averages from May to October inclusive, 1889 and from April to October inclusive, 1890.

TABLE SHOWING LOSS OF HEAT BY TERRESTRIAL RADIATION.

1889.

	May	June	July	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o
Mean of minimum temperatures,	46.63	53.25	55.08	53.65	49.07	33.91	48.50
Mean of Tem. from Ter. Rad. Ther.,	38.48	49.20	50.59	47.66	44.60	28.48	43.17
Loss of heat by radiation,	8.15	4.05	4.49	5.39	4.74	5.43	5.33

1890.

	April	May	June	July	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of minimum temperatures,	29.17	42.52	48.71	53.61	53.52	45.32	36.05	44.13
Mean of Tem. from Ter. Rad. Ther.,	19.95	37.10	42.10	44.55	46.25	38.40	27.14	36.50
Loss of heat by radiation,	8.22	5.42	6.61	9.06	7.27	6.92	9.91	7.63

On cloudy nights the difference in the reading of the two thermometers is small, and on exceptionally clear (dry) nights it is a maximum. The greatest range observed was 19°.5. On the morning of July 2d, 1889, the radiation thermometer was the higher, showing that the moist air resting upon the surface of the ground served as a warm blanket, and that the amount of heat absorbed was greater than that radiated. From the table above it appears that the mean radiation for the two seasons was 6°.48.

SOLAR RADIATION.

The temperature of the atmosphere does not indicate the intensity of the sun's heat, as only a small percentage is absorbed as the rays are transmitted through the air. The maximum thermometer in the shade, therefore, does not give the intensity of solar radiation; neither does exposure of an ordinary thermometer to the direct rays of the sun in consequence of the cooling effects or draughts of air. In order to avoid the effects of currents of air, the *vacuum solar radiation thermometer* has been devised. "This consists of a blackened bulb radiation thermometer inclosed in a glass tube and globe, from which all air is exhausted. Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher, than when placed side by side with a similar instrument with the bulb exposed to the passing air." By the use of this instrument the amounts of solar radiation at different places and in different seasons at the same place are rendered comparable. The relations of solar intensity, as distinct from temperature of the air, to the growth and maturity of crops are worthy of careful investigation. High solar intensity maintained through the latter part of the growth season has an important bearing upon the complete ripening of vegetables and fruits and likewise upon their keeping qualities. From the wide range of observations undertaken by Experiment Stations with radiation thermometers, important deductions may reasonably be expected. I subjoin tables of results from the maximum thermometer and the thermometer for solar radiation expressed in monthly averages.

1889.

	May	June	July	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o
Mean of readings, Sun Ther.,	133.02	134.22	139.55	137.56	122.79	105.86	128.83
Mean of Maximum Temp.,	67.85	73.45	75.30	73.72	71.23	52.78	69.05
Excess of solar intensity,	65.17	60.77	64.25	63.84	51.56	53.08	59.78

1890.

	April	May	June	July	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of readings, Sun Ther.,	119.19	119.45	128.81	139.37	138.25	114.94	112.52	124.65
Mean of Maximum Temp.,	49.37	61.16	68.01	76.53	74.67	62.32	55.61	64.38
Excess of solar intensity,	69.82	58.29	60.80	62.84	63.58	49.62	56.92	60.27

From the above records it appears that the average excess of solar intensity above that given by the maximum thermometer for the growing period of 1889 and 1880 was 60.°02.

Amount of Sunshine.

The amount of sunshine as an essential factor in crop production is worthy of observation and record. Observations were commenced May 1, 1890, and the table below furnishes the summary for the six months following.

Bright Sunshine in Hours.

1890.

May	June	July	Aug.	Sept.	Oct.
180	186	216	193	126	133

During this period, the average hours of bright sunshine per day was 5.6 or 41 per cent. of the possible amount.

WIND AND RAIN.

The velocity of the wind has been determined by a Robinson's Anemometer attached to the Experiment Station building, and the amount of rain by means of a guage, signal service pattern, located in the same plat as the soil thermometers.

1889.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	253.93	10.58	1.36
May,	189.83	7.91	1.61
June,	171.12	7.13	4.86
July,	200.33	8.34	3.27
August,	139.35	5.81	1.69
September,	198.06	8.25	2.10
October,	194.31	8.09	3.96
Mean,	192.42	8.02	Total, 18.85

1890.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April	241.73	10.07	1.98
May,	235.14	9.79	10.13
June,	230.40	9.60	3.78
July,	166.28	6.95	3.84
August,	187.03	7.65	5.39
September,	155.59	6.45	4.21
October,	189.01	7.85	3.19
Mean,	200.74	8.34	Total, 32.52

For the full year 1890, the mean monthly velocity of wind was 211.16 miles, and the mean hourly velocity, 8.90 miles. The rain-fall in May, 1890, amounting to 10.13 inches was larger than in any other month in twenty-two years.

CONCLUSION.

This report covering simply the growing periods of two years, is based upon and contains summaries of more than twenty thousand independent observations. In order to show more definitely the nature and daily requirements of the meteorological work in progress, I append the records for one month, selecting the month of July, 1890. Their examination will disclose many points of interest which cannot be incorporated into a brief report.

By lapse of time such records and their antecedent observations become increasingly valuable, and their thorough discussion, as expressed in my former report, "adds to the sum of available knowledge and furnishes rules for guidance useful alike for the scientist and the farmer."

HYGROMETER NO. 1.—IN OPEN FIELD.

July, 1890.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°		°	°	°		°	°	°	
1.	59.2	59.2	59.2	100	81.0	68.0	61	51	68.5	62.2	58	71
2.	62.0	59.0	57	84	71.8	61.9	56	57	64.8	59.0	55	71
3.	59.7	59.7	59.7	100	63.6	63.6	63.6	100	62.2	62.2	62.2	100
4.	66.0	64.0	63	90	71.7	67.5	66	81	67.0	65.2	64	91
5.	62.0	62.0	62	100	73.5	73.5	73.5	100	73.8	69.5	67	81
6.	62.5	56.8	54	71	75.2	63.3	72	91	71.8	64.6	61	68
7.	65.0	62.2	60	86	74.1	66.0	62	66	70.0	64.0	60	72
8.	66.3	64.0	62	88	81.2	75.7	73	78	76.7	72.8	71	83
9.	73.8	68.0	65	75	70.4	61.6	55	61	59.7	54.0	50	69
10.	51.2	48.0	45	79	66.3	56.2	48	53	63.2	58.2	55	74
11.	53.7	49.6	44	70	73.0	66.8	69	85	72.7	67 8	66	78
12.	56.7	55.7	55	94	76.4	64.3	57	52	70.3	66.4	62	77
13.	66.7	61.6	59	76	70.2	62.0	57	63	62.9	57.8	55	74
14.	60.0	58.2	57	90	74.0	65.3	61	63	76.2	69.0	66	69
15.	66.8	64.0	62	86	80.9	76.5	77	86	82.2	76.5	74	78
16.	73.2	69.0	67	81	82.6	82.6	82.6	100	78.3	74.3	72	83
17.	66.1	63.0	61	85	78.0	73.0	71	79	68.0	65.1	63	85
18.	58.7	55.0	53	80	64.5	56.0	50	59	68.0	55.3	64	87
19.	60.0	54.3	50	69	60.0	57.5	56	86	56.5	56.5	56.5	100
20.	56.3	54.5	53	89	66.3	57.8	51	59	61.3	58.0	55	82
21.	55.0	53.0	52	88	72.0	63.5	59	63	68.1	62.0	58	71
22.	58.1	55.0	53	83	74.0	65.7	61	65	67.0	62.3	60	77
23.	62.5	60.0	59	87	74.0	69.0	67	78	65.2	59.0	55	69
24.	62.2	61.5	61	96	72.7	64.2	60	63	67.8	59.8	59.8	63
25.	61.7	61.1	61	97	67.0	65.0	64	90	62.3	62.3	62.3	100
26.	67.1	66.1	66	95	70.2	69.0	69	94	67.8	67.0	67	96
27.	70.0	65.6	63	79	77.3	66.4	76	95	74.7	66.8	63	66
28.	65.1	61.2	59	80	80.3	71.8	68	66	72.8	69.7	69	86
29.	71.8	67.5	65	80	84.1	71.4	66	54	73.3	66.0	62	68
30.	64.6	64.2	64	97	86.0	78.3	75	71	78.0	71.6	68	73
31.	70.0	67.0	66	86	80.0	72.5	69	70	75.1	72.0	71	87
Means				.85				.74				.79
Mean for month							.83					

HYGROMETER NO. 2.—IN OPEN FIELD.

JULY, 1890.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°		°	°	°		°	°	°	
1.	63.3	61.5	60	90	86.0	69.2	60	43	89.3	62.3	58	67
2.	71.0	64.5	61	70	78.3	65.8	58	51	67.0	60.0	55	66
3.	61.0	60.0	59	94	64.4	64.4	64.4	100	63.1	63.1	63.1	100
4.	68.4	65.8	64	88	74.5	68.5	66	74	69.2	66.3	64	86
5.	63.2	62.7	62	97	74.0	74.0	74.0	100	80.6	72.0	69	66
6.	66.7	58.8	54	62	77.0	65.0	58	52	75.9	66.7	62	62
7.	66.7	63.0	61	82	77.6	66.6	61	56	73.4	65.3	61	65
8.	71.0	67.3	66	83	84.8	74.8	71	63	80.7	73.1	70	70
9.	74.8	68.0	64	71	70.3	58.0	48	47	60.6	51.4	44	53
10.	54.0	48.0	42	64	68.6	57.9	51	52	67.0	60.6	56	69
11.	56.2	51.6	48	74	73.6	63.2	57	56	79.0	77.5	77	94
12.	63.2	61.4	40	90	82.0	68.3	61	49	69.8	66.3	65	83
13.	70.2	63.2	59	68	76.0	64.0	57	52	68.0	57.5	50	52
14.	66.6	61.3	48	74	77.6	66.0	50	54	82.6	68.8	62	50
15.	70.6	66.0	64	79	85.1	77.0	74	70	86.4	78.1	75	69
16.	77.0	73.0	71	83	83.1	83.1	83.1	100	82.5	75.8	74	74
17.	70.5	66.2	64	80	82.5	70.8	66	57	69.2	65.7	63	83
18.	60.0	55.7	52	76	65.8	55.8	48	53	71.0	58.1	48	45
19.	63.0	57.0	53	69	61.0	58.7	57	88	57.2	57.2	57.2	100
20.	58.0	55.7	54	87	65.5	57.0	51	59	63.0	58.2	55	75
21.	59.0	55.3	53	80	71.8	59.5	51	48	74.2	61.4	52	47
22.	66.3	60.8	57	73	77.5	62.1	49	39	69.7	59.7	53	55
23.	68.3	63.2	60	76	75.0	64.8	59	57	67.3	60.3	55	66
24.	66.4	61.2	58	74	74.1	64.0	58	58	70.0	61.1	55	60
25.	63.0	61.6	61	92	68.6	65.8	64	87	63.0	63.0	63	100
26.	67.8	66.3	66	93	70.6	69.2	69	93	68.6	67.0	66	93
27.	71.8	66.3	93	75	79.0	68.0	62	57	75.6	68.6	66	70
28.	73.0	66.3	63	70	81.1	68.4	62	52	74.6	65.7	61	62
29.	72.4	68.0	66	81	87.0	74.0	68	54	75.6	67.1	63	64
30.	66.0	64.7	64	93	89.3	81.0	77	70	79.0	73.5	71	77
31.	70.6	67.6	67	86	80.3	72.5	68	69	74.3	71.3	70	86
Means				.80				.63				.71
Mean for month							.71					

HYGROMETER NO. 3.—IN FOREST.

JULY, 1890.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	
1.	58.0	57.2	56	95	74.3	69.5	67	79	66.6	63.2	61	83
2.	60.3	58.6	58	91	70.8	67.0	65	82	65.2	63.0	62	89
3.	59.3	58.7	58	97	61.0	61.0	61	100	59.8	59.8	59.8	100
4.	63.8	63.3	63	97	67.8	66.8	67	95	65.3	64.1	63	94
5.	61.6	61.6	61.6	100	70.2	70.2	70.2	100	70.3	68.2	67	90
6.	60.2	58.3	57	89	70.8	66.8	65	81	69.4	67.7	67	92
7.	62.4	61.2	60	94	69.7	67.0	67	87	68.0	66.2	65	91
8.	63.8	63.0	62	96	76.7	74.8	74	91	74.8	73.3	73	93
9.	70.8	68.4	68	88	68.4	64.5	72	83	58.7	56.0	55	85
10.	52.4	50.9	49	90	62.4	58.6	55	80	63.3	60.0	57	83
11.	50.6	49.2	48	90	68.3	64.7	62	83	66.2	63.0	61	84
12.	53.0	52.0	51	94	72.0	67.8	66	81	75.2	65.8	60	60
13.	64.3	62.4	61	90	68.8	61.0	56	64	61.4	59.6	58	90
14.	57.3	56.0	55	92	69.8	66.6	66	85	69.7	67.2	67	88
15.	62.0	61.0	60	95	78.0	75.8	75	90	78.3	76.0	75	90
16.	69.0	67.2	66	91	70.8	67.9	69	86	73 0	72.0	72	95
17.	63.0	61.8	61	94	71.2	67.9	66	85	66.7	64.2	63	88
18.	59.3	58.0	57	93	62.3	57.1	53	73	63.9	58.7	62	76
19.	54.7	53.0	53	90	59.2	58.5	58	96	55.4	55.4	55.4	100
20.	55.5	54.7	54	95	61.9	60.0	59	89	59.5	57.4	57	89
21.	50.8	50.0	49	94	66.3	59.0	53	64	62.1	58.2	55	79
22.	56.8	54.6	54	87	67.7	63.2	61	78	64.3	62.2	61	90
23.	59.6	58.9	59	96	71.0	68.0	67	86	61.7	59.2	58	87
24.	59.1	58.0	57	94	68.0	64.1	62	81	66.0	63.7	62	88
25.	61.0	60.5	60	97	65.8	65.2	65	97	61.7	61.7	61.7	100
26.	66.8	66.2	67	98	70.0	69.6	70	98	67.6	67.0	68	98
27.	67.2	66.0	66	94	75.3	72.3	71	87	71.0	69.0	68	91
28.	59.4	57.8	57	92	75.8	68.0	64	67	70.3	66.5	64	82
29.	63.4	62.2	61	94	79.5	76.8	77	88	72.2	70.6	70	93
30.	64.6	64.0	64	97	80.6	78.1	77	90	76.3	74.6	74	92
31.	68.7	66.9	65	91	76.3	74.5	73	92	74.1	72.5	72	93
Means				.93				.85				.83
Mean for month							.87					

HYGROMETER NO. 4.—IN FOREST.

JULY, 1890.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°		°	°	°		°	°	°	
1.	58.0	58.0	58	100	74.6	69.0	67	76	66.8	63.3	61	83
2.	60.3	58.9	58	92	71.9	64.8	61	69	66.1	62.2	60	80
3.	60.0	59.0	58	94	61.6	61.6	61.6	100	58.9	58.9	58.9	100
4.	65.2	65.2	65.2	100	68.3	67.7	68	98	65.6	64.8	64	96
5.	61.7	61.7	61.7	100	70.1	70.1	70.1	100	71.7	69.3	69	88
6.	60.9	58.0	56	84	71.0	64.3	61	69	69.4	66.8	65	88
7.	63.0	61.2	60	90	69.0	65.0	63	81	67.0	63.3	61	82
8.	64.6	63.2	63	92	77.8	73.2	71	81	74.5	71.7	71	88
9.	69.8	67.0	66	87	68.3	62.7	59	74	57.8	52.5	49	70
10.	52.1	50.0	48	87	62.4	58.2	55	78	61.2	59.0	58	88
11.	50.3	49.0	47	91	69.0	60.6	55	61	65.6	59.3	55	69
12.	53.1	52.3	51	95	74.6	66.3	62	65	69.0	61.7	57	66
13.	65.0	61.6	59	82	69.0	63.0	59	72	61.2	56.1	52	73
14.	57.8	56.0	55	90	67.1	62.2	59	76	68.5	64.0	62	78
15.	62.8	61.2	61	92	78.8	74.9	78	83	78.5	74.6	73	83
16.	69.8	67.3	67	88	72.0	68.8	68	85	73.3	72.0	71	94
17.	63.3	62.3	61	95	72.0	68.0	66	82	67.3	64.6	63	87
18.	58.9	57.1	56	90	62.7	56.2	52	67	61.5	57.0	54	76
19.	55.3	53.3	52	88	59.2	58.1	57	94	55.0	55.0	55	100
20.	55.7	54.6	54	64	62.3	57.7	54	76	59.1	57.7	57	92
21.	51.6	50.2	49	90	68.1	60.0	55	63	61.0	57.0	57	78
22.	57.3	54.2	52	83	67.9	59.0	53	58	63.6	61.1	60	87
23.	61.6	60.2	60	92	72.7	68.2	66	80	61.8	58.6	57	83
24.	61.0	58.0	56	84	68.8	60.2	57	65	66.8	63.4	61	83
25.	61.2	60.5	60	96	66.0	65.0	64	95	61.5	61.5	61.5	100
26.	66.8	66.2	67	98	69.8	69.3	70	98	67.0	67.0	67	100
27.	67.7	66.2	66	93	74.0	69.1	67	78	69.0	65.8	64	85
28.	60.0	59.0	58	94	74.2	69.7	67	80	69.6	65.0	93	79
29.	64.1	63.0	62	95	81.0	73.9	71	72	71.4	67.0	64	79
30.	65.0	64.2	63	96	81.4	77.2	76	84	76.0	72.1	70	82
31.	69.6	67.1	67	88	77.0	73.3	72	84	74.0	70.6	69	84
Means				.91				.79				.85
Mean for month						.85						

SOIL THERMOMETERS.

July, 1890.

Day.	Depth, 1 inch.			Depth, 3 inches.			Depth, 6 inches.			Depth, 9 inches.			Depth, 12 inches.			Depth, 24 inches.			Depth. 36 inches.		
	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1.	60.5	66.7	66.4	60.5	66.0	65.7	60.2	61.4	61.3	60.0	60.0	60.0	59.5	59.5	59.5	55.7	56.0	56.0	53.5	53.5	53.5
2.	61.1	66.5	65.5	60.6	65.3	65.1	61.0	61.8	63.0	61.0	60.9	61.5	60.8	65.5	60.8	56.2	56.5	56.5	53.7	53.8	53.8
3.	61.5	61.0	60.7	61.0	61.0	61.5	61.0	61.0	60.8	61.2	60.7	60.5	61.0	60.5	60.5	56.5	56.5	56.5	54.0	54.0	54.1
4.	62.3	64.0	61.8	62.0	63.6	61.0	61.3	62.0	61.0	61.0	61.0	61.2	60.5	60.6	60.8	56.8	57.0	57.0	54.2	54.3	54.3
5.	63.0	67.3	66.8	62.6	66.7	66.2	62.2	63.0	63.7	61.5	61.7	62.0	61.0	61.2	61.4	57.0	57.0	57.0	54.5	54.5	54.5
6.	60.9	66.4	67.2	60.3	65.5	67.0	60.0	62.5	64.5	61.2	61.6	62.7	61.0	61.5	61.7	57.0	57.5	57.6	54.5	54.8	54.9
7.	63.6	66.5	66.6	63.5	65.7	66.2	63.2	63.7	64.4	63.0	62.8	63.2	62.5	62.4	62.5	57.7	56.9	58.9	55.0	55.1	55.2
8.	64.0	69.1	69.6	63.7	68.2	69.3	63.3	64.5	66.0	63.0	63.0	63.9	62.6	62.5	63.0	58.0	58.2	58.3	55.1	55.4	55.4
9.	66.4	68.9	65.7	66.0	68.3	66.0	65.2	65.7	65.8	64.5	64.5	64.8	63.8	63.6	63.7	58.5	58.6	58.7	55.5	55.6	55.6
10.	60.6	67.8	64.9	61.6	67.2	65.2	61.1	62.7	63.0	63.0	63.3	63.6	63.4	63.5	63.5	59.0	59.0	59.0	55.9	56.0	56.0
11.	59.7	65.5	65.3	60.0	64.5	64.8	60.7	62.3	63.1	61.2	61.6	62.1	61.7	61.8	62.0	59.0	59.0	58.9	56.0	56.0	56.2
12.	59.5	67.3	66.7	59.5	67.1	65.2	60.6	62.4	62.4	61.5	61.8	62.2	62.0	62.2	62.4	58.8	58.8	58.8	56.1	56.1	56.2
13.	63.3	66.0	66.0	63.0	65.0	65.6	62.5	63.0	63.3	62.5	62.5	63.0	62.5	62.4	62.7	58.8	58.8	58.8	56.3	56.2	56.2
14.	62.0	67.0	67.0	61.5	66.0	66.5	62.0	63.0	64.3	62.5	62.5	63.0	62.6	62.3	62.5	58.9	59.0	59.0	56.1	56.3	56.3
15.	63.2	68.7	69.2	63.0	67.4	67.9	63.0	64.2	65.7	63.2	63.3	64.0	63.1	62.9	63.3	59.0	59.3	59.2	56.4	56.5	56.6
16.	66.0	69.2	69.6	65.5	69.0	69.2	65.0	67.4	66.9	64.5	64.7	65.3	64.2	64.5	64.5	59.3	59.4	59.5	56.5	56.5	56.7
17.	65.0	67.5	67.2	65.0	66.7	66.9	65.0	66.0	65.5	65.0	65.0	64.8	64.6	64.3	64.2	59.6	60.0	59.7	56.7	56.9	56.9
18.	63.3	66.8	65.4	63.5	66.5	65.5	63.0	66.0	64.7	64.0	64.5	64.0	64.0	64.2	63.6	59.8	59.8	59.8	57.0	57.0	57.2
19.	59.7	61.8	60.0	59.5	61.3	60.6	61.0	61.2	61.0	62.1	61.5	61.0	63.0	62.2	62.0	59.9	59.8	59.6	57.0	57.0	57.0
20.	59.8	62.8	63.1	60.3	62.0	63.0	60.5	61.0	62.0	60.7	60.5	61.0	61.5	61.1	61.0	58.4	59.4	59.2	57.1	57.1	57.1
21.	59.1	64.0	63.5	58.5	63.0	63.5	60.0	60.6	62.1	60.2	60.0	60.8	61.0	60.5	60.6	59.0	59.0	59.0	57.0	57.0	57.0
22.	57.8	69.9	67.5	58.0	69.5	68.2	59.0	62.5	65.6	59.9	60.7	62.9	60.8	60.5	61.4	58.8	59.0	58.8	57.0	57.0	57.0
23.	60.6	70.5	67.4	60.7	69.9	68.5	61.2	64.0	63.6	61.8	62.1	62.3	60.2	61.7	61.7	58.9	59.0	59.0	56.8	57.0	57.0
24.	61.8	70.6	67.8	61.9	70.2	68.5	62.3	65.1	66.9	62.6	63.0	64.5	62.6	62.3	63.0	59.2	59.2	59.1	56.9	57.0	57.0
25.	63.4	66.5	65.3	63.5	66.3	65.7	63.6	64.5	64.2	63.5	63.5	63.5	63.0	62.9	62.7	59.3	59.4	59.4	57.0	57.0	57.0
26.	66.9	68.7	67.1	66.7	68.5	67.2	63.8	64.3	65.7	63.5	63.5	64.0	62.5	62.7	63.1	59.3	59.4	59.5	57.0	57.0	57.2
27.	65.3	72.4	71.2	65.2	71.4	71.3	64.5	66.3	68.7	64.0	64.5	66.5	63.5	63.5	64.2	59.6	59.8	59.8	57.4	57.5	57.5
28.	63.5	72.5	71.1	63.6	61.9	71.5	64.7	67.3	69.1	65.1	65.5	66.7	64.5	64.3	64.7	60.0	60.3	60.4	57.5	57.6	57.6
29.	65.5	75.7	73.4	65.6	74.8	73.6	66.0	69.3	71.0	65.9	66.7	68.1	65.2	65.2	65.7	60.5	60.8	60.7	57.9	58.1	58.0
30.	67.0	76.2	74.7	67.0	75.0	74.6	67.2	69.6	71.8	67.0	66.7	78.8	66.3	66.2	66.6	60.9	60.8	61.5	58.1	58.3	58.4
31.	69.2	71.6	71.3	69.3	71.2	71.2	69.0	69.1	69.8	68.2	68.0	68.3	67.0	67.0	66.9	61.6	61.6	61.7	58.4	58.5	58.6
Means....	62.82	64.69	64.03	62.66	66.93	66.81	65.91	64.11	64.87	62.85	62.95	63.89	62.70	62.60	62.78	58.77	58.84	58.77	56.20	56.28	56.34

July, 1890.

Day.	Maximum and Minimum Thermometers and Record of Sunshine. Maximum.	Minimum.	Hours of Sunshine.	Terrestrial Radiation Thermometer.	Solar Thermometer.	Precipitation. Time of beginning.	Time of ending.	Amount of rain. Inches.	Anemometer observed at 1 P. M. Movement of Wind. Number of miles in last twenty-four hours.	Average velocity per hour, miles.
	°	°	°	°	°					
1.	82.9	51.2	12½	45.5	151.0				195.4	8.14
2.	75.5	50.3	7	42.0	154.0				116.3	4.85
3.	64.2	50.1	0	42.3	82.8	6.30 A. M.			158.2	6.59
4.	72.0	60.2	0	57.8	96.0				303.8	12.66
5.	77.3	61.0	3½	56.1	145.3		2 P. M.	1.20	147.5	6.15
6.	78.9	50.3	12½	40.0	152.0				77.9	3.25
7.	75.6	59.1	6½	50.5	137.0				109.2	4 55
8.	82.7	60.5	8	51.4	143.0	7.30 P. M.	8.30 P. M.	1.20	130.8	5.45
9.	75.4	64.0	9½	57.1	152.2				323.0	3.46
10.	69.7	43.6	13½	34.0	153.4				284.8	11.87
11.	75.5	50.0	11½	43.6	159.9				184.9	7.70
12.	79.9	43.1	10½	34.1	151.0				66.8	2.78
13.	74.0	57.2	6	47.5	139.6				177.3	7.40
14.	77.1	49.9	9	40.0	150.0				185.1	7.71
15.	84.5	49.9	7	45.8	147.6	10.30 A. M.	10.45 A. M.	.02	131.9	5.50
						2.45 P. M.	1.30 P. M.	.10		
16.	84.5	61.0	12½	49.6	153.0	Night.	Night.	.02	179.2	7.47
17.	79.0	57.5	0	46.0	119.1	7.30 P. M.	Night.	.04	53.9	2.25
18.	70.7	54.9	12	43 9	146 7				199.6	5.38
19.	68.0	43.0	1¾	31.4	124.0				146 8	6.12
20.	66.8	52.0	3	46.3	153.5	2.30 P. M.	3.30 P. M.	.01	126.2	5.96
21.	73.5	43.5	12½	33 8	153.2				83.1	3.46
22.	75.3	46.9	11	35.8	138.7				68.5	2.85
23.	77.1	48.2	9½	36.1	139.8				182.5	7.52
24.	73.9	50 2	9	38.7	139.3				256 8	10.70
25.	67.8	55.2	0	48.3	100.0	Early Morning.			165.9	6.91
26.	76.0	62.0	½	57.0	97.5		5 P. M.	1.21	214.3	8.93
27.	81.0	63.7	11	56.2	152.0				242.6	10.11
28.	81.5	52.2	11	43.1	146 3				114.7	4.30
29.	84.4	58.6	7	49.0	151.0				175.6	7.32
30.	86.8	58.6	0	39.1	144.8				195.0	8.13
31.	80.8	58.1	0	39 0	126.9	6.30 A. M.	3 P. M.	.04	257.1	10.71
		Total,	216½			Totals,		3.84	5154.7	
Means.	76.53	53.61	7	44.55	139.37				166.28	6.95

INDEX.