MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

COTTONSEED MEAL.

J. B. LINDSEY AND P. H. SMITH.

Because of heavy rainfalls last autumn large quantities of cottonseed were considerably damaged, and as a result, much of the cottonseed meal that has been offered during the present season has been off grade, both in color and texture and in chemical composition. The Station has endeavored to keep close watch of the quality of the meal brought into Massachusetts. The following analyses made from samples collected during the past three months are reported below.

TABLES OF ANALYSES.

Manufacturer or Jobber, Brand and Retailer.	Sampled at.	Protein.		Fat.	
		Found.	Guar.	Found.	Guar.
		%	%	%	%
High Grade.					
American Cotton Oil Co., New York.					
W. T. Dwyer.....	Sunderland.	42.08	41.00	9.35	9.00
Chapin & Co., Boston.					
Green Diamond,..A. Dodge & Son.....	Beverly	41.59	41-43	9.24	9.00
Green Diamond,..W. J. Meek	Fall River..	41.24	41-43	9.07	9.00
Green Diamond,..W. N. Potter Grain Co.	Gardner....	41.47	41-43	8.90	9.00
Green Diamond,..C. A. Pierce.....	Hinsdale ..	46.38	41-43	10.51	9.00

Manufacturer or Jobber, Brand and Retailer.	Sampled at.	Protein.		Fat.	
		Found.	Guar.	Found.	Guar.
		%	%	%	%
Hunter Bros. Milling Co., St. Louis.					
C. W. Marsh.....	Bradstreet..	41.77	41.00	9.60	9.00
G. C. Turner	Chester	43.31	41.00	9.32	9.00
S. P. Puffer & Son....	N. Amherst.	41.99	41.00	9.47	9.00
Spr'g'd Flour & Gr. Co	Springfield .	41.85	41.00	8.01	9.00
J. H. Day	Sunderland.	41.03	41.00	8.75	9.00
T. M. Lyons.....	Sunderland.	41.11	41.00	7.27	9.00
W. P. Griffen	Pittsfield ...	40.94	41.00	10.06	9.00
S. D. Viets Co., Springfield.					
Mackenzie & Winslow.	Fall River..	41.03	40-43	9.02	—
J. Lindsay Wells Co., Memphis, Tenn.					
Star,.....A. F. Sanctuary.....	Amherst ...	41.20	41-43	9.25	9-10
Star,.....Eastern Grain Co.....	Bridgewater.	43.17	41-43	8.80	9-10
Star,.....Haverhill Milling Co..	Haverhill...	44.18	41-43	8.59	9-10
Medium Grade.					
American Cotton Oil Co., New York.					
A. D. Potter.....	Orange.....	39.45	41.00	10.65	9.00
J. O. Ellison & Co	Bradford ...	39.14	41.00	8.82	9.00
H. E. Bridges & Co., Memphis, Tenn.					
F. E. Smith.....	Amherst ...	37.60	41.00	10.11	9.00
F. W. Brode & Co., Memphis, Tenn.					
Owl, ...J. E. Merrick & Co....	Amherst ...	38.48	41-43	10.54	7-9
Owl, ...Griswold & Adams ...	Dalton.	39.62	41-43	9.25	7-9
Owl, ...J. Cushing & Co.....	Fitchburg ..	39.19	41-43	8.50	7-9
Owl, ...W. W. McIntyre.....	Marboro ...	39.97	41-43	8.74	7 9
Owl, ...E. C. Frost.....	Shelb'ne Fls	40.01	41-43	11.63	7-9
Owl, ...A. W. Charter.....	Springfield .	38.13	41-43	8.23	7-9
Owl, ...Taunton Grain Co....	Taunton ...	40.63	41-43	8.42	7-9
Buckeye Cotton Oil Co., Augusta, Ga.					
Buckeye,.....Mackenzie & Winslow.	Fall River..	36.42	35.97	8.03	—
Standard,.....S. R. Carter.....	W. Berlin ..	38.25	38.60	8.05	—
T. H. Bunch, Little Rock, Ark.					
Old Gold, ...A. E. Lawrence & Son	Ayer	39.27	41.00	9.65	9.00
Old Gold, ...J. B. Garland & Son...	Worcester .	40.80	41.00	9.12	9.00
Chapin & Co., Boston.					
Green Diamond,..Mackenzie & Winslow	Fall River..	38.75	41-43	8.03	9.00
Chas. M. Cox Co., Boston.					
Magnolia,.....H. A. Crossman.....	Needham ..	39.92	41-43	9.06	9.00
Magnolia,.....F. A. Fales & Co.....	Norwood...	40.72	41-43	9.12	9.00
Magnolia,.....Whitman Coal & Gr. Co	Whitman...	37.34	41-43	8.30	9.00
Magnolia,.....G. A. Stevens.	Worcester..	36.42	41-43	8.86	9.00

Manufacturer or Jobber, Brand and Retailer.	Sampled at.	Protein.		Fat.	
		Found.	Guar.	Found.	Guar.
		%	%	%	%
Humphreys, Godwin & Co., Memphis.					
Dixie,.....Pierce & Winn.....	Arlington...	40.27	41.00	7.91	9.00
Hunter Bros. Milling Co., St. Louis.					
G. M. Stratton.....	Montague ..	40.36	41.00	8.06	9.00
Warner Bros.....	Sunderland.	40.10	41.00	8.29	9.00
T. M. Welsh	Sunderland.	40.85	41.00	8.69	9.00
A. E. Lawrence & Son.	Ayer	37.08	38-41	12.82	7.5-8
D. L. Marshall Co., Boston.					
Phoenix, ...W. N. Potter & Sons..	Greenfield .	40.80	41.00	9.60	9.00
Phoenix, ...G. B. Brown.....	Ipswich	37.16	41.00	9.56	9.00
Phoenix, ...A. N. Whittemore&Co.	Worcester..	40.14	41.00	10.26	9.00
Roberts=Ruffin Co., Memphis, Tenn.					
Eagle,.....B. W. Brown.....	Concord....	40.63	41.00	9.37	9.00
Tennessee Cotton Oil Co., Jackson,Tenn.					
Tennessee, ...Potter Bros. & Co	N. Adams..	37.99	41 00	7.38	9.00
Tennessee, ...Walker Grain Co.....	N. Adams..	36.77	41.00	10.05	9.00
J. Lindsay Wells Co., Memphis, Tenn.					
Moon,.....Lexington Grain Co...	Lexington ..	38.70	38-41	8.99	9-10
Star,.....A. D. Copeland.....	Brockton. ..	39.97	41-43	10.47	9-10
Star,.....J. H. Nye	Brockton. ..	37.86	41-43	8.67	9-10
Star,.....J. W. Raymond	Concord....	40.18	41-43	9.03	9-10
Star,.....H. K. Webster	Lawrence ..	37.73	41-43	9.67	9-10
Star,.....G. M. Foster.....	Lowell	37.69	41-43	10.22	9-10
Star,.....Hale Knight	Newburyp'rt	36.24	41-43	8.22	9-10
Star,.....C. B. Sawin & Son....	Southboro..	37.55	41-43	9.58	9-10
Star,.....C. B. Sawin & Son....	Southboro..	37.34	41-43	8.85	9-10
Low Grade.					
Florida Cotton Oil Co., Jacksonville, Fla.					
Sea Island,.....W. J. Meek	Fall River..	24.83	25.30	8.32	6.00
Sea Island,.....City Mills.....	Holyoke. ..	22.81	25.30	6.71	6.00
Sea Island,.....Hathaway&Mackenzie	New Bedf'rd	25.80	25.30	7.15	6.00
Sea Island,.....G. P. Rogers.....	Worcester..	24.18	25.30	7.42	6.00
Humphreys, Godwin & Co., Memphis.					
Dixie,.....S. D. Viets & Co.....	Springfield .	33.83	41.00	9.54	9.00
Kaiser & Brown, Memphis, Tenn.					
C. P. Washburn	Middleboro.	20.01	41.00	5.25	9.00
S. L. Davenport.....	N. Grafton .	21.50	41.00	5.50	9.00
S. L. Davenport.....	N. Grafton .	23.96	41.00	6.06	9.00
C.W.&G.W.Nightingale	Quincy	20.44	41.00	4.81	9.00

Manufacturer or Jobber, Brand and Retailer.	Sampled at.	Protein.		Fat.	
		Found.	Guar.	Found.	Guar.
		%	%	%	%
D. L. Marshall Co., Boston.					
Phoenix, ...Mackenzie & Winslow.	Fall River..	35.10	41.00	7.72	9.00
Phoenix, ...J. Cushing & Co.....	Fitchburg ..	34.71	41.00	11.04	9.00
Glenwood,.....G. B. Pope & Co	Waltham. ..	20.71	22.00	4.89	5.00
Southern Cotton Oil Co., Albert Carr	Northboro..	33.92	—	7.79	—
J. Lindsay Wells Co., Memphis, Tenn.					
Star,.....Wallace Lord	Athol	35.97	41-43	8.32	9-10
Star,.....F. F. Woodward & Co	Fitchburg ..	35.97	41-43	8.33	9-10
Star,.....Chandler Gr. &Mill.Co	Lawrence ..	34.97	41-43	8.58	9-10
Star, ...George R. Doane.....	N. Brookf'ld	34.53	41-43	10.29	9-10
Star,.....George R. Doane.....	N. Brookf'ld	35.80	41-43	10.38	9-10
Star,.....Potter Grain Co.....	Shelb'ne Fls	33.79	41-43	8.86	9-10
Star,.....C. B. Sawin & Son....	Southboro..	34.10	41-43	9.62	9-10

Of the 75 samples herein reported, 65 were guaranteed to contain 41 or more per cent protein, and of these 49 or 75 per cent fell below the guarantee. Of this number, 20 were one-half to two per cent below, 12 were two to four per cent below, 9 were four to six per cent below, and the remainder more than six per cent below the guarantee. Three samples put out by Kaiser & Brown, Memphis, Tenn. bore a 41 per cent guarantee and tested 20 to 21.50 per cent of protein. These goods were unquestionably fraudulent. They were handled by the D. L. Marshall Co., who claim that they were utterly deceived as to their character. Of the 18 lots of Star Brand put out by J. Lindsay Wells Co., Memphis, Tenn., guaranteed to contain 41 per cent protein, only three met their guarantees, eight fell one to nearly five per cent below, and seven showed a deficit of five to seven per cent. Replying to a letter addressed to them by this station concerning the poor quality of their product, they stated that under the existing conditions "it was a matter with us to take whatever our mills gave us and be only too glad to get it."

WHO IS TO BLAME?

The heavy rains which so injured the cottonseed were naturally beyond the control of man. Some southern brokers with a high reputation for honorable dealings· frequently found it difficult

to secure meal that fully conformed to the minimum guarantee. Others were *unquestionably lax* and attached a 41 per cent protein guarantee to whatever meal they shipped without any particular regard to its quality. The northern jobbers claim they were deceived and under the conditions prevailing were in a large measure powerless to help themselves; they state that they bargained for 41 per cent meal and supposed they were getting it. That this claim is in a measure true cannot be denied. The writer is convinced, however, that certain parties knew, or soon discovered that the meal they were receiving although guaranteed to be choice or extra prime in quality, was really inferior; they proposed to take their chances, and in case they were found out plead ignorance and bad weather, and if absolutely necessary settle with the local dealer with the least loss to themselves. It would appear that northern jobbers who have dealt largely in cottonseed meal have had a trying season and suffered financially. It is believed, however, that the northern farmer has borne the brunt of the burden, unless he has been alive to the existing conditions. The station has endeavored by all means in its power to keep both the dealer and the consumer informed in this matter.

PRESENT CONDITIONS.

It is to be regretted that the entire business of handling cottonseed meal is not under better control. A few months since a firm of reputable southern jobbers wrote as follows:

"The oil mills are feeling that the ammonia content in C-S meal is the cheapest on the market and as they cannot secure a premium for high grade meal they are adulterating with hulls so as to reduce the ammonia content, and thereby secure something like the proper valuation of their goods. We oppose this attitude, as we think they should make the very best goods possible and in that way make a standing for their goods. We have spoken of ammonia content, but of course, we mean the equivalent in protein and nitrogen."

Cottonseed meal has been one of the most valuable protein concentrates available to the northern dairyman. Its consumption, however, is sure to be curtailed, unless adulteration is checked and a reform in the methods of dealing is speedily brought about. It is assuredly for the interest of the southern merchant to use every

means in his power to see that this most valuable product is unadulterated, that it is properly branded and that it substantially conforms to the guarantee placed upon it.

Northern and southern dealers must get together and arrange a more systematic and just code of business rules relative to the handling of this product.

RULES OF THE INTERSTATE COTTON CRUSHERS' ASSOCIATION FOR SAMPLING COTTONSEED MEAL.

RULE 17. SECTION 1. Samples shall in every case be drawn in the presence of representatives of both seller and buyer at American destination by a reliable party or parties, who shall make affidavit as prescribed by these rules in the "form of claims."*

SEC. 2. If the seller refuses or neglects for 48 hours after notification to appear in person or appoint a representative to draw the samples in the presence of the buyer or his representative for arbitration, then the buyer may appoint any disinterested person to draw such samples.

RULE 20. Two ounces or more from a sack shall constitute a sample of meal and must be drawn so as to fairly represent the entire contents of the bag. Twenty samples from each carload, or 50 sacks from each 100 tons, if not shipped in car lots, shall be sufficient to represent a shipment. Samples of meal if of approximately the same grade and quality need not be kept separate, but may be commingled in which case they must be placed in a metal mailing or sample box and carefully marked, showing the number of samples taken as well as car number and mark.

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*FORM OF CLAIMS. Sec. 6. I, the undersigned, do hereby make affidavit that I have drawn fair and true samples from . . . . . packages of . . . . . being not less than . . . . . per cent of the entire number of packages embraced in a shipment made by . . . . . from . . . . . as evidenced by bill of lading dated . . . . . and issued by . . . . . .

The samples were carefully taken so as to secure a fair representation of the contents of the individual package and a true average of the quality of the entire shipment.

I certify to the correctness of the samples, which are marked as follows: . . . . . and which represents the shipments marked or identified as follows: . . . . . or contained in . . . . . .

Sworn to before me, a notary or justice of the peace of . . . . . county, and state of . . . . . and duly authorized by law to take depositions, this . . . day of . . . . . 190–.

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THE STATION METHOD OF SAMPLING.

This station takes a core sample from 20 different bags in each lot by means of a tube run the entire length of the bag. These samples are carefully mixed and the necessary quantity put into a bottle bearing a label, on which is written all of the obtainable data. It is believed that a sample thus drawn is representative.

THE PROTECTION OF THE LOCAL DEALER.

It naturally is not possible for the station to send its representative to sample goods received by local dealers in all sections of the state. The dealer can, however, when purchasing, notify the jobber that he intends to sample the goods immediately on arrival and have the same tested by the Experiment Station, or other responsible party. He should immediately notify the jobber on the arrival of the car as per Rule 17, Sections 1 and 2, and take the sample as therein specified. Open 20 bags, and if a sampling tube is not available, thoroughly mix the contents of the top of each bag by means of both hands, then take out a handful from each bag and place on a clean newspaper. Mix the 20 handfuls and send preferably in a tin box not less than one-half pound by mail or express to the Station, stating the name and number of the car, date received, of whom purchased, and enclose a guarantee tag. The Station probably will be able to make returns in a few days.

CONCERNING REBATE.

Rule 9, Section 6, of the Cotton Crushers' Association :

"Cotton Seed Meal not coming up to contract grade shall be a good delivery if within one-half of one per cent of the ammonia contents of the grade sold, or the sale sample, but the settlement price shall be reduced at the rate of one tenth of the contract price for each one per cent and proportionately for the fractions, of deficiency in ammonia."

Illustration : If a lot of cottonseed meal is guaranteed to test 41 per cent protein (8 per cent ammonia) and only tests 35.50 per cent (6.9 per cent ammonia) it shows a deficit of 1.1 per cent. If the contract price was $28.00 a ton, $\frac{1}{10}$ of the price would be $2.80 and $\frac{1}{10}$ of that .28, which added to the $2.80 would be $3.08 which is to be deducted from the $28.00 in the form of rebate.

NITROGEN, AMMONIA AND PROTEIN EQUIVALENTS.

One per cent of nitrogen=1.2 per cent ammonia=6.25 per cent protein.

One per cent ammonia=.83 per cent nitrogen=5.2 per cent protein.

One per cent protein=.17 per cent nitrogen=.20 per cent ammonia.

		Percentages.		
Nitrogen.		Ammonia.		Protein,
5.75	=	7.00	=	36.00
5.90	=	7.20	=	37.00
6.10	=	7.40	=	38.00
6.25	=	7.60	=	39.00
6.40	=	7.80	=	40.00
6.56	=	8.00	=	41.00
6.70	=	8.20	=	42.00
6.90	=	8.40	=	43.00

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

CUTWORMS.

BY H. T. FERNALD, PH. D.

The general term "Cutworms" refer to the larvae of the Noctuids or owlet moths, but all Noctuid larvae are not necessarily cutworms. There are two classes of cutworms, those which feed on weeds, vegetables, and flowers, and which are the ones herein treated, and those which feed on the leaves and buds of trees, which are not usually abundant enough in Massachusetts to cause serious injury.

The cutworms attack almost any succulent and juicy plant, such as grass, clover, corn and wheat, garden vegetables and flowering plants.

LIFE HISTORY.

The moths lay their eggs, 200-500 in number, in masses of rank vegetable growth, usually on the stalk, though sometimes on the leaves. This occurs about the last of August or the first of September and about the last of September or the first of October the young caterpillars begin to feed on the plant upon which the eggs were laid. After they have grown to about three-fourths of an inch in length, they go into a dormant state for the winter in the ground and remain there until spring. They then come to the surface and eat whatever plant food they may find until full grown, this being generally between the last of June and the last of July. The following features are possessed by nearly all the species and by these they may be recognized. They are from 1 ¼ to nearly 2 inches in length: have sixteen feet, the three anterior pairs being sharp, the five posterior pairs blunt and stout and armed with minute hooks for clasping; they have the appearance of being stout with an inclination to taper at both ends and they are usually dull-colored, greasy-looking, dingy-brown, gray or greenish, with some light and dark longitudinal lines and sometimes with oblique dashes. The head is large, shiny and usually of a red or reddish brown color. The first ring or collar bears a darker colored, shiny, horny plate as also does the last segment of the body.

When full grown the caterpillars cease feeding and work their way into the soil for a depth of four to six inches, and there form an oval cell by rolling and twisting about until it is smooth and compact and then change to brown, conical pupae.

Usually in August, the moths emerge from these pupae and fly at night feeding upon the nectar of flowers and other sweet exudations from trees or plants.

The life history of this insect is completed about the last of August when the eggs are laid for the new generation.

HABITS.

The presence of cutworms becomes noticeable in a field as soon as the plants are set out or when the seeds have begun to sprout. Plants all through the field will have fallen or will have disappeared. If examined they will be found to have been cut off at the surface or a little below the surface of the ground by the cutworms and this injury continues until the worms are full grown.

ENEMIES.

Because of their large size and hairless bodies these insects are an easy prey to many enemies. The robin is especially effective as it destroys more than any other bird. Poultry, especially chickens destroy many of them and if trained to follow the plow they will do effective work. The beetle larvae known as the cutworm lion and the cutworm dragon, as well as the toad, help much to keep this insect pest in check.

REMEDIES.

There are two kinds of remedies to be applied to this insect; preventive and destructive. Of the former *clean culture* is the most important. As the moths usually deposit their eggs in rank growth, it is advisable where the land is not seeded down to keep it clean and not let it grow up to weeds. Fall plowing will in many cases prove quite beneficial, provided it is done early.

If on preparing a field for planting any crop liable to attack, cutworms are noticed as abundant, complete the preparation of the field, then spray some clover heavily with Paris green, and then cut the clover and scatter it here and there over the field. The cutworms coming up after food will feed on this and be poisoned.

After a crop is in a different treatment is necessary. In such cases prepare a bran mash made of fifty pounds of bran or middlings, one pound of Paris green, enough molasses to sweeten well, and water to make a dough or mash. Place a little of this at the base of each plant in the latter part of the afternoon, and keep fowls away. The cutworms coming up to feed at night will find in this mash a food they prefer because of its sweetness, to the plant stem and will feed on it instead. In this way nearly all of these pests will be destroyed and it is not often necessary to repeat this treatment.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

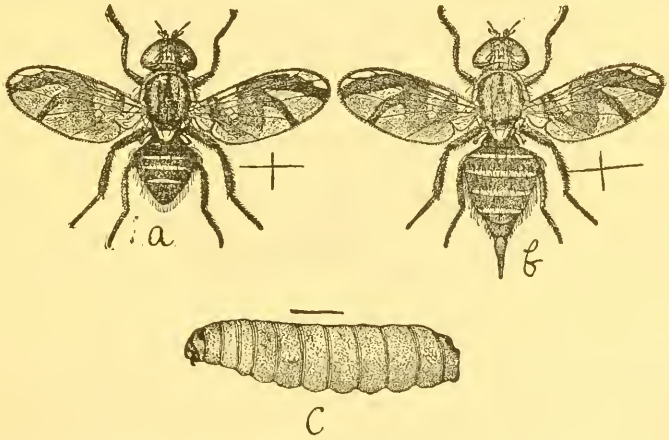
THE APPLE MAGGOT OR RAILROAD WORM

Rhagoletis pomonella (Walsh).

BY C. E. HOOD, B. S.

This insect pest is a native of America and first began to attract attention because of its injury to apples about 1867. It originally fed upon the hawthorn, but unfortunately for fruit-growers has acquired the habit of feeding on the apple though contrary to the original belief, it does not restrict itself to early varieties, but is found on both early and late kinds.

It was first noticed injuring fruit trees in Vermont, Massachusetts and Connecticut. It is now found from Maine to North Carolina and also in some of the western states as Minnesota and Wisconsin.

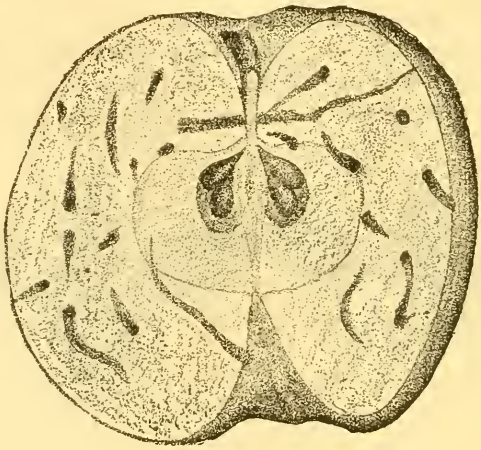


The apple-maggot much enlarged. *a*, adult male fly; *b*, adult female fly; *c*, maggot. Fine lines show the true size of these stages.

The adult of the Apple-maggot is a two-winged fly, somewhat similar to the common house fly, but smaller. It is easily recognized by its general black color, yellowish head and legs, dark feet, three pairs of white bands across the abdomen and four black bands

across the wings. The adult fly appears about the first of July and commences to lay its eggs on all parts of the apple, the cheek however being preferred. As the flies emerge at all times between the first of July and the last of September, the egg laying continues through the same period, and the fruit in which the eggs are laid may be an early or a late variety according to the time of emergence of the fly. Each female lays on the average from 300 to 400 eggs; the fly first puncturing the skin of the apple with her sharp ovipositor, generally on the shady side, as the skin is not apt to be tough upon that side, then in this puncture a single egg is deposited.

The eggs hatch in four or five days and the young greenish white larvae begin their feeding. They burrow in all directions through



Apple showing work of the maggot.

the apple by means of two black curved hooks which are situated just above the mouth. By a vertical motion of the head they rasp the fruit with these hooks and suck up the juices thus liberated. While the larvae are small and the fruit is still growing, the tunnels which they make largely heal, but when they grow larger and the fruit approaches maturity the tunnels turn brown thus showing the presence of the maggot. "Finally they involve the whole fruit rendering it a worthless mass of disgusting corruption held together by the peel."

After the fruit has fallen or been picked the larvae emerge from the apple and if on the ground each generally buries itself an inch or so in the soil and there changes to the pupa stage. When in storage, the larvae come out onto the bottom of the bin or barrel and pass the pupa stage there, though occasionally they may pass this stage in the apple. The pupa does not differ much from the larva except that it is pale yellowish brown in color, and is somewhat shorter, assuming a more oval form. In the pupa stage the winter and following spring are passed and about the first of July the adult flies begin to appear, having undergone the transformation from the larva to the adult in the pupa. The female fly begins to lay her 300 to 400 eggs and when this is done her life work is completed and she dies, thus completing the life history or cycle of this insect.

TREATMENT.

The Apple-Maggot is a difficult insect to destroy. During its whole life cycle it is well protected : the eggs are laid under the skin of the apple ; the larva stage is spent in the inside of the fruit and the pupa stage is passed in the ground. The protection thus afforded renders them free from the attacks of parasites and puts them beyond the reach of poisons applied by spraying.

The only method of combatting the pest is by killing the larvae and pupae. The remedy which is recommended by nearly all entomologists who have written on the subject, is to pick up the windfalls every day or so and either bury them deep or else feed them to stock. This is based on the fact that the maggots do not leave the fruit until it has either fallen or been picked. These maggots if not destroyed at this time enter the ground and appear the next year three hundred fold stronger. Every orchardist should gather the windfalls as a matter of economy as it not only checks this insect but other insects and fungi which live upon the fallen fruit. If neither of these methods is practicable, it is advisable to turn sheep, swine or fowls into the orchard in sufficient numbers to consume all the windfalls. All refuse from barrels, bins and other places where fruit has been kept, has been found to contain pupae in abundance in the spring; therefore, it should be destroyed by burning or burying.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

WIRE WORMS.

BY C. E. HOOD, B. S.

This serious pest of field crops is a long slender grub, yellowish white in color and with an unusually hard body. These wire worms, so called because of their hard bodies are the larvae or younger stages of the click-beetles or snap bugs. There are many species of these, found under varying conditions. Some are not injurious, while others do great damage to the roots of plants and to seeds, and as they work in the ground out of sight it is very difficult to combat them.

The click beetles lay their eggs and from these the larvae or wire worms hatch and commence feeding. They continue in this stage for about two years when they go into the pupa stage, rolling themselves up in a little case of dirt. In three or four weeks they become adult beetles but remain in the ground until spring when they emerge and lay their eggs for another generation.

Three different classes of remedies have been tried on these insects. 1. Protection of the seed. 2. Destruction of the larvae (wireworms). 3. Destruction of pupae and adults.

The first method consists of coating or soaking the seed in various substances as tar, Paris green or kerosene, but the results are not such as to recommend them generally.

The destruction of larvae by clean fallow ; by planting of the so-called immune crops ; and by insecticides has not proven as successful as had been hoped for.

The remedies which seem to be the most effective in the control of this insect, are the destruction of the pupae and adults by fall plowing and by traps.

Much can be done towards checking the increase of wireworms by fall plowing, as it has been found that if the pupa cases of the insects are disturbed the insects in them are almost sure to die. The plowing may be done any time after July 20, for by then all mature wireworms have changed to pupae. After plowing the soil should be well pulverized. If this thorough cultivation be continued for three

or four weeks previous to Sept. 20, wheat, rye or grass may then be sown.

A short rotation of crops in land badly infested with wireworms has been recommended; and the experience of those who have practiced it is, that the soil is rendered comparatively free from these pests.

Trapping by baits such as sliced potatoes, wads of green clover, and corn meal dough have been tried, and it has been found that the best results have been obtained by dipping a small handful of clover into Paris green water, the clover being freshly cut, and placing the bunches under boards in various parts of the field. They should be renewed once or twice a week during early summer.

Considering the small amount of labor involved, and the large number of beetles that are destroyed in this way, many of them before they have laid their eggs, this seems to be about the best method thus far devised. This, however, should be coupled with fall plowing three years in succession if the best results are to be obtained.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

ROOT MAGGOTS.

BY H. T. FERNALD, PH. D.

For many years persons who have tried to grow cabbage, cauliflower, onions, turnips or radishes, have realized that maggots are most formidable enemies to these plants. It has been said that tens of thousands of acres of these vegetables have been ruined in a single season by these pests.

THE CABBAGE ROOT MAGGOT.

Phorbia brassicæ, (Bouchè).

This was considered as a serious pest in the U. S. as early as 1833. It, like its food plants, is probably of European origin, and was probably first introduced into Massachusetts, from which in a little over half a century it has spread practically all over the United States and Canada.

This insect as its name implies feeds upon the cabbage, but it also attacks cauliflower, radishes, turnips and hedge mustard. The presence of the pest where it occurs in considerable numbers is indicated by a checking of the growth of the plant, a tendency to wilt badly in the hot sun and a sickly bluish cast to the leaves.

The adult fly somewhat resembles the common house fly but is smaller. It makes its first appearance in the spring, about the last of April or the first of May and lays its eggs near the stalk of the plant on which the larvae or young maggots are to feed when they hatch.

In from three to five days the eggs hatch and the young commence feeding on the roots of the plant. They continue to feed and grow for about three weeks. At this time they are footless and of a shining white color and the body is cylindrical, blunt at one end and tapering somewhat at the other. When full grown they are about one-third of an inch long, and they then usually work their way into the soil an inch or two and there enter the pupal stage. This stage is spent in the puparium which is elliptical-ovate in form, dark brown in color and consists of the dried outer skin of the maggot.

After remaining in this stage from two to three weeks the adult fly emerges about the middle of June and lays its eggs for another generation of maggots which work in July. Whether there is still another brood of flies in one season has not been definitely worked

out. Most of them pass the winter in the pupa state, although some probably winter as adults.

REMEDIES.

This is a very difficult insect to combat and many methods of treatment both preventative and destructive have been tried with varying results although the former class seems to be the more practical.

Closely encircling the stems of cauliflower or cabbage plants by tar paper collars, which rest upon the ground has proven satisfactory where practicable. These collars are six sided cards of tar paper with a slit reaching to the center, and with a star shaped cut at the center so that the card may accommodate itself to any sized stem and still make a tight joint.

The cards should be placed about the plants at the time of transplanting. Slip the stem to the center of the card, after which spread the card out flat, and press the points formed by the star-shaped cut snugly around the stem. Have the paper lie flat on the ground and do not have any dirt on top of it.

For onions, radishes and turnips, carbolic acid emulsion has proven to be quite effective. It is made by dissolving one pound of hard soap in one gallon of boiling water and then adding one pint of crude carbolic acid and churning immediately with a force pump or syringe until it becomes quite thick and thoroughly emulsified. In treating take one part of this standard emulsion and dilute it with thirty parts of water. Begin treatment early, a day or two after the plants are up, or in case of cabbage and cauliflower the day after they are set out. A knapsack or a wheelbarrow sprayer may be used in applying the emulsion on a large scale.

Cauliflower and cabbage plants whose roots have been dipped in a mixture of white hellebore one part, hot water two parts have made an excellent showing. The mixture should be allowed to cool and the plants emersed deep enough to also coat the lower part of the stems.

THE ONION MAGGOT.

Phorbia ceparum (Meigen).

This insect attacks the onion only, but is as destructive in its sphere as is the cabbage maggot. When attacked, the leaves of the onions become soft and often change to a yellowish color before wilting. The life history of the onion maggot is very similar to that of the cabbage maggot and the carbolic acid emulsion treatment as given above will prove as effective as any.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

THE LECANIUMS, OR SOFT SCALES.

BY C. E. HOOD, B. S.

Scale insects of this group abound everywhere, and are found on almost all kinds of plants, both in hothouses and in the open air. They are known to gardeners under the general name of soft scales. The five most common kinds in this state are the *Apricot scale*, *New York Plum scale*, *Terrapin scale*, *Tulip scale* and the *Hemispherical scale.*

THE APRICOT SCALE.

Eulecanium armeniacum (Craw).

This scale acquired its name because of the ravages it commits among the apricot orchards of California, but in the East it is more prone to attack the plum and grape, although it has been found feeding on the pear, prune, cherry, gooseberry and hackberry.

The adult female scale is yellowish brown and a little over one-eighth of an inch long and later appears to be covered with a powdery or cottony material. The eggs are laid inside the horny skin or shell of the mother and this becomes really a basket for holding the eggs until they hatch in July. After emerging from the egg the young wander about for a few hours and then select places to settle down, usually on the under side of the leaves near the large veins. Here they remain until the latter part of August when they migrate back to the twigs before the leaves fall and remain there for the rest of their lives.

During the winter and early spring they are quite small and not protected by any hard, horny shell, so this is the favorite time for spraying. The leaves having fallen, the surface to be sprayed is at a minimum, and the scales themselves are crowded together as much as they ever will be.

Spraying in winter with kerosene emulsion is a very effective method. To make the emulsion, thoroughly dissolve one-half pound hard soap, or whale-oil soap in one gallon of boiling water. While this solution is still very hot add two gallons of kerosene and quickly begin to churn the whole mass, drawing the liquid into the pump

and forcing it back again into the dish. Continue this for about five minutes or until the whole mass is like a thick cream. It may now be readily diluted with cold water. This standard emulsion if covered and kept in a cool place will keep for a long time. For spraying for this insect, in winter, take one part of the standard emulsion to every four parts of water, and spray *thoroughly* as only the scales which are touched by the spray are killed.

THE NEW YORK PLUM SCALE.

Eulecanium cerasifex (Fitch).

These scales are brown, hemispherical bodies, about one-eighth of an inch in length and with a dark brown, shiny surface, sometimes wrinkled slightly.

During the early summer these scales are soft but by the middle of June they have become hard and are filled with eggs which have been laid by the female insect under her own body. The number of eggs under each scale has been estimated at between one and two thousand. The young hatch in July and crawl to the under side of the leaves, settle down and begin to suck the juices. They remain here until the last of August when they go back onto the twigs. The treatment for the Apricot scale as given above will answer fully as well as any for this insect also, using one part of the standard emulsion to four parts of water. Spray once in the fall before winter closes in and if possible once or twice in March.

THE TERRAPIN OR PEACH SCALE.

Eulecanium nigrofasciatum (Perg).

This scale insect has been found feeding on the peach most extensively, but feeds also on the plum, apple, linden, birch, maple, sycamore and olive. It is somewhat smaller than the preceding Lecaniums and the scales are reddish brown, elevated oval or pyriform. The top of the scale is lighter than the sides. They pass the winter nearly full grown and become adult in the spring. Hatching of the eggs begins about June 10 and continues for nearly a month. The young settle down on the under side of the leaves and suck the juices until the last of August when they return to the twigs and branches for the winter.

The fact that these scales are nearly mature before winter sets in,

renders the treatment a little different from that for the Apricot scale. As the eggs hatch in June and July the best time for fighting them probably will be during the period shortly after they hatch and while the young scales are yet tender. At this time during late June and early July, then a spray, or better, two or three of them at intervals of two weeks, of kerosene emulson, diluted ten times, should be very effective.

THE TULIP SCALE.

Eulecanium tulipiferæ (Cook).

This scale is quite common on wild and cultivated tulip trees throughout the state. It is the largest of all the soft scales, often reaching a diameter of one-third of an inch. It also attacks the linden, lime, magnolia and clover.

The scale as it appears in summer is soft and somewhat hemispherical, gray in color, slimy and repulsive. The female continues to grow until late in August. Early in September it becomes mature, and the young begin to appear. These little black creatures begin feeding at once and make some growth before winter sets in.

The best time to deal with this insect is in September when the young are settling. If only a single twig or branch is infested, the best way is to cut it off and burn it. Spraying thoroughly about the middle of September with kerosene emulsion one part, water five parts will kill all the larvae it reaches and this is perhaps the most effective method. Strong whale-oil soap suds may be used during the winter effectively. It must not be made weaker than one pound to one gallon of water and the application should be thorough.

THE HEMISPHERICAL SCALE.

Saissetia hemisphærica (Targ).

This is a very common scale found in greenhouses and dwellings. Its food plants are many, among which may be named ferns, palms, orchids, peach and orange trees. It is hemispherical in shape being about one-eighth of an inch in diameter and one-twelfth of an inch in height. The color varies from light brown when young to dark brown when old. These insects are found both on leaves and stems, and it probably breeds continuously throughout the year. Kerosene emulsion or soap and water can be used as sprays and greenhouses can be fumigated with hydrocyanic acid gas to destroy this insect.

CIRCULAR NO. 7. JULY, 1907

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

ANTS.

BY C. E. HOOD, B. S.

These little creatures are found in various localities and under various conditions, but those with which we are most familiar are the little red house ant and those occuring in lawns.

THE LITTLE RED ANT.

Monomorium pharaonis (Linn.)

These are the ants we find in food, in dishes and in many other places around the house. It is not so much the loss caused by their devouring food but their getting into everything, which is objectionable. They are attracted to sweets, greases, dead insects and many other things. They form their nests in any secluded spot either in or just outside of the house. This species is also common in fields and gardens where it sometimes does much injury to corn by gnawing the blades when but a few inches high for the purpose of drinking the sweet exuding juice. Though a nuisance this ant has one redeeming habit in that it is an efficient enemy of the bedbug.

Each nest of these insects contains several females laying hundreds of eggs each and attended by workers whose duty is to care for the eggs and larvae and also to provide the females with food. The females are rarely met with by the ordinary observer and the same is true of the males. The wingless workers are by far the most numerous and are the ones we commonly see infestlng foods of all kinds.

REMEDIES.

If the ants can be traced to their nest they may be killed by making a few holes about a foot apart with a stick and pouring into each, a tablespoonful of bisulphide of carbon, then immediately covering the holes with dirt.

If the nest is located in a wall where the bisulphide of carbon cannot be used, the location of the nest might be soaked with kerosene emulsion. If thoroughly done it would probably kill all the insects.

If the nest is in the wall of the house or cannot be found, various baits may be used effectively. It is stated that maple syrup mixed with London purple in a low dish and exposed to the ants, not only killed large numbers but prevented the recurrence of the pest for a long time afterward. An old and popular remedy is dipping a sponge in sweetened water and placing it where the ants are, and when the ants have collected in the sponge it may be dropped into hot water. A greasy bone may be used in a similar manner. A few repetitions of any of these baits is generally sufficient, for the ants seem to communicate the intelligence of danger or disaster one to another and they all seek safer quarters. A broad chalk line is an effectual barrier for many species, especially if frequently renewed. Placing the legs of tables in shallow vessels containing water is another protection from this pest, and a ring of powdered cloves around an article it is desired to protect is generally effective.

ANTS IN LAWNS.

In case of ants in lawns the first essential is to find the nests, which can be easily detected by the scant herbage and the excavated dirt, or if more obscure it can be discovered by following the travelling ants to their home. When the nest is found take a cane or broom handle and make a hole in the nest or if large make two or three holes to the depth of the nest and pour in each a tablespoonful of bisulphide of carbon, immediately covering the hole with dirt. The volatile vapor will permeate through the nests and kill the insects.

If nests of no large colonies can be found, but it seems that the lawn is generally infested, take kerosene emulsion on a bright sunny day when the ants seem to be out in full force and spray the entire surface. A repetition of this a few times should rid the lawn of this pest.

CIRCULAR NO. 8. JULY, 1907.

BULLETINS

OF THE

Agricultural Experiment Stations

OF

MASSACHUSETTS.

1883-1907.

AMHERST, MASSACHUSETTS
1907

LIST OF BULLETINS.

* Bulletins marked with an asterisk can no longer be sent on general application. Of many of these, a few copies remain, which will be furnished to complete sets in public and institutional libraries.

† The publications so marked and designated "Fertilizer Bulletins" in most cases include only analyses and trade values.

The Station publishes Annual Reports, of which all issues subsequent to the Ninth are still available for general distribution.

BULLETINS OF THE MASS. STATE EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHORS.	No. Pages
*1	July, 1883	Fodder Analyses, ...	C. A. Goessmann.	15
*2	Aug., 1883	Fertilizer Analyses, ...	C. A. Goessmann.	8
3	Sept., 1883	Fodder Analyses. Fertilizer Analyses,	C. A. Goessmann.	12
*4	Oct., 1883	Fodder Analyses. Fertilizer Analyses,	C. A. Goessmann.	12
*5	Nov., 1883	Fodder Analyses. Fertilizer Analyses,	C. A. Goessmann.	12
*6	Dec., 1883	Fodder Analyses. Fertilizer Analyses,	C. A. Goessmann.	12
*7	March, 1884	Insects Injurious to the Apple. Special Fertilizers in Fruit Culture. Experiments with Currants. Garden Crops. Fertilizer Analyses, ...	S. T. Maynard and C. A. Goessmann.	12
*8	April, 1884	Fodder and Fodder Analyses. Valuation of Fertilizers, ...	C. A. Goessmann.	12
*9	May, 1884	Insects Injurious to Farm and Garden Crops. Fodder and Fodder Analyses. Fertilizer Analyses, ...	S. T. Maynard and C. A. Goessmann.	12
*10	June, 1884	Vitality of the Seed of Various Weeds. and the Causes of Certain Diseases of Grasses. Corn Ensilage. Fodder and Fodder Analyses. Fertilizer Analyses,	S. T. Maynard and C. A. Goessmann.	12
*11	Sept, 1884	Corn Ensilage. Fodder Analyses. Fertilizer Analyses, ...	C. A. Goessmann.	12
*12	Oct., 1884	Gluten Meal for Milch Cows. Fodder Analyses, ...	C. A. Goessmann.	12

BULLETINS OF THE MASS. STATE EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages.
*13	Nov., 1884	Feeding Experiments with Pigs. Fertilizer Analyses, ...	C. A. Goessmann.	12
*14	March, 1885	Fodder Analyses. Valuation of Fertilizers, ...	C. A. Goessmann.	12
*15	April, 1885	Meteorological Summary for two Months. Feeding Experiments with Milch Cows. Fodder Analyses. Fertilizer Analyses, ...	C. A. Goessmann.	12
*16	July, 1885	Meteorogical Summary. Fodder Analyses. Analyses of Garden Crops. Fertilizer Analyses, ...	C. A. Goessmann.	12
*17	Aug., 1885	Meteorogical Summary. Fodder Analyses. Analyses of Fruits. Analyses of Weeds. Fertilizer Analyses, . .	C. A. Goessmann.	12
*18	Oct., 1885	Meteorological Summary. Feeding Experiments with Pigs. Fodder Analyses. Fertilizer Analyses, . . .	C. A. Goessmann.	20
*19	April, 1886	Valuation of Fertilizers and Analyses of Fertilizers, ...	C. A. Goessmann.	12
*20	May, 1886	Meteorological Summary. Fodder Analyses. Fertilizer Analyses, . .	C. A. Goessmann.	12
*21	June, 1886	Meteorological Summary. Fodder. Fertilizers, ...	C. A. Goessmann.	12
*22	Oct., 1886	Meteorological Summary. Feeding Experiments with Milch Cows. Fodder Analyses, ...	C. A. Goessmann.	12
*23	March, 1887	Meteorological Summary. Trade Values of Fertilizers. Fodder Analyses,	C. A. Goessmann.	12
*24	April, 1887	Meteorological Summary. Planting Trees and Small Fruits. Fodder Analyses. Fertilizer Analyses, . .	S. T. Maynard.	12
*25	July, 1887	Meterological Summary. Feeding Experiments with Pigs, ...	C. A. Goessmann.	16
*26	Aug., 1887	Meteorological Summary. Fodder Analyses. Fertilizer Analyses, . .	C. A. Goessmann.	12

BULLETINS OF THE MASS. STATE EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages
*27	Oct., 1887	Meteorogical Summary. Feeding Experiments with Milch Cows, . .	C. A. Goessmann.	16
*28	March, 1888	Meteorological Summary. Trade Value of Fertilizers. Fertilizer Analyses. Fodder Analyses, . . .	C. A. Goessmann.	12
29	June, 1888	Meteorological Summary. Fodder Analyses, ...	C. A. Goessmann.	12
*30	Aug., 1888	Meteorological Summary. Feeding Experiments with Pigs, . . .	C. A. Goessmann.	16
31	Oct., 1888	Meteorological Summary. Commercial Fertilizers, ...	C. A. Goessmann.	16
32	Feb., 1889	Meteorological Summary. Record of Twelve Cows. Fodder Analyses, .	C. A. Goessmann.	12
33	March, 1889	Commercial Fertilizers, . . .	C. A. Goessmann.	12
34	June, 1889	Meteorological Summary. Outlines of the Work during the present Season. Fertilizer Analyses, ...	J. E. Humphrey and C. A. Goessmann.	16
35	Nov., 1889	Meteorological Summary. Feeding Experiments with Milch Cows, . .	C. A. Goessmann.	12
36	March, 1890	Meteorological Summary. Productiveness of our Farm Lands. Fodder Analyses. Fertilizer Analyses, . .	C. A. Goessmann.	16
37	July, 1890	Meteorological Summary. Feeding Experiments with Lambs. Fodder Analyses. Fertilizer Analyses, . .	C. A. Goessmann.	16
38	Sept., 1890	Feeding Experiments with Milch Cows. Fertilizer Analyses, ...	C. A. Goessmann.	12
	March, 1891	Circular on Commercial Fertilizers, .	C. A. Goessmann.	8
39	April, 1891	Meteorological Summary. Treatment of Fungous Diseases, ...	J. E. Humphrey.	12
40	July, 1891	Meteorological Summary. Diseases of Lettuce and Cucumbers. Fertilizer Analyses. Feeding Experiments with Steers, . , ...	J. E. Humphrey and C. A. Goessmann.	16
41	Sept., 1891	Meteorogical Summary. Fertilizers. Experiments with Milch Cows, . .	C. A. Goessmann.	16

BULLETINS OF THE MASS. STATE EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages.
42	June, 1892	Feeding Experiments with Milch Cows. Fodder Analyses, ...	C. A. Goessmann.	16
43	Aug., 1892	Meteorological Summary. Feeding Experiments with Lambs. Fertilizer Analyses, ...	C. A. Goessmann.	12
44	Oct., 1892	Meteorological Summary. Feeding Experiments with Steers, . . .	C. A. Goessmann.	16
45	Nov., 1892	On Fodder Articles and Fodder Supplies, ...	C. A. Goessmann.	15
*46	March, 1893	Fertilizer Bulletin, ...	C. A. Goessmann.	14
47	May, 1893	Meteorological Summary. Feeding Experiments with Pigs. Fodder Analyses, ...	J. B. Lindsey and C. A. Goessmann.	16
48	June, 1893	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
*49	Aug., 1893	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
*50	Oct., 1893	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
51	March, 1894	Commercial Fertilizers. Fodder Analyses, ...	C. A. Goessmann.	8
52	June, 1894	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
*53	July, 1894	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
54	Aug., 1894	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
55	Oct., 1894	Meteorological Summary. Fertilizer Analyses, ...	C. A. Goessmann.	8
*56	Nov., 1894	Meteorological Summary. Fertilizer Analyses. Analyses of Fodder Articles,	C. A. Goessmann.	8
57	March, 1895	Meteorological Summary. Human Food Articles. Analyses of Fodder Articles. Fertilizer Analyses, . .	C. A. Goessmann.	8

BULLETINS OF THE HATCH EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages
*1	July, 1888	Reports of the Entomologist, Horticulturist and Meteorologist, . . .	C. H. Fernald, S. T. Maynard and C. D. Warner.	16
*2	Oct., 1888	Reports of the Entomologist and Horticulturist, ...	C. H. Fernald and S. T. Maynard.	35
*3	Jan., 1889	Tuberculosis, ...	C. H. Fernald.	20
*4	April, 1889	Report of Horticulturist. Greenhouse Construction and Heating. Greenhouse Pests and Plant Diseases. . . .	S. T. Maynard.	22
*5	July, 1889	Household Pests, ...	C. H. Fernald.	10
*6	Oct., 1889	Greenhouse Heating, steam vs. hot water. Strawberries. Fungous Diseases of Plants, ...	S. T. Maynard and J. E. Humphrey.	19
*7	Jan., 1890	Small Fruits. Vegetables. General Results of a Trial of a few Japanese Crops. The Gypsy Moth, . . .	S. T. Maynard, W. P. Brooks and C. H. Fernald.	23
*8	April, 1890	Greenhouse Heating, steam vs. hot water. Peach Yellows. How far may a Cow be Tuberculous before her Milk Becomes Dangerous as an Article of Food, ...	S. T. Maynard and H. C. Ernst.	24
*9	May, 1890	Soil Tests with Fertilizers, . . .	W. P. Brooks.	47
*10	Oct., 1890	Special Fertilizers for Greenhouse Crops. Small Fruits, ...	S. T. Maynard.	14
*11	Jan., 1891	Strength of Rennet. Hay Crops. Flandres Oats. Prevention of Potato Rot. Fungicides and Insecticides on Fruits, ...	W. P. Brooks and S. T. Maynard.	22
*12	April, 1891	Report on Insects, ...	C. H. Fernald.	32
*13	April, 1891	Directions for the Use of Fungicides and Insecticides, ...	S. T. Maynard.	12
*14	May, 1891	Fertilizers for Corn, ...	W. P. Brooks.	62
*15	Oct., 1891	Experiments in Greenhouse Heating. Special Fertilizers for Plants under Glass. Varieties of Strawberries, Blackberries and Raspberries, . .	S. T. Maynard.	16

BULLETINS OF THE HATCH EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages.
*16	Jan., 1892	A Brief Summary of Results in Electro Culture, ...	C. D. Warner.	8
*17	April, 1892	Experiments with Fungicides and Insecticides, ...	S. T. Maynard.	47
*18	April, 1892	Soil Tests with Fertilizers, . . .	W. P. Brooks.	104
*19	May, 1892	Report on Insects, ...	C. H. Fernald.	40
*20	Jan., 1893	Report on Insects, ...	C. H. Fernald.	16
*21	April, 1893	Report on Fruits, ...	S. T. Maynard.	23
*22	Oct., 1893	Report on Fruits, ...	S. T. Maynard.	15
*23	Dec., 1893	Electro-culture, ...	C. D. Warner.	15
*24	April, 1894	Insecticides. The Horn Fly, . .	C. H. Fernald.	15
*25	April, 1894	Fungicides and Insecticides. Tests of Grapes, ...	S. T. Maynard.	18
*26	Oct., 1894	Strawberries, Blackberries, Raspberries,	S. T. Maynard.	13
*27	Dec., 1894	History of Tuberculosis in College Herd. Use of Tuberculin in Diagnosis.	J. B. Paige.	42
*28	April, 1895	Report on Insects, ...	C. P. Lounsbury.	30
*29	May, 1895	Fungicides, Insecticides, Spraying Calendar, ...	S. T. Maynard.	11
*30	June, 1895	Commercial Fertilizers, . . .	C. A. Goessmann.	8
*31	July, 1895	Commercial Fertilizers, . . .	C. A. Goessmann.	8
*32	Aug., 1895	Commercial Fertilizers, . . .	C. A. Goessmann.	8
33	Oct., 1895	Glossary of Fodder Terms, . . .	E. B. Holland.	8
34	Oct., 1895	Analyses of Manurial Substances sent on for Examination, and Licensed Fertilizers, ...	C. A. Goessmann.	8
*35	Dec., 1895	The Agricultural Value of Bone Meal.	Chas. Wellington.	24
*36	Feb., 1896	The Imported Elm-leaf Beetle and other Insect Pests, ...	R. A. Cooley.	20

BULLETINS OF THE HATCH EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages.
*37	March, 1896	Report on Fruits, Insecticides, Fungicides, ...	S. T. Maynard and J. H. Putnam.	40
*38	March, 1896	General Discussion on Commercial Fertilizers. Observations regarding the Composition of Paris Green, .	C. A. Goessmann.	16
*39	April, 1896	Economic Feeding of Milch Cows, .	J. B. Lindsey.	23
*40	July, 1896	Analyses of Manurial Substances and Licensed Fertilizers, ...	C. A. Goessmann.	20
41	Aug., 1896	On the Use of Tuberculin, . . .	D. B. Bang.	27
*42	Oct., 1896	Fertilizer Bulletin,†	C. A. Goessmann.	31
*43	Jan., 1897	Electro-Germination, ...	Asa S. Kinney.	32
*44	March, 1897	Variety Tests of Fruits. Tests of Vegetable Seeds, ...	S. T. Maynard, J. H. Putnam and S. W. Fletcher.	48
*45	March, 1897	Fertilizer Bulletin,†	C. A. Goessmann.	16
*46	April, 1897	The Habits, Food and Economic Value of the American Toad, . . .	A. H. Kirkland.	30
*47	April, 1897	On Field Experiments with Tobacco in Massachusetts, ...	C. A. Goessmann.	31
*48	July, 1897	Fertilizer Bulletin.†	C. A. Goessmann.	24
*49	Nov., 1897	Fertilizer Bulletin,†	C. A. Goessmann.	24
*50	Jan., 1898	The Feeding Value of Salt Marsh Hay,	J. B. Lindsey and B. K. Jones.	48
*51	Feb., 1898	Fertilizer Bulletin,†	C. A. Goessmann.	12
*52	March, 1898	Variety Tests of Fruits. Spraying Calendar, ...	S. T. Maynard.	19
*53	April, 1898	Concentrated Feed Stuffs, . . .	J. B. Lindsey.	24
*54	July, 1898	Fertilizer Bulletin,†	C. A. Goessmann.	24
*55	Nov., 1898	Nematode Worms, ...	G. E. Stone and R. E. Smith.	68
*56	Nov., 1898	Concentrated Feed Stuffs, . . .	J. B. Lindsey.	24
*57	Nov., 1898	Fertilizer Bulletin,†	C. A. Goessmann.	24

BULLETINS OF THE HATCH EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages.
*58	March, 1899	Manurial Requirements of Crops,	W. P. Brooks.	16
*59	March, 1899	Fertilizer Bulletin,†	C. A. Goessmann.	14
*60	April, 1899	Insecticides. Fungicides. Spraying Calendar,	S. T. Maynard.	11
*61	April. 1899	The Asparagus Rust in Massachusetts,	G. E. Stone and R. E. Smith.	20
*62	July, 1899	Fertilizer Bulletin,†	C. A. Goessmann.	20
*63	Nov., 1899	Fertilizer Bulletin,†	C. A. Goessmann.	26
64	Feb., 1900	Concentrated Feed Stuffs,	J B. Lindsey.	32
*65	March, 1900	Fertilizer Bulletin,†	C. A. Goessmann.	14
*66	March, 1900	Variety Tests of Fruits,	S. T. Maynard.	19
*67	May, 1900	The Grass Thrips. Treatment for Thrips in Greenhouses,	H. T. Fernald and W. E. Hinds.	15
68	July, 1900	Fertilizer Bulletin,†	C. A. Goessmann.	28
*69	Sept., 1900	The Rotting of Greenhouse Lettuce,	G. E. Stone and R. E. Smith.	40
*70	Nov., 1900	Fertilizer Bulletin,†	C. A. Goessmann.	26
*71	Jan., 1901	Concentrated Feed Stuffs. Condimental Stock and Poultry Foods,	J. B. Lindsey.	40
*72	March, 1901	Summer Forage Crops,	J. B. Lindsey.	16
*73	March. 1901	Orchard Experiments,	S. T. Maynard and G. A. Drew.	15
*74	March, 1901	Fertilizer Bulletin,†	C. A. Goessmann.	16
*75	July, 1901	Fertilizer Bulletin,†	C. A. Goessmann.	24
76	July, 1901	The Imported Elm-leaf Beetle,	H. T. Fernald.	8
*77	Nov., 1901	Fertilizer Bulletin,†	C. A. Goessmann.	30
*78	Jan., 1902	Concentrated Feed Stuffs,	J. B. Lindsey.	40
*79	Feb., 1902	Growing China Asters,	R. E. Smith.	26
*80	March, 1902	Fungicides. Insecticides. Spraying Calendar,	G. E. Stone, H. T. Fernald and S. T. Maynard.	15

BULLETINS OF THE HATCH EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages
81	March, 1902	Fertilizer Bulletin,†	C. A. Goessmann.	20
*82	April, 1902	Orchard Management, . . .	S. T. Maynard and G. A. Drew.	24
83	July, 1902	Fertilizer Bulletin,†	C. A. Goessmann.	24
84	Nov., 1902	Fertilizer Bulletin,†	C. A. Goessmann.	30
*85	Jan., 1903	Concentrated Feeds, ...	J. B. Lindsey.	32
*86	Feb., 1903	Orchard Treatment for the San José Scale, ...	H. T. Fernald.	16
*87	Feb., 1903	Cucumbers under Glass, . . .	G. E. Stone.	44
*88	1903	Coccidae of the World, . . .	Mrs. M. E. Fernald.	360
89	March, 1903	Fertilizer Bulletin,†	C. A. Goessmann.	15
90	July, 1903	Fertilizer Bulletin,†	C. A. Goessmann.	30
*91	Aug.. 1903	Injuries to Shade Trees from Electricity	G. E. Stone.	21
92	Nov., 1903	Fertilizer Bulletin,†	C. A. Goessmann.	36
*93	Dec., 1903	Concentrated Feeds, ...	J. B. Lindsey.	52
*94	March, 1904	Distillery and Brewery By-products, .	J. B. Lindsey.	28
*95	March, 1904	Fertilizer Bulletin,†	C. A. Goessmann.	18
*96	May, 1904	Fungicides. Insecticides. Spraying Calendar, ...	G. E. Stone, H. T. Fernald and F. A. Waugh.	16
97	May, 1904	A Farm Woodlot, ...	F. A. Waugh.	20
98	July, 1904	Inspection of Concentrates, . . .	J. B. Lindsey.	36
99	July, 1904	Dried Molasses-Beet-Pulp. The Nutrition of Horses, ...	J. B. Lindsey.	16
100	July, 1904	Fertilizer Bulletin,†	C. A. Goessmann.	30
*101	Dec., 1904	Inspection of Concentrates, . .	J. B. Lindsey.	40
102	Dec., 1904	Fertilizer Bulletin,†	C. A. Goessmann.	40
103	March, 1905	Fertilizer Bulletin,†	C. A. Goessmann.	20
104	July, 1905	Fertilizer Bulletin,†	C. A. Goessmann.	28

BULLETINS OF THE HATCH EXPERIMENT STATION.

No,	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages
105	Aug., 1905	Tomatoes under Glass, . . .	G. E. Stone.	40
*106	Sept., 1905	Condimental Stock and Poultry Foods,	J. B. Lindsey.	24
107	Dec., 1905	Fertilizer Bulletin,† - . . .	C. A. Goessmann.	42
*108	Jan., 1906	Inspection of Concentrates, . .	J. B. Lindsey.	52
109	March, 1906	Fertilizer Bulletin,†	C. A. Goessmann.	23
*110	June, 1906	Market Milk, ...	J. B. Lindsey and P. H. Smith.	48
*111	July, 1906	Fertilizer Bulletin,†	C. A. Goessmann.	28
*112	Jan., 1907	The Examination of Cattle and Poultry Foods, ...	J. B. Lindsey.	60
113	Jan., 1907	Fertilizer Bulletin,†	C. A. Goessmann.	30
114	Jan., 1907	The Oriental Moth a Recent Importation, ...	H. T. Fernald.	14

BULLETINS OF THE MASS. AGRICULTURAL EXPERIMENT STATION.

115	Feb., 1907	Cranberry Insects, ...	H. J. Franklin.	15
116	March, 1907	The San José Scale, ...	H. T. Fernald.	22
117	March, 1907	Fertilizer and Soil Analyses and Trade Values, ...	C. A. Goessman and H. D. Haskins.	22

SPECIAL BULLETINS OF THE HATCH EXPERIMENT STATION.

No.	Date of Publication.	SUBJECTS.	AUTHOR.	No. Pages.
*	Nov., 1889	The Gypsy Moth, ...	C. H. Fernald.	8
*	May, 1890	On the Most Profitable Use of Commercial Fertilizers, ...	‡Chas. Wellington.	44
	Jan., 1894	Green Manuring, ...	E. W. Allen.	15
*	July, 1897	The Brown-tail Moth, ...	C. H. Fernald and A. H. Kirkland.	13
	Aug., 1899	The Coccid Genera Chionaspis and Hemichionaspis, ...	R. A. Cooley.	58
*	July, 1903	The Dairy Law and its Results, . .	J. B. Lindsey.	14
	1905	Index Number—Mass. State Agricultural Experiment Station, Vols. 1–12, 1883–1894, ...		44
	1895	Index of Publications of the Hatch Experiment Station, 1888–1895, . .		29
	1907	Complete Index of Publications of the Hatch Experiment Station, . .		48

TECHNICAL BULLETINS.

*1	Aug., 1903	The Greenhouse and Strawberry Aleyrodes, ...	A. W. Morrill.	66
2	Oct., 1904	The Graft Union, ...	F. A. Waugh.	16
3	April, 1907	The Blossom End Rot of Tomatoes, .	Elizabeth H. Smith.	19

‡ Translated from the German.

CIRCULAR No. 9. SEPTEMBER 1907.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

RULES RELATIVE TO TESTING DAIRY COWS.

GENERAL REQUIREMENTS.

The Massachusetts Agricultural Experiment Station working in conjunction with the various "breed" associations will conduct, when possible, official tests of pure bred cows on the following conditions:

1. Two weeks notice of a desired test must be given the Station. All necessary costs in connection with a test, including time at $2.00 to $2.50 a day, traveling expenses, breakage, affidavits, supervision and clerical work, shall be paid for immediately upon receipt of statement, as the Station has no funds to advance for this work.

2. The owner of the stock must care for the supervisor during the test and when necessary convey him to and from the railroad station or car line.

3. Only cows which are entered in the herdbook of the breed to which they belong are eligible to advanced registry.

4. There must be an interval of at least six days* between calving and the commencement of an official test.

DUTIES OF THE SUPERVISOR.

1. The supervisor shall not be held responsible for the identity of any cow tested, but shall accept the statement of the owner or his representative as to her name and registration number. The supervisor, however, shall state whether the cow answers her registered description, if the same has been furnished him; otherwise he will

*The A. G. C. C. requires an interval of fourteen days and the Holstein-Frisian Association an interval of four days before a seven day test can be started.

include in his report a brief description or sketch of each new animal tested.

2. The supervisor shall see the cow milked dry at the regular milking prior to beginning the test,* shall verify the fact with his own hands and note the time of the same. The last milking must occur at the same hour, one or more days later according to the length of the test.

3. The number of cows to which an inspector is limited shall be dependent upon the amount of work required and the facilities at hand. He shall not exceed five cows when milked four times daily, without special permission from the station. He shall allow only one of the cows entered to be milked at a time and shall personally oversee the entire milking.

4. A cow must be milked out at a single sitting. In no case will it be allowable to go back and strip her a second time.

5. The supervisor shall weigh the milk and verify the weight of the pail. He must thoroughly mix the milk previous to taking the necessary sample and retain the same under absolute control until tested.

6. Disturbing conditions such as sickness, being in heat, change of milker, etc., must always be entered on the report, also the weight of scattered milkings during the month when required. The supervisor must also record date of the cow's birth, when last calf was dropped, when the cow was served, and if a yearly test when begun, together with a statement of kind and amount of feed, both grain and roughage, and method of feeding, also the use of condiments, condition powders, or drugs of any kind.

7. Any tampering with a cow under test or with the samples by the owner or an employee, or refusal to comply with the rules must be reported at once to the station by telephone. Lack of proper apparatus or facilities for doing satisfactory work should also be reported.

8. As soon as possible after the completion of the test, the supervisor shall bring or send to the station, on blanks furnished by the

*The Secretary of the A. G. C. C., William H. Caldwell, writes under date of March 16, 1904, "We have not considered it necessary for the inspector to be present at the previous milking in case of the yearly tests as he can tell from the records whether the animal is giving normal amount or not."

cattle clubs, a detailed report over his signature and affidavit. This record after being verified, endorsed and copied will be forwarded to the club. The station, however, reserves the right of using the data if deemed advisable. The supervisor shall submit an itemized statement of time and expenses at each place, also breakage and number of records sent in.

9. In case of long tests, supervisors will be changed every thirty days if deemed advisable.

THE TESTING OF SAMPLES.

1. Each sample* must be tested in duplicate by the Babcock test; the separations must be clean (free from curd and charred material); and no variations in excess of 0.10 per cent. shall be allowed.

2. In a seven day test when any of the milk or a test sample is accidentally lost, the average of the corresponding milkings during the other six days shall be substituted for the missing weight or test, but such results must always be reported as estimations.

3. With all tests of a week or more duration, a seven day composite sample shall be taken, when required, by means of a sampling pipette (1 c. c. for every pound), preserved with bichromate of potash and forwarded in a full bottle to the station by prepaid express. Accompanying the sample shall be a statement of the total amount of milk and of fat produced during the seven days represented by the composite. Results by the station's test and by the inspector's data ought not to vary more than 0.15 per cent.

ADDITIONAL RULES WITH THE CHURN TEST.†

1. In case the churn test is employed in addition to the Babcock, milk samples *of the same amount* must always be taken so that the loss of fat in the samples can readily be calculated from the total weight of the samples and the average percentage of fat.

2. The skim milk should be weighed daily, carefully mixed and a composite taken by means of a sampling pipette.

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*In case of the Guernsey yearly tests it is only necessary to test a composite of the days milking which must be taken by means of a sampling pipette.

†Confirmed Butter.Test. A. J. C. C.

3. The butter milk should be weighed, sampled, and if more than one churning, a composite taken by means of a sampling pipette.

4. The skim milk and butter milk should be tested in duplicate by the Babcock test and no variation in excess of 0.02 per cent allowed.

5. The finished butter should be weighed and sampled immediately by slicing the entire lump (not prints) by means of a thin case knife or spatula, and by taking small pieces (size of a walnut) from various parts of the different slices. Great care should be exercised to prevent loss of water. The sample, amounting to about one half a pound, should be shipped to the station in a sealed Lightning fruit jar by prepaid express.

SPECIAL RULES.

1. The Ayrshire and Holstein-Friesian Associations rule that a yearly test shall not exceed 365 days and in one lactation period only. The Guernsey Club insists upon 365 consecutive days.

2. The Ayrshire Association and the Guernsey Club estimate butter by increasing the amount of butter fat by $\frac{1}{6}$; the Jersey Club by $\frac{3}{17}$, (or divide the butter fat by .85); the Holstein-Friesian breeders usually add $\frac{1}{4}$.

3. The Ayrshire Association reinburses the station for analytical work and semi-yearly inspections, and the breeders pay the express charges on all samples sent to the station as well as the entire cost of seven day tests.

4. The entire cost of seven day and yearly tests under the Guernsey Club is met by the owners of the cows tested.

5. The Jersey Club pays one-half the cost for time, traveling expenses and affidavits on seven day and yearly tests and the owners reinburse the club for the remainder including breakage, supervision and clerical work.

6. Under the rules of the Holstein-Friesian Association, the owners pay the station direct for all expenses of the test and also the cost of any ordered retest that does not corroborate the previous one.

YIELD OF MILK AND BUTTER FAT REQUIRED FOR ADVANCED REGISTRY.

	7 Days.		365 Days	
	Milk.	Fat.	Milk.	Fat.
Ayrshire.	lbs.	lbs.	lbs.	lbs.
2 years old at commencement of test,	200.0	8.0*	5,500.0	225.0*
3 years old " " " "	250.0	10.0*	6,500.0	375 0*
4 years old " " " "	300.0	12.0*	7,500.0	325.0*
5 years old " " " "	350.0	14.0*	8,500.0	375.0*
Daily increase required.	.137	.0055	2.74	.137
Guernsey.				
2 years old at commencement of test,		10.0	6,000.0	250.5
3 years old " " " "		11.7	7,333.3	287.0
4 years old " " " "		13.3	8,666.7	323.5
5 years old " " " "		15.0	10,000.0	360.0
Daily increase required.		.00456	3.65	.1
Holstein-Friesian.				
2 years old at calving,		7.2		
3 years old " "		8.8		
4 years old " "		10.4		
5 years old " "		12.0		
Daily increase required.		.00439		
Jersey.				
Under 2½ years old at commencement of test,		12.0	6,000.0†	260.0
2½ to 4 years old " " " "			8,000.0	300.0
4 to 5 years old " " " "			9,000.0	350.0
5 years old " " " "			10,000.0	400.0

Confirmed Butter Tests: 14 pounds of actual butter testing at least 80 per cent. fat for 7 days and 500 pounds for 365.

APPARATUS REQUIRED AND FURNISHED.

The owner of each herd desiring tests must provide a satisfactory Babcock machine, the necessary acid and hot water.

The inspector will be furnished the following supplies:

Spring balance,	1
Sampling pipettes,	2
Sample bottles,	12
Milk pipettes, 17.6 c. c.,	3
Milk test bottles, 10%,	12
Acid measures, 17.5 c. c.,	2

*These figures represent butter and were obtained by adding one-sixth to the butter fat.
†1100 pounds for 30 days.

Dividers,	1 pair
Bottle brush,	1
Crayon,	1
Wire sieve,	1
Speed indicator,	1
Stick tags,	1 box
Preservative,	
Report blanks,	
Record book and stationery.	

CHURN TEST.*

Skim milk bottles, (.01% graduations),	6
Steel spatula,	1
Sealing wax and seal.	1

*Confirmed Butter Test. A J. C. C.

SECRETARIES OF BREEDERS ASSOCIATIONS.

Ayrshire Breeders Association,
C. M. Winslow, Brandon, Vt.

American Guernsey Cattle Club,
W. H. Caldwell, Peterboro, N. H.

Holstein-Friesian Association of America,
Malcolm H. Gardner, Supt. of Adv. Reg., Delavan, Wis.

American Jersey Cattle Club,
J. J. Hemingway, 8 West 17th. St., New York, N. Y.

CIRCULAR NO. 8.10 JULY 1907

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

THE SAMPLING AND SENDING OF FERTILIZERS, SOILS AND FEED STUFFS FOR FREE EXAMINATION.

It is important that parties who desire to have material examined should take particular pains in sampling, packing and forwarding, in order that the results obtained may represent the average quality of the goods sampled, and that no gain or loss in moisture may take place during transportation. The station reserves the right to reject unsatisfactory samples, as well as those not accompanied by the necessary information, and to publish all free analyses if the circumstances warrant it. *In the package containing the sample* should be placed the name and address of the sender, character of the material, name of the brand, of whom purchased and if possible the guarantee tag or a copy of the guarantee (See special form to be filled out).

METHOD OF SAMPLING.

(a) MATERIAL IN BULK.

In sampling ashes, grain or other bulk material, numerous portions should be taken preferably by a tube, or by means of a small scoop, or in double handfuls from various parts of the heap, placed on a thick, smooth piece of clean paper and thoroughly mixed; from this mixture should be drawn a sample of about one pound, which should be placed in a clean bottle or tin box together with the necessary data, tightly stoppered or covered and sent to the Station by mail or prepaid express.

(b) MATERIAL IN BAGS.

Samples should be drawn from 10 per cent. of the number of bags present, or in case of small lots from 10 different bags, *preferably by means of a tube* run the entire length of each bag. A reasonably fair

sample may be secured as follows: Open the requisite number of bags, thoroughly mix the contents of the top of each bag with both hands, then take a double handful from each bag and place upon a clean paper. Mix the several amounts and pack and send as described under (a).

Cottonseed meal: In order to be representative a sample must be drawn from twenty bags of every car. (See special circular concerning rebate).

Distillers' and brewers' dried grains and similar coarse material should be sampled by means of a tube run the entire length of the bag, or the contents of the bags should be emptied on the floor, well mixed and sampled as under (a). A sample taken from the top of the bag is not representative for the reason that the finer portions, rich in protein, are likely to settle to the bottom.

(c) Sampling Soils.

The taking of representative soil samples to be used for a chemical examination is of the first importance, for unless proper care is exercised the results secured will have no particular meaning. The samples should be taken from different portions of the field and to a depth not exceeding the downward limit of the surface soil. After selecting a place, pull up all growing vegetation and remove all surface matter which is not a part of the soil. Dig a hole about two feet square, making the sides smooth and clean by means of a sharp shovel or other instrument; now place a sharp bladed shovel at the point of separation of the surface soil from the subsoil, and by means of another flat bladed instrument shave off a portion (about two inches) from all four sides of the aperture, letting the soil fall into the shovel which is held in a proper position to receive the same. Place the soil in a suitable receptacle and proceed to take other samples in like manner from several different parts of the field. The bulk of soil which has thus been taken is now placed on a clean floor or on a large piece of thick paper and thoroughly broken up and mixed; a pound sample is then drawn, packed and shipped as described under (a). Soil should be sampled only when the weather conditions are normal.

Statements should accompany the sample or be sent by letter, stating the locality, depth at which the sample was taken, nature and

depth of subsoil, the method of fertilization and crop rotation which has been in practice, general fitness of land for cultivation and all other information that would aid the chemist in making his report.

Parties are not encouraged to send samples of soil for chemical examination without previous correspondence. In many cases a statement giving the locality and physical character of the soil, the method of crop rotation and fertilization followed for a number of years previous may be sufficient to enable the station to advise intelligently concerning future treatment. The chemical examination of soils is time consuming and expensive and unless all the conditions are understood the results are likely to be misleading and of questionable value.

SENDING SAMPLES.

All samples should be addressed to Dr. J. B. Lindsey, Mass. Agricultural Experiment Station, Amherst, Mass., (shipping tag accompanying this circular.) The samples will be referred to the head of the fertilizer or feed division, who will see that the same are examined and make his report direct to the sender. It is important that all samples be sent *as soon as drawn.* Express charges should always be prepaid.

CIRCULAR NO. 11. NOVEMBER 1907.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

CHEMICAL ANALYSIS OF SOILS.

WILLIAM P. BROOKS, DIRECTOR.

Every year brings to the Station numerous inquiries in relation to the chemical analysis of soils, as well as a considerable number of requests for such analyses. It seems best, therefore, to present a brief statement as to the probable value of such analyses, and to state the policy which will be followed in relation to work of this character.

There exists much misapprehension as to the value to the individual of a chemical analysis of the soil which he is to use for crops. Persons writing in relation to this matter as a rule make a statement to the effect that they desire a chemical analysis in order to learn what fertilizer is needed. The results of such analyses do not, as a rule, afford a satisfactory basis for determining manurial requirements. The chemist, it is true, can determine what the soil contains, but no ordinary analysis determines with exactness what proportion of the several elements present is in available form for the crop. Indeed, there is no such thing as a constant ratio of availability. While one crop may find in a given soil all the plant food it requires, another may find a shortage of one or more elements. Further, on the very same field, one crop will find an insufficient amount of potash, another may find enough potash for normal growth, but insufficient phosphoric acid, and a third may suffer from an insufficient supply of nitrogen.

Most of our soils are of mixed rock origin, and as a rule possess similar general chemical characteristics, provided they have been farmed under usual conditions. The manurial and fertilizer requirements are determined more largely in most instances by the crop than by peculiarities in the chemical condition of the soil. The chemical analysis of soils then does not, as a rule, afford results which have a value commensurate with the cost, and as a rule this

Station will not make such analyses unless the soil differs widely from the normal in natural characteristics, or has been subjected to unusual treatment of such a nature as to probably greatly influence its chemical condition.

In some cases, the correspondent reports that his crop is diseased and that he desires a chemical analysis in order to ascertain what is the cause. The chemical composition of the soil may in some instances exercise a controlling influence in determining a condition of health or disease, and is never unimportant from the standpoint of vigorous, normal and healthy growth ; but in the case of most diseases, the immediately active cause is the presence of a parasitic fungous, and this fungous is usually capable of fixing itself upon the plant whatever may be the composition of the soil. A knowledge of the chemical composition of soils, therefore, will not make it possible to advise such manurial or fertilizer treatment as will insure immunity from disease.

Correspondents are urged, therefore, when writing in reference to the chemical analysis of soils, to state all the conditions as fully as possible. This statement should include a full description of the soil and as full a report as possible as to manures and fertilizers applied and crops raised for a number of years previous to the date of writing. If on receipt of such information a chemical analysis seems to promise results of value, it will be made, for the present free of charge, but as explained in the preceding paragraphs such analyses appear to be only rarely worth while. It will usually be possible to give helpful advice in relation to the use of manures and fertilizers on receipt of a full statement as to the character and history of the soil and the crop which is to be raised, and such advice will always be gladly given.

Every Farmer Can Help Himself.

CIRCULAR NO. 12. MARCH, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

Department of Plant and Animal Chemistry.

THE UNPROFITABLE COW

AND

HOW TO DETECT HER.

Cow testing associations may be defined as voluntary associations of neighbors desiring through co-operative effort to detect unprofitable cows in their herds.

These associations are very common in Europe, and are being rapidly organized in several of the Western states and in Canada. Experts are employed who make periodic visits to weigh the milk and test it for butter fat, and who are willing, when called upon, to offer advice and suggestions relative to care, feeding and method of improving the dairy herd.

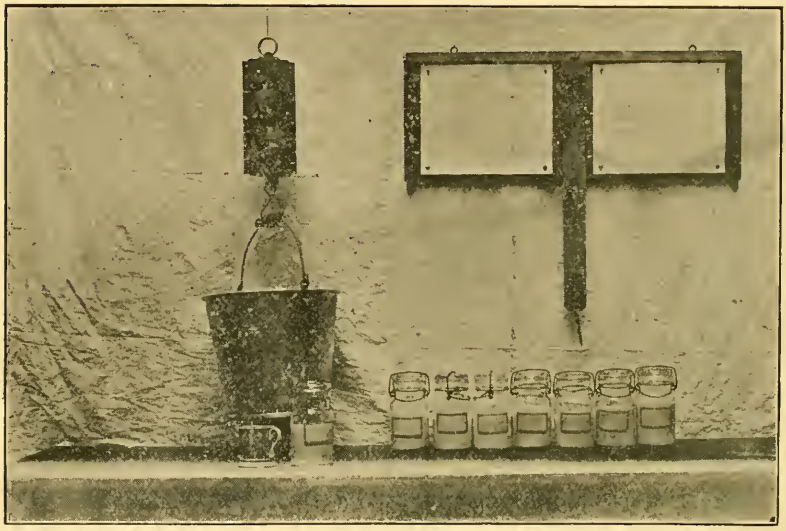
The cost of doing the work, which includes travelling expenses, board and salary, in many cases is borne partly by the members of the association and partly by the state, and may amount to from $2 to $6 per cow yearly. The plan is perfectly feasible if well organized and if a sufficient number can be induced to become members. It is believed that ere long many such associations will be organized in Massachusetts, and that they will be under the direction and receive help from the State.

The following plan is tentatively suggested whereby the average farmer can *help himself* and at a minimum outlay of time and money, ascertain the profitable and unprofitable cows in his herd.

METHOD OF PROCEDURE.

Weighing: Begin when the cow is fresh and weigh her milk for three consecutive days in each month, preferably about the middle

and record the weight on previously prepared ruled paper.* The sum of the amount produced for three days *multiplied by* 10 gives the amount produced for the month. The amount of milk produced in a portion of a month can be estimated by weighing the milk for one or two days and multiplying by the proper number. Continue the weighing for one year, and from year to year if you would know the whole truth. *Preserve yearly summary in permanent record book.*



Balance, Pail, Record Sheet and Sample Bottles.

The Balance: Any spring balance or scale will do, but the Chatillon balance, with the scale graduated into pounds and tenths, and with a movable pointer so that when the empty pail is suspended, the pointer may be made to indicate zero, is to be preferred. The scales cost $3.00 at any dairy supply house.

SAMPLING THE MILK.

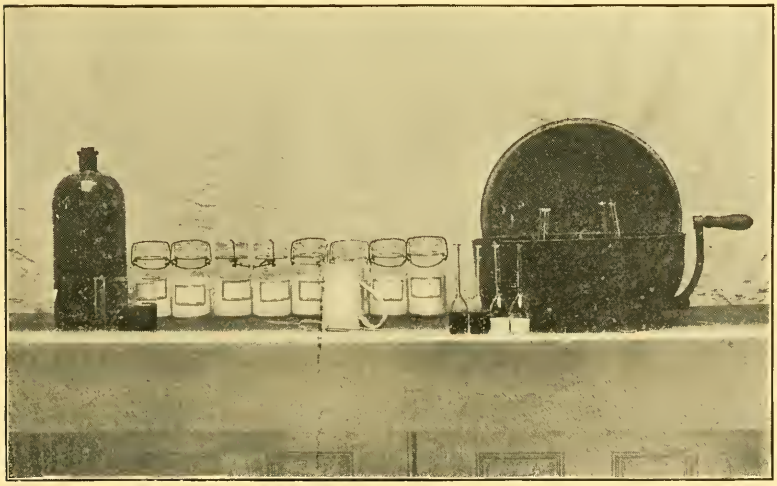
When to Sample: Sample the milk of each cow in the *second*, *fourth* and *seventh* month after calving; any time during the month will do, but the middle is to be preferred. The average of the three

* Blank forms for keeping complete monthly records can be had at dairy supply houses.

tests will be a fair index of the quality of the milk during the milking period. Thus if the milk tests 3.8, 4.2 and 4.8 per cent fat, the average would be 4.27 per cent for the entire period.

Utensils Needed in Sampling: A pint lightning jar for each cow; a small coffee cup or long handled gill dipper for taking the sample; a box of bichromate of potash or B. and W. corrosive sublimate tablets for preserving the sample* to be procured of any dairy supply house at a cost of $1.00 to $1.25 per box.

How to Sample: Powder fine with a knife one-half of a tablet and put in each jar. Milk the cow dry and pour the milk as carefully as possible from one pail to another three times in order to mix it. Do not allow any more frothing (air bubbles) than possible. Dip out a cupful of the milk at once and pour into the jar. Mix the milk with the preservative by a careful rotary motion. *Do not shake* or turn the jar upside down. Proceed in this manner for four consecutive milkings, (two full days). Be sure to mix the milk by the rotary motion each time a sample is added to the jar and keep the jar tightly covered. The jar should be marked with the name and number of the cow.



Samples of Milk and Babcock Machine.

TESTING THE MILK.

The samples may be tested by the owner of the cow if he has a

* A solution of formalin may be used in place of the tablets; it can be procured of any druggist. Add 5 drops with a medicine dropper.

Babcock machine, glassware and acid,* or it may be taken to the creamery, or in exceptionable cases sent to the experiment station.

ILLUSTRATION OF YEAR'S MILK PRODUCT.

MONTH.	3 days yield. lbs.		30 days yield. lbs.	MONTH.	3 days yield. lbs.		30 days yield. lbs.
January, . .	90	x 10	900	July, . . .	48	x 10	480
February, . .	78	x 10	780	August, . .	42	x 10	420
March, . . .	72	x 10	720	September, .	30	x 10	300
April, . . .	66	x 10	660	October. . .	20	x 10	200
May, . . .	60	x 10	600	November, .	15	x 10	150
June, . . .	54	x 10	540	December, .	(dry)		—
Totals, . .			4200	Totals, .			1550

Total 5750 lbs. milk $\times$ 4.27 (average per cent fat)=245.5 lbs. butter fat.

Converting Butter Fat into Butter. Increase the pounds of butter fat by $\frac{1}{6}$† thus : $\frac{1}{6}$ of 245.5 lbs. butter fat = 40.9 + 245.5 = 286.4 lbs. butter produced during the year.

The above method as described is, of course, not strictly accurate, but sufficiently so to enable the farmer to form a fair estimate of the productive capacity of his cows.

WHAT IS A PROFITABLE COW?

(a) *For Market Milk.* In order to be considered profitable, a cow should produce 6000 lbs. (2800 quarts) of 3.5–4 per cent milk yearly, without being forced.

(b) *For Butter.* A cow ought to produce 300 pounds of butter yearly—if she does not do it, she is not helping you.

QUERY! *How many of your cows* are returning you these results? If you *don't know*, isn't it time you *found out?*

* Testing outfits with full instructions may be had of any dairy supply house, who furnish catalogs on application.

† The $\frac{1}{6}$ represents the water, ash and curd,

CIRCULAR NO. 13. MARCH, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

J. B. LINDSEY, CHEMIST.

LAWS REGULATING THE SALE OF COMMERCIAL FERTILIZERS IN MASSACHUSETTS.

ACTS AND RESOLVES FOR 1896, CHAPTER 297.

Be it enacted, etc., as follows:

Statements to be attached to packages.

SECTION 1. Every lot or parcel of commercial fertilizer or fertilizer material sold or offered or exposed for sale within this Commonwealth shall be accompanied by a plainly printed statement, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the location of the factory, and a chemical analysis stating the percentage of nitrogen, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Certified statement to be filed and deposit of sample.

SEC. 2. Before any commercial fertilizer is sold or offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within this Commonwealth shall file with the director of the Hatch* experiment station of the Massachusetts agricultural college a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request, a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

* Recently changed to Massachusetts.

License fee on each distinct brand to be paid annually.

SEC. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or fertilizer material shall pay for each brand, on or before the first day of May annually, to the director of the experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand of fertilizer : *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section ; and on receipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

Character of inferior material used must be stated.

SEC. 4. No person shall sell or offer or expose for sale in this Commonwealth any pulverized leather, hair or wool waste, raw, steamed, roasted or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany or go with every parcel or lot of the same.

Penalty for violation.

SEC. 5. Any person selling or offering or exposing for sale any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence and one hundred dollars for each subsequent offence.

SEC. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use and not to sell in this Commonwealth.

Analysis of samples and publication of results. Prosecution of violators.

SEC. 7. The director of the experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or fertilizer material to be made annually, and shall publish the results from time to time, with such additional information as the circumstances render advisable, provided such information relates only to the composi-

tion of the fertilizer or fertilizer material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or fertilizer material which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels, and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, and the time and place of drawing; and said label shall also be signed by the director or his deputy and by the party or parties in interest, or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station.

Sec. 8. Chapter two hundred and ninety-six of the acts of the year eighteen hundred and eighty-eight is hereby repealed.

Sec. 9. This act shall take effect on the first day of November in the year eighteen hundred and ninety-six.

[*Approved April 17, 1896.*

Acts and Resolves for 1907 (Chapter 289.)

Be it enacted etc. as follows:

Publication of valuations.

Section 1. The bulletins or other publications of the Massachusetts agricultural experiment station containing information about fertilizers shall, in all cases, state the dealers' cash price per ton for such fertilizers, and the value per ton of the ingredients of the same, and the percentage of difference between the said price and the said value.

Sec. 2. This act shall take effect upon its passage.

[*Approved April 11, 1907.*

Instructions to Manufacturers, Importers, Agents, and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this state must be accompanied :

First, with a distinct statement of the name of each brand offered for sale, the name of the manufacturer and place of factory.

Second, with a statement of the percentages of phosphoric acid, soluble in distilled water, reverted as well as total, of nitrogen and of water soluble potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the state for a certificate, which is five dollars for each of the following ingredients : nitrogen, phosphoric acid and potassium oxide guaranteed in each and every distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes offered for sale in this state. Inferior substances like leather, hair, and wool waste, shall not be used unless so stated in the guarantee.

3. The certificate of compliance with the laws of the state must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint as many agents as they desire after having secured at this office the certificate of compliance with the laws of the state.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers shall upon request furnish a list of their agents.

All inquiries regarding the sales of commercial fertilizers, may be addressed to H. D. Haskins, Chemist in charge of the official inspection.

Amherst, Massachusetts, March, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

FERTILIZERS FOR POTATOES.

WILLIAM P. BROOKS, DIRECTOR.

There is general agreement that fertilizers rather than manure should generally be used for the potato. The principal reasons are:

1. The chances that the crop will be free from blight, rot and scab are greater on fertilizer. This does not of course mean that immunity from any of these troubles is certain if fertilizers only are used.

2. The period of growth is relatively short and the plant food supplied should be in highly available forms. High grade fertilizers are superior to ordinary farm manures in this particular.

Manure may be used for this crop with greatest safety and profit on the lighter soils deficient in organic matter and humus. The quantity should be moderate and it should be applied broadcast and plowed or deeply harrowed in rather than placed in hill or drill. It will usually pay to use some fertilizer in connection with manure.

Experiments with fertilizers for potatoes on the Station grounds on soils which are retentive in character indicate:

1. **Method of Application:** The application of all the fertilizers in the drill, making it cover a strip some 10 to 15 inches in width is likely to give a better crop than broadcast application of all the fertilizers used.

2. **The Nitrogen Supply:**

(a) When grown upon a clover or mixed grass and clover sod, a relatively low percentage of nitrogen in a potato fertilizer is sufficient.

(b) In order to make it safe to apply the entire amount of fertilizer needed for the crop at planting time, the nitrogen should be derived from materials possessing a varying rate of availability, such, for example, as nitrate of soda, sulfate of ammonia, dried blood and tankage.

3. **Phosphoric Acid Supply:** There is little doubt that the presence of a liberal amount of available phosphoric acid in fertilizers for potatoes is favorable to early maturity and wherever the tops usually make a rank growth, or where an early crop is important this element should be relatively abundant in the fertilizer.

4. **The Potash Supply:**

(a) The percentage of potash in a potato fertilizer should be relatively high. There is considerable evidence which tends to show that a relatively high percentage of potash in the fertilizer used for potatoes is favorable to the maintenance of healthy growth and the production of a sound crop.

(b) The potash of a potato fertilizer should usually be supplied in the form of sulfate rather than muriate. When these two salts have been compared, the sulfate has generally given the heavier yields and the better quality. On light soils, especially those rich in lime and in excessively dry seasons, the muriate may be the better of the two salts.

The Use of Lime and Wood Ashes: It has been clearly shown that potatoes are more subject to scab when grown in soils which are alkaline than in those which are moderately sour. The free application of lime will render most soils alkaline and this fact explains why the potato is so often seriously injured by scab when grown on freshly limed land. This practice should be avoided. A heavy application of wood ashes may have a similar effect in favoring the development of scab and it is usually preferable to derive the phosphoric acid and the potash needed for the potato from other fertilizers.

The Composition of Potato Fertilizers: It is believed that fertilizers for potatoes should under the different conditions specified have about the following composition:

A. When fertilizers only are to be used:—

1. On clover sod or soils rich in humus and relatively fertile:

	Per Cent.
Nitrogen,	2.5— 3.
Phosphoric acid,	8. —10.
Potash,	8. —10. in form of sulfate.

2. On lighter and poorer soils:

	Per Cent.
Nitrogen,	3.5— 4.5
Phosphoric acid,	6. — 8.
Potash,	8. —10.

B. For use in connection with manure:

1. On clover sod or soils rich in humus:

	Per Cent.	
Nitrogen,	1.5— 2.	mostly in soluble forms.
Phosphoric acid,	8. —10.	
Potash,	12. —14.	

2. On lighter and poorer soils:

	Per Cent.	
Nitrogen,	3. — 3.5	mostly in soluble forms.
Phosphoric acid,	6. — 8.	
Potash,	10. —12.	

Amounts recommended per acre:

A (either 1 or 2) 1500-2000 lbs.

B (either 1 or 2) 600-1000 lbs. varying with the amount of manure used.

HOME MIXTURES.

The judicious selection and purchase of unmixed materials usually makes it possible to obtain needed elements of fertility at lower cost than in the "potato specials." Home mixture of these materials is neither difficult nor expensive if the materials are of good grade and reasonably free from lumps. They have simply to be alternately added to a heap upon a solid floor in proper proportions and then shoveled over a few times, taking care to break such lumps as are present by pounding. Should any single ingredient appear to be lumpy, it will be best to pulverize it by itself before adding to the mixture. A gravel screen is sometimes convenient in connection with such work.

The following mixtures are suggested as likely to prove satisfactory under the conditions indicated:

A. For use where fertilizers only are employed:

1. On clover sod or soils rich in humus and in high fertility:

In each 100 pounds:

Nitrate of soda,	7 lbs.
Dried blood,	8 lbs.
Tankage,	15 lbs.
Acid phosphate,	50 lbs.
High grade sulfate of potash,	20 lbs.

Use 1600 to 2000 pounds per acre.

2. On lighter and poorer soils:

In each 100 pounds:

Nitrate of soda,	12 lbs.
Dried blood,	15 lbs.

Tankage,	20 lbs.
Acid phosphate,	35 lbs.
High grade sulfate of potash,	18 lbs.

Use 1600 to 2000 pounds per acre.

B. For use in connection with manure:

1. On clover sod or soils rich in humus:

In each 100 pounds:

Nitrate of soda,	8 lbs.
Dried blood,	5 lbs.
Acid phosphate,	60 lbs.
High grade sulfate of potash,	27 lbs.

Use 600 to 1000 pounds per acre.

2. On lighter and poorer soils:

In each 100 pounds:

Nitrate of soda,	8 lbs.
Dried blood,	10 lbs.
Tankage,	20 lbs.
Acid phosphate,	40 lbs.
High grade sulfate of potash,	22 lbs.

Use 800 to 1200 pounds per acre.

Conditions under which Muriate of Potash may be Substituted for Sulfate: If the soil on which potatoes are to be grown is of coarse texture and deficient in capacity to retain water and if experience indicates a considerable probability that the crop at some period in its growth will suffer from drouth, it may be wise to substitute muriate of potash for the high grade sulfate recommended in any of the above mixtures. As already indicated, the substitution of muriate for the high grade sulfate may be especially advisable if in addition to being light, the soil is naturally rich in lime.

Method of Applying; If the potatoes are to be planted by hand, good results may be obtained by opening the furrows and then scattering the material widely the full length of the furrow, making it cover not only the entire furrow, but a space a few inches in width on each side. If spread in this way, the fertilizer will not be so thick that it will be necessary to take any special steps to mix it with the soil. It will be sufficiently mixed in covering the seed. If planting is done by machine, the fertilizer attachment of the machine should be one which scatters the fertilizer over a relatively wide area. If such a machine cannot be used, it may be best to withhold a portion of the fertilizer until the crop is three or four inches high, when it should be scattered along lines six to eight inches wide on either side of the row and cultivated in.

CIRCULAR NO. 14. 15 JULY, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

AMHERST.

THE COST OF TESTING PURE BRED COWS.

(SUPPLEMENTARY TO CIRCULAR NO. 9.)

The experiment station committee of the board of trustees of the Massachusetts Agricultural College at its last quarterly meeting, adopted the following schedule of prices for conducting dairy tests, and the same will go into effect September 1, 1908.

1. The charge for a single day's test, *when made in a sequence with others of a similar character*, shall be $5.00. Additional days for the same party shall be at the rate of $2.75 per day.

2. The charge for a "seven day" test shall be $25.00. An allowance of nine consecutive days will be made, which shall include the tester's time while enroute. Additional days beyond the nine day limit will be charged for at the rate of $2.75 a day.

3. The charge for a "thirty day" test shall be $80.00, and 32 consecutive days will be allowed, which shall include the tester's time enroute. Additional days beyond the 32 day limit will be at the rate of $2.50 a day.

4. The above statement includes the entire cost, excepting that as formerly, the owner of the stock must, at his expense, care for the supervisor during the test, and when necessary, convey him to and from the railroad station or car line.

In explanation of the new schedule, it may be said that the charges heretofore have included simply the actual wages paid the tester, in addition to his traveling expenses, breakage, etc. No charge whatever has been made for the time employed in securing men and in general supervision. Work of this character has interfered with other important work and has cost the station considerable money. Inasmuch as the breeders for whom the testing is done are the ones primarily benefited, it is held to be no more than fair that they should pay the entire expense. In fact, tests made under the direct supervision of a college or station official, have a direct advertising and money value to

the breeder which far exceeds the expense involved, either under the old or new schedule.

The station is of the opinion that yearly tests give much more accurate information concerning the productive capacity of an animal than seven day tests, and strongly urges breeders to adopt the longer period.

As heretofore, farmers and breeders can place five cows in the seven day test when milked four times daily, and when the conveniences are adequate, eight to ten cows can be included in the one or two day tests, providing the cows are not milked more than twice per diem.

J. B. LINDSEY,

Circular No. 16. July, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

Amherst.

SEEDING MOWINGS.

By William P. Brooks

The average product of hay to the acre in Massachusetts is reported to be only a little more than one ton. As good farmers are not satisfied with an average yield of less than three tons, it is self-evident that there is much mismanagement, or lack of intelligence in the management of mowings.

This paper will discuss seeding down to grass or mixed grass and clover. The topics to be especially considered are as follows:

Preparatory fertilization.
Time and method of seeding.
Preparatory tillage.
Varieties of grass and clover to be used.

Preparatory Fertilization.

Manure. It is quite unnecessary to state to the average farmer that a liberal application of manure will bring the soil into good condition to produce profitable crops of hay and wherever sufficient manure is produced on the farm, or can be purchased and laid down upon the farm at a low cost, its use is to be advised. The liberal use of manure in preparing the soil for seeding to mowing will bring it into condition to produce a grade of hay made up principally of such grasses as timothy, red top and orchard grass, while the clovers are present in relatively small proportion. This is because manure supplies an abundance of nitrogen, which greatly favors the growth of grasses. These accordingly become so rank in their growth that the clovers are to some extent suppressed. While the fact that the free use of manure in preparing land for seeding will bring it into fine condition for the production of heavy yields of hay is well established, it is not as generally known as it should be that profitable hay production on fertilizers alone is possible. Indeed there can be no doubt that in most localities if the plant food must be purchased for the purpose under consideration, money can be more wisely used in buying fertilizers than in buying manure.

If manure is to be used in preparing for seeding, it is best to keep it relatively near the surface. It should be well worked in with a harrow rather than plowed under, providing its mechanical condition makes thorough incorporation with the soil by harrowing possible.

The Necessity for Lime.

In most parts of the state our soils appear to be relatively deficient in lime. In soils where this deficiency is marked, the necessity for liming will be indicated by the following conditions :—

1. Clovers will either fail absolutely or make a feeble growth.
2. Sorrel is likely to come in abundantly.
3. If red top and timothy are sown with the clovers, the red top will do much better relatively than the timothy.

The reasons for the above results briefly stated are :—

(*a.*) Red top and sorrel can thrive in acid soils.

(*b.*) Neither clover nor timothy will do well in such soils.

Wherever such results as are above named have been noted, a heavy application of lime will usually be found to be beneficial. Various forms of lime are available. Among the more important are fresh burned lime, air-slaked lime and fine ground lime.

Of these different forms, the fresh burned or lump lime exercises the most energetic action on the soil. Before application, it should be slaked, either by exposure in small heaps to the weather or by the addition of just enough water to cause it to crumble into a fine, dry powder. The rate of application likely to prove useful is about one ton to the acre. After slaking, the lime should be spread on as promptly and as evenly as possible upon the rough furrow, and immediately deeply harrowed into the soil, for which operation, the disk or cutaway harrow is usually best. In determining whether it is better economy to purchase fresh burned lime or air-slaked lime, it should be remembered that a ton of the former is equivalent in its action on the soil in most cases to from 3,000 to 3,500 pounds of the latter.

Fine ground limes are put upon the market in sacks, and are the most convenient form, both for handling and for application; but they usually cost more in proportion to efficiency than fresh burned lime.

The effects of liming upon the character of the growth are very clearly shown in the cuts. The soil used in this experiment was taken from one of our fields which was supposed to need liming. A quantity sufficient to fill the two cylinders was first very thoroughly mixed and an equal amount was then placed in each. Both received

No Lime Lime

EFFECT OF LIMING.

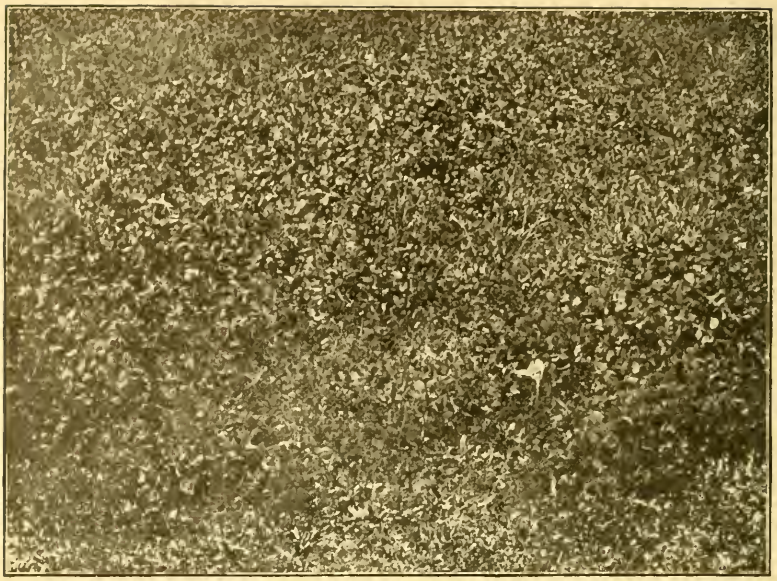
a general fertilizer, and in both were sown precisely the same kinds and quantities of seeds—timothy, red top and clover.

Fertilizers to be Used.

The selection of fertilizers for application to land which is to be seeded should, in all cases, be varied in accordance with the kind of hay desired. If hay containing a large proportion of clover is wanted, materials which supply relatively large amounts of potash and phosphoric acid, and relatively little nitrogen should be employed. If hay, largely timothy and relatively free from clovers is wanted, then the proportion of materials furnishing potash and phosphoric acid should be smaller, while the materials supplying nitrogen should be applied in relatively large proportion. There is considerable evidence to show that if timothy is desired, potash in the form of muriate is preferable to sulfate, while for clovers on many soils, and especially in wet seasons, the sulfate is preferable.

The cuts on pages 4 and 5 show the difference in crops of clover produced on the college farm respectively on the muriate and the high grade sulfate of potash, used in each case in connection with bone meal at the rate of 600 pounds to the acre.

The application of fertilizer in preparation for seeding should be varied also with the season. Materials supplying considerable nitro-



FERTILIZER ANNUALLY.

Per Acre, { Bone Meal, 600 pounds.
Muriate of Potash, 250 pounds.

gen in available forms may safely and wisely be applied in spring seeding, but for late summer or autumn seeding, the application of such materials in any considerable amounts would be a mistake.

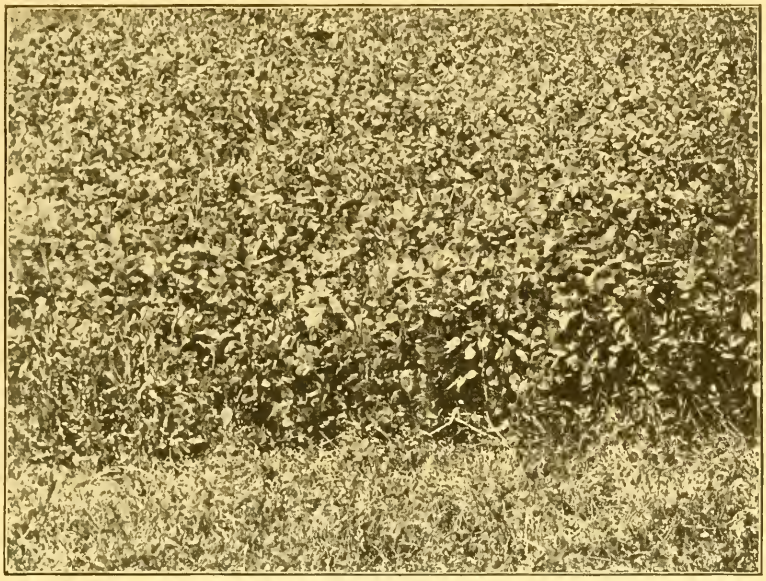
It should be understood that in presenting specific advice as to applications of fertilizers under different conditions, no attempt is made to give an exhaustive discussion of the subject. The materials advised have been used with excellent results on the college farm as well as by numerous private farmers.

Fertilizers in Connection with Manure.

As has been stated, manure is relatively rich in nitrogen, and the application of manure alone in liberal quantities will be favorable to the production of hay, made up largely of such grasses as timothy and red top. If it is desirable to increase the proportion of clover, either of the following fertilizer applications may be recommended :—

(*a.*) Per acre, in addition to the manure, muriate of potash or high grade sulfate of potash 150 to 175 pounds,—the former to be selected for the lighter soils, and in cases where it is desirable that the proportion of timothy should be relatively large.

(*b.*) Per acre, muriate or high grade sulfate of potash 150 to 175 pounds, and basic slag meal 600 to 800 pounds,



FERTILIZER ANNUALLY.

Per Acre, { Bone Meal, 600 pounds.
High Grade Sulfate of Potash, 250 pounds.

This application will, it is believed, be especially favorable to clovers. Slag meal, besides supplying phosphoric acid, will furnish a considerable quantity of free lime which will help sweeten a sour soil, or hold in condition a soil where the excess of acid has first been neutralized by liming.

A. For spring seeding, per acre :—

Fertilizer Alone.	Basic slag meal,	800 to 1000 pounds
	Muriate or high grade sulfate of potash,	175 to 200 "
	Tankage or dry ground fish,	300 to 400 "

B. For summer seeding, per acre :—

Basic slag meal,	800 to 1000 pounds
Muriate or high grade sulfate of potash,	175 to 200 "
Tankage or dry ground fish,	200 to 300 "

And, if the soil is in a very low state of fertility, in addition

Nitrate of soda,	75 to 100 pounds

C. For fall seeding, per acre :—

Basic slag meal,	800 to 1000 pounds
Muriate or high grade sulfate of potash,	175 to 200 "

And, if the soil is in very low fertility, in addition

Nitrate of soda,	75 to 100 pounds

In either of the above fertilizer combinations containing tankage, it will be best to apply the slag meal by itself, for if this be mixed with tankage, the free lime which it contains will cause a loss of ammonia. The other materials advised under A and B should be mixed together before application. All the materials advised under C should be mixed before application. The best results will usually be obtained by spreading all these fertilizers on the rough furrow and working them in thoroughly with the disk or other deep working harrows. The nitrate of soda, it is true, does not require deep working in, and it is most safely used if spread only a short time before seeding, while the other materials will prove the most useful if they can be put on a few weeks before the seed is sown. It is doubtful, however, whether enough will be gained in the direction of greater effectiveness of the nitrate to pay the extra cost of separate application.

Where the land is seeded in the summer or fall with fertilizer as advised, it will not infrequently be found profitable to apply some nitrate of soda the following spring. Whether or not such application will prove profitable must be determined by the appearance of the grass at that time. If it shows comparatively light foilage and a moderate or feeble growth, a dressing of nitrate will be profitable, and to facilitate its distribution, it is advised that it be mixed with about double its weight of basig slag meal.

Time and Method of Seeding.

There is no season of the year, not even excepting winter, which has not been advocated by some one as the best season for seeding to grass, and indeed each season has its advantages. The limits of this circular will not permit a full discussion of the subject. The writer is convinced that on all soils fairly retentive of moisture and in seasons not characterized by very unusual drought, the best results in seeding to mixed grass and clover will be obtained if the seed is put into the ground during dog days, and on farms where corn is cultivated, he strongly recommends seeding in the standing corn. The cultivation of the corn must of course be level. Just previous to seeding, the spiked-toothed cultivator should be used, working as close to the hills or rows as possible. The seed should be sown when the corn is about waist high. Much care should be taken to distribute the seed evenly, and it seems best in most cases to walk between every pair of rows aiming to cast the seed about three rows wide, but of course in very small quantity. By sowing in this way a

very even distribution of the seed may be secured. In showery weather, seed sown in this way will not need covering.

Spring Seeding. Grass and clover sown in the early spring usually start well, but there is much risk of damage to the young plants during the hot dry weather which is likely to prevail in midsummer. If sown alone in the spring, there is likely in most fields to be a rank growth of weeds spring up with the grasses and clovers. In most cases, therefore, a nurse crop (most frequently oats) is put in with the clover. In either case, the ranker and more rapidly growing weeds or grains make heavy drafts on the moisture of the soil, and when these are cut, the exposure of the young and tender grass and clover plants, up to that time shaded by the taller growth, to the full glare of the summer sun often seriously injures them. Principally for this reason the writer is not in favor of spring seeding. Good results may be obtained by seeding at almost any time between the middle of August and the first of October, provided the soil is well drained and the lay of the land such that water will not stand upon it during the winter. Clovers may be sown with grass seeds up to about the 10th of September. If put in later than that they are not likely to make enough growth to become sufficiently well rooted to go through the winter safely. If the date of seeding must be late and clover in the mowing is desired, it is common to withhold the clover seed until the following spring, at which time, of course, the soil is somewhat compacted and covering the seed is impossible, as harrowing the ground would uproot the young grass plants. Clover sown in this way will, in some seasons, germinate well and make a good growth, but this method of seeding is attended by a great deal of risk of failure and at best the crop the first season where this method is followed will contain but little clover. In fall seeding, it is customary to sow the grasses and clovers without a nurse crop.

Covering the Seed. Shallow covering only is essential, and in case of summer seeding in the corn, no covering at all is needed in many cases, as the shade of the corn keeps the surface of the ground moist. The heavy pelting rains of dog days moreover will help to bury the scattered seeds. In all other cases, the weeder, or the familiar home-made brush, will in most cases be the best implement for covering the seed, these implements to be followed in most cases by the roller, which will make the surface smooth and sufficiently compact so that moisture will rise to the surface.

Preparatory Tillage.

The fact is now much more generally appreciated than formerly that it pays to bring land into the best of tilth in preparation for seeding. Careful plowing followed by numerous harrowings will in almost all cases be necessary. The soil at the time of seeding should be fine and mellow at the top and moderately compact below. Wherever it is possible, ploughing should precede the seeding by a few weeks at least, and between the date of ploughing and seeding, the field should be harrowed a number of times. Fall plowing is generally preferable to spring plowing if the land is to be seeded in the spring.

Varieties of Grass and Clover to be Used.

No attempt will be made here to consider the characteristics of the different species of grasses and clovers. The most generally useful mixture will be made up about as follows per acre :—

Timothy,	18 pounds
Fancy re-cleaned red top,	8 "
Alsike clover,	4 "
Mammoth red clover,	4 "

This mixture is suited for mowings on all medium and heavy soils which are occasionly broken up and put into hoed crops.

For lighter soils, and especially where it is desirable to leave the mowing down to grass for a considerable number of years, the following mixture is recommended, per acre :—

Orchard grass,	15 pounds
Tall oat grass,	5 "
Italian rye grass,	5 "
Awnless brome grass,	5 "
Common red clover,	6 "

For medium soils, especially where it is desirable to leave the mowing down to grass for a number of years, the following mixture is recommended, per acre :—

Orchard grass,	8 pounds
Italian rye grass,	3 "
Yellow oat grass,	4 "
Meadow fescue,	10 "
Red clover,	5 "
Alsike clover,	4 "

In the purchase of grass and clover seeds, it is of much importance to pay particular attention to the quality. It is wise to obtain samples and to examine them, or to have them examined by the experiment station with a view to determining, not only the germinating quality, but whether there is an admixture of weed seeds. In the purchase of clover, it is now especially important to be on guard against dodder. Dodder is a parasite which, if it once obtains a foothold in a field of clover, will soon render it valueless. Dodder seed, unfortunately, appears to be found with increasing frequency in samples of clover and alfalfa seeds offered in the markets.

CIRCULAR NO. 17. SEPTEMBER, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

J. B. LINDSEY, CHEMIST.

AN ACT TO REGULATE THE SALE OF CONCENTRATED COMMERCIAL FEED STUFFS.

ACTS AND RESOLVES FOR 1903, CHAPTER 122,

Be it enacted, etc., as follows:

Statements to be attached to packages.

SECTION 1. Every lot or parcel of concentrated commercial feed stuff, as defined in section two of this act, used for feeding farm live stock, sold, or offered or exposed for sale within this Commonwealth, shall have affixed thereto, in a conspicuous place on the outside thereof, a plainly printed statement, clearly and truly certifying the name, brand or trademark under which the article is sold for feeding purposes, the name and address of the manufacturer, importer or dealer, the net weight of the package, and the minimum percentage of crude protein, reckoning one per cent of nitrogen equal to six and one-fourth per cent of protein, and crude fat which it contains; the several constituents to be determined by the methods adopted by the Association of Official Agricultural Chemists of the United States. If the feed stuff is sold in bulk, or if it is put up in packages belonging to the purchaser, the agent or the dealer shall, upon request of the purchaser, furnish him with the certified statement described in this section.

Defines feed stuffs included in law.

SECTION 2. The term "concentrated commercial feed stuff," as used in this act, shall include cotton-seed meals, linseed meals, pea meals, bean meals, peanut meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried distillers' grains, dried brewers' grains, dried beet refuse, malt sprouts, malt refuse, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat feeds, corn, oat and barley feeds, chop feeds, corn bran, ground beef or fish scraps, meat and bone meals, mixed feeds—except as otherwise provided in section three of this act,—clover meals; condimental stock and poultry foods, patented, proprietary or trade-mark stock and poultry foods, and all other materials of a similar nature not included in section three of this act,

Defines feed stuffs exempt from law.

SECTION 3. The term "concentrated commercial feed stuff," as used in this act, shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn. Neither shall it include wheat bran or wheat middlings not mixed with other substances but sold separately as distinct articles of commerce, nor wheat bran and wheat middlings mixed together, not mixed with any other substances, and known in the trade as "Mixed Feed," nor pure grains ground together unmixed with other substances.

Penalty for violation of previous sections.

SECTION 4. Any manufacturer, importer, agent or other person selling, offering or exposing for sale any concentrated feed stuff included in section two of this act, without the printed statement required by section one of this act, or with a label stating that the said feed stuff contains substantially a larger percentage of either crude protein or crude fat than is actually present therein, shall be fined fifty dollars for the first offence and one hundred dollars for each subsequent offence.

Director or deputy required to collect and analyze samples. Penalty for Interference. Results to be published.

SECTION 5. The director of the Hatch experiment station of the Massachusetts Agricultural College is hereby authorized, in person or by deputy, to enter any premises where feed stuffs are stored and to take a sample, not exceeding two pounds in weight, from any lot or package of any commercial feed stuff used for feeding any kind of farm live stock as defined in section two or of excepted materials named in section three of this act, which may be in possession of any manufacturer, importer, agent or dealer. Any samples so taken shall be put in a suitable vessel, and a label signed by the director or his deputy shall be placed on or within the vessel, stating the name or brand of the feed stuff or material sampled, the guaranty, the name of the manufacturer, importer or dealer. the name of the person, firm or corporation from whose stock the sample was taken, and the date and place of taking: *provided, however*, that whenever a request to that effect is made the sample shall be taken in duplicate and carefully sealed in the presence of the person or persons in interest, or their representative, in which case one of the said duplicate samples shall be signed and retained by the person or persons whose stock was sampled. Any person who shall obstruct the director or his deputy while in the discharge of his duty under this act shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than twenty-five dollars nor more than one hundred dollars for each offence. The aforesaid director shall cause at least one analysis of each feed stuff collected as herein provided, to be made annually. Said analysis may include determi-

nations of crude protein, of crude fat, and of such other ingredients as it is deemed advisable at any time to determine. Said director shall cause the results of the analysis of the sample to be published from time to time in station bulletins, special circulars, or elsewhere, together with such additional information concerning the character, composition and use thereof as circumstances may require.

Adulteration of whole or ground grain or standard by-products; penalty.

SECTION 6. Any person who shall adulterate any whole or ground grain with milling or manufacturing offals, or with any foreign substance whatever, or adulterate any bran or middlings, or mixtures of wheat bran and wheat middlings known in the trade as "Mixed Feed," or any other standard by-product made from the several grains or seeds with any foreign substance whatever, for the purpose of sale, unless the true composition, mixture or adulteration thereof is plainly marked or indicated upon the package containing the same or in which it is offered for sale; and any person who knowingly sells or offers for sale any whole or ground grain, bran or middlings, or mixture of wheat bran and wheat middlings known in the trade as "Mixed Feed," or other standard by-product, which have been so adulterated, unless the true composition, mixture or adulteration is plainly marked or indicated upon the package containing the same or in which it is offered for sale, shall on conviction be fined not less than twenty-five dollars or more than one hundred dollars for each offence, and such fines shall be paid into the treasury of the Commonwealth.

Director to prosecute violators of Act.

SECTION 7. The director of the Hatch experiment station upon ascertaining any violations of this act for the first time shall forthwith notify the manufacturers or importers in writing, giving them not less than thirty days thereafter in which to comply with the requirements of this act. In case of second or subsequent violations by the same person or persons, or in case after a lapse of thirty days the requirements of this act remain uncomplied with, it shall be the duty of the director of the said station to prosecute the person or persons violating any provision of this act, and for this purpose the director may, if necessary, employ experts, and may further designate some person connected with the said station, or some other suitable person, to make complaints in its behalf; and in making complaints for violations of this act the persons so designated shall not be required to enter into any cognizance or to give security for the payment of costs; *provided, however*, that there shall be no prosecution in relation to the quality of any unadulterated commercial feed stuff if the same shall be found to be substantially equivalent to the statement of analysis made by the manufacturers or importers.

SECTION 8. This act shall not affect persons manufacturing, importing or purchasing feed stuffs for their own use and not to sell in this state.

SECTION 9. The term "importer," for all the purposes of this act, shall be taken to include all who procure or sell concentrated commercial feed stuffs.

SECTION 10. To defray the expenses of making the analyses and of carrying out the regulations provided for or made by under this act the sum of three thousand dollars shall be allowed for the present year from the treasury of the Commonwealth, payable in semi-annual payments.*

SECTION 11. Section twenty and so much of any other section of chapter fifty-seven of the Revised Laws as is inconsistent with this act are hereby repealed,

SECTION 12. This act shall take effect on the first day of July in the year nineteen hundred and three. [*Approved March 2, 1903.*]

INTERPRETATIONS.

Bulk Sales. For sales in bulk from the wholesaler or jobber to the retailer, plainly printed cards tacked to the outside and inside of the car, stating brand, name and address of the manufacturer and guaranty of protein and fat meet the legal requirements. The retailer must have similar statements to furnish the purchaser upon request for the same. In most cases the cards from the car tacked up in a conspicuous place on or near the bin will probably suffice. If the retailer bags the feed in his own sacks and so offers the same for sale, tags must be attached as in the case of other feeds.

Feed Exempt. It has not been deemed necessary to assume any oversight of the sale of wet brewers' grains, wet malt refuse, wet yeast refuse and similar products. Hays and straws; the grains—wheat, rye, barley, oats, Indian corn, buckwheat and broom corn—when whole, ground separately or ground together; wheat bran, wheat middlings and wheat mixed feed (bran and middlings) are exempt under section 3 of the law, but this exemption only applies when these products are free from other substances.

Poultry meals and scratching grains composed solely of the grains mentioned above, free from other seeds, by-products, and materials like charcoal, grit, shells, etc., are also exempt.

Unground wheat screenings are considered exempt; ground wheat screenings, however, must conform to the law.

The writer earnestly desires the fullest co-operation of all manufacturers, jobbers, local dealers and consumers. Communications may be addressed to

P. H. SMITH,
MASS. AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

*Section 10 amended, by striking out the words "for the present year," and substituting the word "annually." Acts of 1904, Chapter 332.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

ALFALFA AS A CROP IN MASSACHUSETTS.

WILLIAM P. BROOKS, Director.

Alfalfa has been under trial in Massachusetts both at the experiment station and on private farms for a number of years. A good start and a thick stand are not difficult to obtain; but in all the experiments, in Amherst at least, and so far as known in other localities, the crop soon gradually dies out, being replaced by grasses and clovers. The limit of satisfactory productiveness seems to be two or three years. It is a question whether under these conditions the crop will prove profitable, but in the opinion of some who have given it an extensive trial, it will pay to cultivate alfalfa even though it furnishes satisfactory crops for only two years.

Its principal advantages as compared with clover are three. (1) The first crop is ready to cut and feed at least two weeks earlier than clover. (2) It starts after cutting more quickly than clover, usually furnishing three crops annually. (3) It is considerably finer than clover, and therefore likely to be more palatable.

Alfalfa does not apparently exceed clover in nutritive value to as great a degree as is often supposed.

COMPOSITION OF CLOVER AND ALFALFA HAYS.

	Water.	Ash.	Protein.	Fiber.	Nitrogen free ex.	Fat.
	%	%	%	%	%	%
Alfalfa,*	15	7.9	13.5	27.2	33.2	3.2
Alsike clover,†	15	9.7	14.0	23.1	36.1	2.1
Medium red clover,†	15	7.6	13.2	24.2	37.4	2.6

These figures indicate that there may be no great difference in the nutritive values of alfalfa and clover hays, although further comparative determinations of digestibility are desirable.

The cost of starting alfalfa must materially exceed the cost of seeding to ordinary mixed mowing.

Soil requirements. Alfalfa may be made to succeed upon a variety of soils, provided these meet certain requirements. Whatever the type of soil, it must be naturally thoroughly underdrained. Standing water within less than six to eight feet of the surface will almost certainly prove fatal, and there must be perfect surface drainage. Standing water or ice will destroy alfalfa in a relatively short time. The

* Calculated on basis of two analyses published by the N. J. Exp. Sta.
† Average of analyses in the Mass. Agr. Exp. Sta.

highest degree of success with alfalfa appears to have been attained on moderately heavy soils. The soil of the typical drumlin of the state is in many cases well adapted to the crop. Freedom from weed seeds or roots such as witch grass is highly important. Localities where sweet clover grows naturally are likely to be peculiarly adapted to alfalfa, as also are those parts of the state where the soils are rich in lime.

Preparation for alfalfa. In preparing for alfalfa the most thorough possible tillage and such treatment as will free the surface soil from weeds and living roots are of prime importance. If a very early crop, the cultivation of which will leave the soil free from weeds and in good tilth, will be profitable, then such a crop may wisely precede alfalfa; but the crop should be one which can be harvested not later than about the 10th of July, in order to allow a sufficient interval for the thorough tillage desirable before seeding. If the cultivation of such a crop does not promise to be profitable, then a summer fallow will be found to be highly beneficial.

The following system of preparation is recommended:

(1) Plow the land the previous fall.

(2) Apply lime to the rough furrow either in the fall or early in the spring, and immediately incorporate thoroughly with the soil by the use of the disk harrow. In most parts of the state success with alfalfa is impossible without first thoroughly liming the soil. Burned lime at the rate of about a ton and one-half to the acre should be used. This should be slaked with enough water to cause it to crumble into a fine, dry powder. This should then be evenly spread and immediately worked in. The usual beneficial effects of liming are clearly shown by the cuts.

ALFALFA.

No Lime. Lime.

The two cylinders were filled with an equal quantity of thoroughly mixed soil, so that conditions are known to have been identical at the start.

(3) Just previous to the first harrowing subsequent to the application of the lime, apply a mixture of the following materials, per acre:

Basic slag meal,	1500 to 2000 lbs.
Low grade sulfate of potash,	600 to 800 lbs.

Spread the mixture evenly and incorporate into the soil by harrowing.

(4) Shortly before seeding apply the following mixture, per acre:

Basic slag meal,	300 lbs.
Nitrate of soda,	100 lbs.

Spread this evenly and work in lightly with the harrow.

Whether manure should be used depends upon conditions. If a supply of fine manure, free from weed seeds, is available, and if the soil is in a very low state of fertility, a dressing of manure is advisable; but on soils in good condition the application of manure is hardly called for, and from some points of view is undesirable. It almost invariably carries some weed seeds and its use produces the conditions which are favorable to the growth of grass, since it supplies an abundance of quickly available nitrogen. Alfalfa does not need large quantities of available soil nitrogen, for under suitable conditions it can draw this element from the air. It seems wise, therefore, except upon soils which are exceptionally low in fertility at the start, to depend mainly upon fertilizers alone, selecting such as will furnish in abundance such elements of plant food as phosphates and potash. It is believed that basic slag meal will be found peculiarly suited to the crop, as it will furnish a considerable proportion of lime in addition to fairly available phosphoric acid.

Time of seeding. It is believed that the best results with alfalfa will usually be obtained by sowing it either alone or together with oats or barley about July 15th to August 5th. Previous to these dates, and as a result of the frequent harrowings which the field receives during the spring and early summer months, most of the weed seeds which were near enough to the surface of the ground to germinate will have started, and accordingly a cleaner stand of alfalfa will be secured than if the seeding be earlier.

Seed. Great care should be taken to secure the very best northern grown seed free from dodder. This parasite, if present in any quantity, will soon ruin a field of alfalfa, and if it becomes established upon the farm is likely to prove a most pernicious weed. The quantity of seed which gives best results seems to be about thirty (30) pounds per acre.

Soil inoculation. In localities in which sweet clover does not naturally grow, inoculation of the soil with the bacteria which develop nodules upon the roots and which give the plant the capacity to assimilate atmospheric nitrogen is advisable. If sweet clover is indigenous in the locality, such inoculation is usually unnecessary, as the bacteria which develop nodules upon the roots of sweet clover appear to be identical with those found on alfalfa roots. If inoculation is necessary it can be carried out in two ways:

(1) A culture may be obtained and used in accordance with directions accompanying it. Such cultures are produced both in the United States Department of Agriculture, Washington, D. C., and by a number of private companies. Most of the experiments with them up to the present time have given results inferior to those obtained by following the second method of inoculation,

(2) Harrow in 300-400 pounds per acre of soil from an old and successful alfalfa field.

In soil inoculation, it should be remembered that exposure of the germs to the light, even if only for a short time, destroys their vitality. It is advisable, therefore, to harrow in the germ-carrying soil as promptly as possible after spreading.

Leaf-spot or rust. In certain localities, and in some sections more than others, alfalfa is subject to a parasitic disease which results first in the appearance of yellowish spots upon the leaves, and later in the loss of a large proportion of the foliage. When these spots are observed it is best to cut the alfalfa immediately. Under this treatment a healthy growth will soon start, but if the diseased plants are allowed to stand they will be greatly weakened. If leaf-spot shows itself in a newly seeded field while the plants are yet young, the cuttings may be allowed to lie where they fall. They will serve to furnish mulch and winter protection which is so greatly needed in our climate.

Harvesting alfalfa. Alfalfa should usually be cut soon after it begins to blossom. If allowed to stand much beyond this period the plants start much less promptly, and the total yield of the season will be less. The last cutting of the season should not be too late. It is desirable that there should be a considerable growth to remain in the field for winter protection. After cutting, alfalfa should be allowed to lie, with possibly one turning, until it is moderately wilted. It should then be put first into windrows and later into cocks, where it should be allowed to remain until cured. If hay caps can be used, the results will be highly satisfactory. Should the time required in curing exceed about five days the cocks should be moved to avoid injury to the roots.

Annual top-dressing. If the soil has been successfully inoculated, so that the nodules which have been referred to are abundant upon the feeding rootlets of the alfalfa plants, it will be unnecessary to top-dress with materials furnishing nitrogen; but in order to secure large crops, it will be essential to supply the mineral elements of plant food in abundance, and the following mixture of materials is recommended annually, per acre:

Basic slag meal,	1,600 to 1,800 lbs.
Low grade sulfate of potash,	600 to 800 lbs.

This mixture may be applied either in the autumn or in the very early spring.

Experiments with alfalfa upon small areas are recommended in all localities where soils of the right character are found.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

THE WHITE FLY.

By C. E. HOOD, B. S.

This insect has become a very serious pest in greenhouses, and were it not possible to hold it in check, the crop each winter where it is present would be a total failure. It is not confined to the tomato alone but also attacks cucumbers, lettuce, melons, tobacco, geraniums and many other plants, and is not only important in hot houses, but in summer does considerable damage out of doors.

The egg of the white fly is oval in shape, somewhat pointed at one end. The rounded end of the egg is fastened to the leaf so the egg will hang down if the leaf is horizontal. In about two weeks these eggs hatch into tiny young, which crawl around for a few hours and then insert their beaks into the leaf and suck the juices until full grown, which is about two weeks from the time they hatch. After passing through the pupa stage, a T shaped opening is made in the back and the adult fly emerges. The mouth parts of both the young and fly are formed for sucking. They push their beaks into the succulent portions of the leaf and extract the juices, and as a result, the leaf soon dies and falls to the ground. Most of the harm, however, seems to be done by the young. Some time after the leaves are infested, there is a sticky substance exuded over the leaf, on which a black fungus grows, which soon covers the entire under surface of the leaf, making it sooty in appearance.

REMEDIES.

There are two methods of attacking this insect. 1. Fumigating with hydrocyanic acid gas. 2. Spraying with contact insecticides, such as a solution of Bowker's Tree Soap.

Fumigation is the most successful and most satisfactory method for the control of this insect that has as yet been discovered, though the gas produced is a deadly poison and extreme caution must be exercised in its use. It is essential in fumigating that the cubic contents or amount of space in the house be known, that the right amount of chemicals to use may be determined. The best proportions to use of the cyanide, sulphuric acid and water are:—

1 part cyanide of potassium (98% or 99%).
2 parts commercial sulphuric acid.
4 parts water.

The water should be first poured into an earthen or granite ware receiving vessel (do not use a metal one), the acid is then added and finally the cyanide, as directed more fully below. Use .01 grams of cyanide per cubic foot of space in the house or box to be fumigated. When the amount of cyanide necessary has been determined, put it in a paper bag. Close the ventilators and firmly fasten every door of the house except the one used by the operator. When all is ready, take the cyanide, fill the lungs with air, drop the cyanide into the vessel containing the water and acid and leave the house immediately, lock the last door and notice the time.

After the required time has passed, open the doors and give the gas plenty of time to escape before you enter. This gas is very poisonous, so do not enter the house during treatment. Fumigate after sunset, allowing three hours exposure. In ventilating afterward, the amount of artificial heat that can be supplied and the outside temperature must be taken into consideration, so that no injury to the plants will result from the lowering of the temperature. Three such treatments, at intervals of about twelve days, will usually completely rid the house of the white fly.

Johnson's work entitled "Fumigation Methods" is indispensable to anyone who has occasion to use hydrocyanic acid gas as an insecticide. The book can be purchased for $1.00 of the publishers, Orange Judd Co., 52 & 54 Lafayette Place, New York City. To those interested in greenhouse fumigation, pages 9-11, 118 and 124-146 are especially recommended.

If the cyanide treatment seems undesirable, use a fumigant and a contact insecticide, such as "Nicoticide," manufactured by The Tobacco Warehousing and Trading Co., Louisville, Kentucky, for the fumigant, and Bowker's Tree Soap, manufactured by The Bowker Insecticide Co., Boston, Mass., for the insecticide.

For each 2000 cubic feet of space, from one to two ounces of Nicoticide should be used according to the tightness of the house. This treatment should last all night, and the next day the plants should be syringed with a solution of Bowker's Tree Soap at the rate of one ounce in one gallon of water. One such combined treatment should be sufficient for several weeks. If a second treatment is desirable, fumigate the same as before, one week later, and spray as before two weeks after the first treatment.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

THE USE OF LIME IN MASSACHUSETTS AGRICULTURE.

BY WILLIAM P. BROOKS, DIRECTOR.

In most parts of Massachusetts lime is present in the soil in too small proportion for the highest productivity. Various types of soil are found which need liming. What the peculiarities of such soils are will be made apparent by a statement of the more common effects following the application of lime.

Possible effects of liming.

The results produced by an application of lime must of course vary with soil conditions; but the principal effects which are likely to follow may be stated as follows:

1. Free acid if present is neutralized: "a sour soil is sweetened."

2. Some of the less soluble potash compounds of the soil are rendered available and the need of potash manures will be lessened, at least for a time. Liming will not permanently take the place of potash manuring.

3. Phosphatic fertilizers are often rendered more effective. This is especially true of the less soluble materials.

4. Organic matter decomposes more rapidly and the plant food it contains becomes more promptly available. This action is most important in its relation to nitrogen. It is especially valuable in heavy soils in which organic matter naturally decays slowly. Its effect is also often important after turning under a green crop.

5. Ammonia and its compounds change into nitric acid more quickly; in other words, ammonia nitrogen becomes more promptly available. Sulfate of ammonia when used as a fertilizer gives poor results in many soils unless these are first heavily limed.

6. Injurious compounds of iron, and perhaps other injurious compounds are rendered harmless.

7. Lime mellows the heavy and more clayey soils. It makes them more friable and permeable. It helps prevent the formation of crusts and cracking, and makes the maintenance of good tilth more easy.

How to determine what soils need liming.

1. Those soils on which, when seeded, timothy and clovers fail, and where sorrel comes in abundantly together with red top, almost invariably need liming. Beeches and locusts among trees are lime lovers and where these grow spontaneously and attain good size lime is hardly likely to be required. The presence of much moss or an abundant growth of bluets (*Houstonia caerulea*), horse tails (*Equisetum*), or polypods (*Polypodium*) is an indication that lime will probably be beneficial.

2. When soil is sour it will when moderately moist turn blue litmus paper placed in contact with it red as the paper absorbs the moisture from the soil. Such paper can be purchased from druggists. It should not be handled with the fingers. "Sour" soils need liming for most crops.

3. If still in doubt after making the litmus test, place a few drops of common ammonia water in a glass with half a cupful of pure water. Into this stir about a teaspoonful of the soil to be tested. Allow the mixture to settle. If the soil needs liming the water standing above it will have a reddish brown appearance, the depth of the color depending upon the amount of soil taken and its need of liming. In making this test it will be wise for the purpose of comparison to stir up an equal amount of soil with the same quantity of pure water without the addition of ammonia. There will be a distinct difference in color if lime is needed.

4. The most certain evidence of all as to whether lime will prove beneficial is afforded by a simple experiment which may be carried out as follows: Lay off two square rods in a part of the field to be tested which seem to be fairly representative and even in quality. To one of these apply twenty (20) pounds of freshly slaked lime after plowing and at once work it in deeply. Then apply to each plot a liberal quantity either of manure or fertilizer and precisely the same amount to each. Plant table beets. If the soil was much in need of lime, these will make much the better growth upon the limed plot.

Kind of lime to use.

No one kind of lime can be named which will invariably be the best to use. The buyer of course seeks maximum efficiency for the money and labor expended. The selection must therefore be in large measure determined by relative prices as related to actual values. The qualities of the more important materials between which choice will usually lie will be briefly stated and figures indicating relative content of actual lime (calcium oxide) will be given for such as are fairly constant in composition. Information on these points will make it apparent that choice should not be based upon ton price alone. Composition and efficiency must be considered also.

(1) *Quick or burned lime.* This, if made by properly burning a good limestone, should contain 95% or more of actual lime. One hundred pounds (100) when slaked will take up about 30 to 35 pounds of water. It is best to slake such lime before spreading it. This can be accomplished either by placing the lime in small heaps in the field where it is to be used and covering with soil, when the lime absorbs water either from the soil or by exposure to the weather; or more quickly and perfectly by sprinkling it with just enough water to cause it to crumble into a dry powder. After water is added the heap should stand a few days when it will be best to shovel it over a screen to separate any lumps which are still unslaked. Fresh slaked lime will prove more effective in correcting most of the faults of soils needing liming than any other form of lime. It will be especially desirable in soils rich in inert organic matter, or in those containing a large proportion of clay. Limes containing a large proportion of magnesia are less desirable as a rule than the purer limes although the magnesia is not usually without value in our soils.

(2) *Air slaked lime.* Air slaked lime is formed when burned lime is exposed to the air, the more quickly in proportion as the air is moist. Under such conditions the lime first absorbs water from the air; later, if the exposure be long conttnued, it will also absorb carbonic acid. From 130 to 170 pounds of fully air slaked lime are required to furnish as much actual lime (calcium oxide) as is contained in 100 pounds of fresh burned lime of good quality. For most purposes the air slaked lime will probably answer almost as well as water slaked lime, but it must be remembered that a larger quantity is required to produce equal effect.

(7) *Slag meal.* This material is used primarily as a source of phosphoric acid, but it usually contains also from 40 to 50 per cent of actual lime. A considerable proportion of this lime is in combination, though about one-fourth of it is usually found in the free form. About one-half of the lime present is believed to exist in combination with phosphoric acid, and the balance is in combination with silica as a basic silicate of lime. The latter compound is usually soluble and when applied to the soil must act in many respects in a manner similar to free lime. It would probably not be advisable to depend upon slag meal for the purpose of producing that sharp change in mechanical condition which is needed in the heavy, sour clays; but by a rather free use of slag meal many of the ordinarily looked for beneficial effects of liming may be expected to follow; and in any case, if soil has once been brought into satisfactory condition by one heavy application of lime, we may doubtless depend upon the lime in slag meal freely used as a source of phosphoric acid to hold the soil in a satisfactory condition as regards that element.

The relation of lime to crops.

Different plants require varying amounts of lime, some are extremely sensitive to and much injured by the presence of free acid. Others are comparatively indifferent to the presence of such acid, while still others appear to do better in soils containing it. Among plants requiring large amounts of lime in the soil are clovers, alfalfa, peas, beans and vetches. Grasses as a rule require less lime than clovers; but timothy will not do well in soils markedly deficient in lime. On the other hand red top thrives in sour soils. Neither corn nor millets are especially sensitive to acid. They will often do well on soils which are sour. The same is true of potatoes, although excessive acidity is undesirable even for these crops. Cabbages and turnips and all the cultivated members of the same family require large amounts of lime. Mangel wurtzels, sugar beets, and table beets are usually benefitted by liming, as are also onions, spinach, lettuce, and parsnips. Celery also is said to be much benefited by liming. Among fruits, the apple, pear, peach, plum, and cherry usually do best where lime is abundant. The blackberry, on the other hand, does well in soils containing free acid and some experiments indicate that the strawberry does not particularly require liming. Lime should not be applied immediately preceding

(3) *Ground limestone.* Raw limestone first ground very fine is now offered by some dealers, and is recommend in certain quarters. In deciding whether to use this form of lime, the following points should be remembered :

(a) Limestone is a carbonate of lime and it will require about 175 pounds of this compound to furnish as much actual lime as will be contained in 100 pounds of burned lime.

(b) Limestone however finely ground is soluble only to a small extent and its action will be far slower in most soils than that of freshly slaked burned lime.

(4) *Agricultural lime.* Some companies are now putting on the market special preparations of lime which are recommended as especially fitted for use in agriculture. These are usually in a very fine mechanical condition and are in most cases made up in part of fine ground carbonate of lime and in part of slaked lime. The package in which these are offered makes them exceedingly convenient for handling and for application, but pound for pound such grades of lime are less effective than equal amounts of burned lime.

(5) *Marl.* Marl is a deposit consisting of variable proportions of carbonate of lime (coming from disintegrated shells) and fine earth. When applied to soils in suitable quantities, it is likely to produce much the same effects as will be obtained from an application of air slaked lime. It is not, however, so rich in actual lime as the latter, and it will require more than one pound of marl to produce the effects likely to be produced by application of that amount of air slaked lime. Statements of the average composition of marl can have no particular value. In order to determine whether it is better economy to use marl or some other form of lime, it will be necessary to know its composition. Efficiency will be measured, in large degree at least, by the relative proportions of actual lime.

(6) *Land plaster.* Land plaster, if pure, is made up of finely ground sulfate of lime (gypsum) which contains only about 40 pounds of actual lime in 100. It is less energetic in its action on most soil constituents than lime in other forms. It is, however, often beneficial and may serve numerous useful purposes which will not be discussed here. At prevailing prices it is not, however, usually advisable to select plaster as the material to be used for the correction of the faults most common in soils needing liming.

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a crop of potatoes. They are more likely to be affected with scab should such an application be made.

Methods of supplying lime.

Although lime applied as a top dressing on grass lands is often beneficial, it proves most effective in correcting most of the faults of soils needing liming if it can be applied to the plowed surface and thoroughly mixed with the soil. The autumn or the early spring is usually best; but lime may be applied without hesitation at any season of the year, when the land is not occupied by crops and when it can be plowed. If manures or fertilizers containing ammonia or organic nitrogen are to be used in connection with lime, the latter should be put on and incorporated with the soil before the manure or fertilizers are applied. Lime should always be applied broadcast. To do this work by hand is extremely disagreeable on accouut of the lime dust which is inhaled. A machine distributer should be used if possible.

Quantity of lime needed.

The amount of lime applied under different conditions varies from a few hundred pounds to several tons, but an average of about one ton of quick lime to the acre will usually be sufficient. If air slacked lime or other weaker forms of lime are employed, the quantity must be proportionally increased. Such application as has been suggested will not usually be called for more frequently than once in five to seven years.

Mixing the lime with the soil.

As soon as possible after it is spread upon the rough furrow, lime should be deeply worked into the soil. For this purpose either the disk, cutaway, or spring-toothed harrow will be most effective.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

THE CONTROL OF ONION SMUT.

BY GEORGE E. STONE.

Onion smut has been known in Massachusetts for about forty years, Mr. Benjamin P. Ware having referred to the injury caused by it in the Massachusetts State Board of Agriculture Report for 1869–70. The smut germs infect the seedlings at a very early stage, the disease taking the form of dark-colored or sooty masses, and as the onion matures the black areas of pustules may be noticed on the leaves and bulbs. Since infection takes place in the early stages of the seedling, onion sets being immune to the disease, any method which will kill the smut spores on the seed or in the soil is beneficial, and treatment of the seed and the soil has given good results.

Onion smut appears to be on the increase in the Connecticut valley and other parts of the United States and in some sections the growing of onions has been discontinued. Positive results have been obtained by applying per acre 100 pounds sulphur thoroughly mixed with 50 pounds air-slaked lime in the drills; and ground lime drilled in with a fertilzer drill at the rate of 75 to 100 bushels per acre is good, but the best results have been obtained by the use of formalin; either 1 pound to 30 gallons of water (1—240) or 1 ounce to 1 gallon of water (1—128) may be used. Formalin can be easily

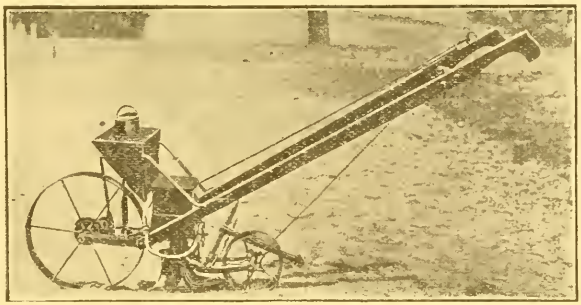


FIG. 1.

applied at the time of sowing the seed by means of a suitable copper or galvanized iron tank (see fig. 1) attached to a "Planet Junior" or almost any form of onion sower. At the bottom of the tank a block tin tube about a quarter of an inch in diameter is fastened, to which is attached a valve to regulate the flow of the formalin, and as the tube is flexible and at the same time more or less rigid, it can be bent in any position desired, and held securely. The tank is attached to the sower by means of strips of iron (see fig. 1) and holds one gallon.

The tank is not fastened to the iron frame, but merely sets in it, which is sufficient to hold it in place, and it can be easily removed. In figure 2, the tank and tube are shown detached from the sower. A special feature in the construction of the tank consists in its being so made that it will drain easily, the middle of the tank being lower than the ends. A larger tank can be used if necessary, as the weight of the formalin is not enough to affect the easy handling of the machine. The flow of the formalin solution in a tank of this shape is nearly uniform. There is little difference between the amount of the formalin flowing when the tank is full and when nearly empty.

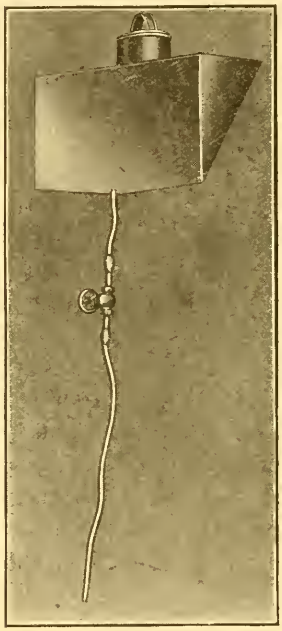


Fig. 2.

Tests have shown that about 1200 feet of drill can be treated with one gallon of formalin solution. The flow of the solution, which should be sufficient to cover the seed and wet the soil around it to a certain extent, is regulated by the valve. An attachment of this sort can be easily made by a local plumber and readily fastened to an onion sower.

CIRCULAR NO. 22. APRIL, 1909.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

POULTRY MANURES, THEIR TREATMENT AND USE.

BY WILLIAM P. BROOKS.

The total number of fowls kept in the state is estimated at two and one-half millions. The average night droppings of medium breeds according to determinations made in this station must amount to 40 pounds per fowl per year. On this basis the amount of poultry manure easily collectible from the fowls of the state annually is 50,000 tons. If the plant food in a ton of average fresh poultry manure be purchased at current prices in fertilizers, the outlay would amount to nearly $7.50. Observations and experiments indicate that as poultry manure is frequently handled it suffers a loss of one-half or more of the nitrogen it contains when voided before it reaches the land. If a loss of one-half correctly represents the average, the total money value of nitrogen annually wasted from our poultry manures must amount to about $160,000. It is the aim of this circular to show how this loss may be prevented.

General character and composition of poultry manures.

Poultry manures are particularly rich in nitrogen and their general characteristics are such that they readily decompose. As a result of decomposition the manure heats and there is a rapid and large loss of moisture and of ammonia.

The composition is subject to wide variations, due to some extent to differences in feeding, but in far greater degree to methods of handling and keeping.

The following tables present the results of recent analyses made in our laboratory.*

*Credit for these analyses is due Mr. H. D. Haskins and L. S. Walker, Chemists in the fertilizer division of the station.

TABLE 1.

COMPOSITION OF POULTRY MANURES.

Hen Manure.	Moisture. %	Nitrogen. %	Potash. %	Phos. Acid. %	Lime. %
C (about 2 weeks), . .	67.62	1.36	.43	1.11	1.33
P " " . .	68.58	1.07	.44	1.10	2.78
L " " . .	74.96	1.21	.43	1.22	1.71
B-1 (1 night), ...	69 76	1.91	.33	1.00	.53
B-2 (2 or 3 weeks), . .	60.61	2.30	.48	1.09	1.40
B-3 (6 to 8 weeks), . .	48.82	1.90	.63	2.07	1.93
G-1 (1 night), ...	66.69	1.58	.42	.50	1.46
G-2 (3 nights), . . .	64.06	1.13	.39	.62	1.89
Pigeon, ...	25.01	3.90	1.06	2.15	.96
Duck, ...	61.62	1.12	.49	1.44	1.12
Goose, ...	67.06	1.12	.51	.53	.26

TABLE 2.

COMPOSITION ON BASIS OF EQUAL DRY MATTER.

Hen Manure.	Dry Matter %	Nitrogen. %	Potash. %	Phos. Acid. %	Lime. %
C (about 2 weeks), . .	32.	1.34	.42	1.096	1.314
P " " . .	32.	1.09	.44	1.120	2.831
L " " . . .	32.	1.486	.52	1.499	2.101
B-1 (1 night), ...	32.	2.021	.31	1.058	.56
B-2 (2 or 3 weeks), . .	32.	1.868	.38	.86	1.137
B-3 (stored 6 or 8 weeks),	32.	1.19	.39	1.294	1.206
G-1 (1 night), ...	32.	1.517	.31	.47	1.402
G-2 (3 nights), ...	32.	1.006	.34	.55	1.682
Average, ...	32.	1.44	.39	.99	1.53

Table 1 shows the composition of the material just as it was collected and taken to the laboratory. Table 2 shows the composition of the different samples of hen manure all reckoned upon the same basis of dry matter in 100 pounds.

Samples B–1, 2 and 3 are richer than the others in nitrogen, because the fowls received more animal food. Potash varies relatively little. Phosphoric acid varies widely and must be greatly affected by the amount of bone in the animal food given to the fowls.

The comparison between the amounts of nitrogen shown in Table 2 in samples B–1, 2 and 3 and between samples G–1 and 2 is particularly instructive. It illustrates the fact that hen manure unmixed with absorbents or chemicals suffers very rapid loss of nitrogen. Sample B–2 differs from B–1 only in the fact that the interval between removal of droppings from beneath the roosts was longer. The season of this experiment was March, and the droppings were frozen a part of the time. During warmer weather the loss must have been yet greater. G–2 though accumulating only during three nights seems to have lost relatively more nitrogen than B–2, perhaps because the house was much warmer than the one from which samples B came; although this seems an insufficient explanation for the difference.

Examination of Table 1, especially comparison of the samples B–1 and B–2 shows that the fact that nitrogen has been lost is obscured by the further fact that there has been an even larger loss of water. The percentage of nitrogen in B–2 (Table 1) is larger than in B–1, but only because the former is dryer. Table 2 shows that there has been a large actual loss.

Methods of Preservation.

The free use of fine dry loam, or the admixture of such materials as kainit, acid phosphate, muriate of potash or land plaster, or of a combination of some of these will effectively prevent loss of nitrogen. Loam alone must be used in quantities so large as considerably to increase cost of handling. Either kainit, muriate of potash or acid phosphate alone is effective, but the mixture especially with the first holds the material too moist for convenient handling. Plaster is somewhat less sure in its action, and if largely used the mixture may form hard, dry cakes. Kiln dried pine sawdust has been successfully used with kainit by the Maine Experiment Station.

The writer recommends fine, very dry earth in moderate quantities on the dropping boards and daily removal. To each 100 pounds of fresh droppings, add a mixture made up as follows :

Kainit,	15 lbs.
Acid phosphate,	12 lbs.
Land plaster,	10 lbs.

Sprinkle this in proper proportion over each lot of fresh material as it is added to the accumulating stock, and mix before use.

Such a mixture will give a combination of fertilizer elements in proportions well suited for most crops.

What not to do.

The frequency with which correspondents inquire as to the suitability of wood ashes, coal ashes or lime for preserving poultry manures leads me to caution against mixing with these materials. All of them are likely to increase the loss of nitrogen. Wood ashes may be used as a fertilizer in connection with poultry manure, but if so used should be applied by themselves, preferably before applying the poultry manure.

The use of poultry manure.

The fact should be kept in mind when planning for the use of poultry manure, that its constituents are quickly available. It should be remembered, moreover, that the material is naturally so strong that in close contact with either seeds, foliage, or delicate rootlets in large quantities, it will burn and injure. Such a mixture as has just been recommended would usually best be used by spreading either broadcast or very widely in the hill or drill. It should give excellent results for mowings, lawns, and in the garden.

If to be used for potatoes, the writer would prefer using 4 pounds of high grade sulfate of potash in place of the 15 pounds of kainit.

The quantity of poultry manure applied must naturally be varied with soils and crops, but it should be remembered that such manures well preserved, or such mixtures of poultry manures and chemicals as have been suggested are much stronger and richer than ordinary manures and should be used in smaller quantities. From about one and one-half to two and one-half (1½ to 2½) tons per acre will be the usual range in quantity. It should be remembered that kainit, acid phosphate and land plaster are in themselves fertilizers, and that in mixtures with poultry manures their usual fertilizer action is not at all diminished.

CIRCULAR NO. 23. JULY, 1909

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

A PARASITE OF THE ASPARAGUS BEETLE.

BY H. T. FERNALD, PH. D.

The injury to asparagus plants caused by the asparagus beetle (*Crioceris asparagi* Linn) is fully appreciated by those who raise this crop for market.

Little protection from this pest has been obtained by the attacks of enemies, and spraying, the use of trap plants and permitting fowls to run in the beds have been the usual methods of control.

No parasite has been reported as attacking the asparagus beetle, but on the second of June of the present year a tiny four-winged fly was observed by the writer at Amherst, passing everywhere over the plants and carefully examining the eggs of the beetle, which were then abundant on the stalks of the plant.

The fly appeared to be in no hurry, but wandered up and down the stalks and their branches, examining the eggs of the beetle which it found, and seemed indeed to be rather stupid, often entirely passing eggs no farther away than the length of its body, without giving them the slightest attention. Occasionally an egg would receive a careful examination, and one in about every eight of these was apparently considered satisfactory. In such cases the parasite crawled out on the upper side of the egg as it projected from the stem of the plant, the egg being none too long to accommodate the insect. Then heading outward, it gradually bent the end of its abdomen downward and slowly pushed its ovipositor into the egg of the asparagus beetle. After a few moments it withdrew the ovipositor and resumed its travels over the plant. This process was observed several times under a lens, the insects not being easily frightened if the movements of the observer were slow, and shadows cast having no effect upon their actions.

A specimen captured at this time was sent to the Department of Agriculture at Washington, where, through the kindness of Dr. L. O.

Howard, it was determined by Mr. J. C. Crawford as a species of **Tetrastichus**, the species not being ascertainable from its poor condition.

For a week or so these parasites could be found in the field, but after that time no more were discovered till July 12, when a single individual was captured. At this time there were almost no eggs present and but very few of the grubs of the beetle, the next brood not having made its appearance. If we consider the great abundance of the eggs in June, the scarcity of the grubs in July would at least suggest that we have a very effective parasite, for no treatment for the beetle had been given to the field, and the weather during the month has been favorable for its preservation.

The fly averages about 2½ millimeters long, varying from slightly over 2 to nearly 3 millimeters. Its body is a metallic green, brightest on the abdomen, more blu.sh on the head and thorax, and when the sun strikes upon it is very noticeable for this reason.

This parasite has also appeared this spring at Concord, Mass., where it seems to have been equally effective, for though the beetles were very abundant early in June and laid many eggs, very few grubs could be found in the fields the last of the month. One of the observers at Concord reports seeing the parasite occasionally attack the eggs with its mouthparts, consuming the contents of the eggs. The writer has not observed this, and considering the small size of the parasite and the ease with which one end of the body might be mistaken for the other without the aid of a magnifying glass, it would seem very desirable to verify this observation.

We may conclude from the above that an egg parasite of the asparagus beetle has now appeared, and promises to be an effective agent in the control of this pest.

CIRCULAR NO. 24. SEPTEMBER, 1909.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

J. B. LINDSEY, CHEMIST.

CONTENTS.

I. AN ACT TO PROVIDE FOR THE PROTECTION OF DAIRYMEN.[1]

Be it enacted, etc., as follows:

SECTION 1. All bottles, pipettes or other measuring glasses used by any person, firm or corporation, or by any employee or agent thereof, at any creamery, cheese factory, condensed milk factory, milk depot, or other place, in this state, in determining by the Babcock test, or by any other test, the value of milk or cream received from different persons or associations at such creameries, factories or milk depots as a basis of payment for such milk or cream, shall before use be tested for accuracy. Such bottles, pipettes, or measuring glasses shall bear in ineffaceable marks or characters the evidence that such test has been made by the authority named in section two of this act. No inaccurate bottles, pipettes or glasses shall bear such marks or characters, but when found inaccurate shall be marked "Bad."

SEC. 2. It is hereby made the duty of the director of the Massachusetts[2] Experiment Station of the Massachusetts Agricultural College, or of some competent person designated by him, to test all bottles, pipettes or other measuring glasses, as required by section one of this act. The director of the experiment station shall receive for such service the amount of the actual cost incurred, and no more,

[1] Chapter 202, Acts and Resolves of Massachusetts for 1901.

[2] Massachusetts substituted for Hatch. See Chapter 66, Acts and Resolves of Massachusetts for 1907.

the same to be paid by the persons or corporations for whom it is rendered.

SEC. 3. Within six months after this act takes effect, and once each year thereafter, the director of the Massachusetts[2] Experiment Station, or his authorized agent, shall inspect at the expense of the owners all centrifugal or other machines used by any person, firm or corporation, or by any agent or employee thereof, for the testing of milk or cream in fixing the value thereof; and the director of the experiment station or his authorized agent shall cause all such machines to be put into condition to obtain accurate results with the Babcock test or other tests, at the expense of the owners thereof. Such machines may be replaced by new ones at the option of the persons to whom they belong.

[3]SEC. 4. No person shall, either by himself or in the employ of any other person, firm or corporation, manipulate the Babcock test or any other test, whether mechanical or chemical, for the purpose of measuring the butter fat contained in milk or cream as a basis for determining the value of such milk or cream, or of butter or cheese made from the same, without first obtaining a certificate from the director of the Massachusetts[2] agricultural experiment station that he or she is competent to perform such work. Rules governing applications for such certificates and the granting of the same shall be established by the said director. The fee for issuing the said certificate shall in no case exceed two dollars, shall be paid by the applicant to the said director, and shall be used in meeting the expenses incurred under this act. If the duly authorized inspector finds an operator who, after receiving his certificate of competency, is not, in the judgment of the inspector, correctly manipulating the Babcock or other test used as a basis for determining the value of milk and cream, or who is using dirty, untested or otherwise unsatisfactory glassware, he shall immediately report the case in writing to the director of the station. The director shall at once notify said operator in writing and give him not less than thirty days to make the necessary improvements. At the expiration of that time the director may order a second inspection, the cost of which shall be borne by the operator or by the person, firm or cor-

[2] Massachusetts substituted for Hatch. See Chapter 66, Acts and Resolves of Massachusetts for 1907.

[3]As amended Chapter 425, Acts and Resolves for 1909.

poration employing him, and if the required improvement has not been made, the director is empowered to notify in writing said operator, or the person, firm or corporation employing him, that his certificate of competency is revoked. In case of any subsequent violation the said director may revoke the certificate of competency without giving the notice aforesaid.

SEC. 5. It shall be the duty of the director of the Massachusetts[2] Experiment Station to test farmers' samples of milk or cream by the Babcock method, and report the results of each test, the cost of such test to be paid by the farmer. The director shall also test by the Babcock method, samples of milk or cream sent from any creamery, factory or milk depot in the state by its proper representative, the actual cost of such tests to be borne by the sender. The experiment station shall publish and distribute such information concerning the Babcock test, and the taking and forwarding of samples, as it deems necessary under this section.

SEC. 6. Any person violating any provision of this act shall be fined not more than twenty-five dollars for the first offence and not more than fifty dollars for each subsequent offence.

SEC. 7. This act shall take effect on the first day of July in the year nineteen hundred and one. (*Approved March 26, 1901.*)

2. THE BABCOCK TEST.[4]

P. H. SMITH.

Attention is called to the following suggestions in regard to the manipulation of the Babcock test the slighting of which, in the haste of commercial work, will tend toward inaccuracy.

Preservation of Samples.

Composite samples of milk and cream should be preserved in clean, wide-mouthed, tightly stoppered bottles; they should be well mixed after each addition to insure a uniform distribution of the preservative and its thorough incorporation with the cream. The samples should be kept in a cool place out of the sun. Ground glass stoppered bottles are to be preferred but owing to the expense they are

[2]Massachusetts substituted for Hatch. See Chapter 66, Acts and Resolves of Massachusetts for 1907.

[4]Revision of an article by E. B. Holland published in a special bulletin in 1903.

not generally used. Bottles with tight fitting corks of first quality form the most satisfactory substitute.

The preservatives most commonly employed for keeping composite samples are corrosive sublimate, bichromate of potash and formalin. The two former are sold in tablets prepared especially for the purpose, and simply need to be powdered and dissolved in the sample; formalin (formaldehyde) is sold in 40 per cent. solutions and the quantity needed for a composite can be easily added by means of a small dropper or pipette.

Corrosive sublimate tablets are to be preferred to other preservatives as they interfere least with the action of the sulfuric acid in making the test. Where the total solids of milk samples are to be determined in addition to the percentage of fat, formalin can be used to advantage as the amount necessary does not affect the accuracy of the test. Six to ten drops are sufficient to preserve a pint sample several weeks if the sample is kept in a cool place. An undue excess of any preservative should be avoided.

Sampling and Pipetting. A thorough preparation of the sample is of vital importance, and is best accomplished by gently rotating and by pouring back and forth from the mixing vessel. Shaking and forcible pouring is not permissable, as it is likely to cause partial churning and is sure to inclose a large amount of air, rendering the sample unfit for pipetting. All cream adhering to the sides and the stopper of the sample bottle should be incorporated, and the resulting mixture not show any solid particles of fat. A small, fine wire sieve is of great help in detecting and correcting a lumpy condition.

After mixing, the sample should be pipetted *immediately* as the fat globules rise rapidly towards the surface. The pipette should be first rinsed with the sample, then filled again slowly taking care to avoid air bubbles, held in a vertical position when lowering the liquid to the mark and read with the entire meniscus or crescent above the line. In transferring to the test bottle, smearing of the neck should be avoided as far as possible and the pipette blown clear.

Sour milk can be readily brought into a condition suitable for pipetting by the use of a wire sieve to break the clots or by neutralizing the acidity with a small pinch of powdered caustic alkali or 5

per cent. (by volume) of household ammonia. In the latter case the results must be increased to offset the dilution by the factor of 1.05.

Churned milk. In partly churned samples the lumps of butter can be temporarily incorporated by heating and pouring, or by dissolving in 5 per cent. (by volume) of ether. With the first method it is necessary to pipette while the sample is warm and it is advisable to weigh the test. It is extremely difficult to secure an accurate test of a badly churned sample.

Separator cream containing more than 25 per cent. butter fat cannot be pipetted directly with accurate results, for the reason that a cream pipette (18 c. c.) will not deliver the requisite amount (18 grams) because of the lower specific gravity and greater adhesiveness of the liquid. The experiment station does not advocate the use of 50 per cent. test bottles for rich cream, but prefers to use one-half amount (9 grams) of the weighed sample in the 30 per cent 6 inch bottle where tests run over 25 per cent., multiplying the results by two. In pipetting thin cream it is well to use two pipettes alternately, allowing one to drain into the test bottle while the other is in use.

Sour cream can be suitably prepared by the use of a sieve but the inclosed gas prevents satisfactory pipetting and makes weighing of the test absolutely necessary, if accurate results are to be obtained.

Adding Acid. Before mixing, the acid and the contents of the test bottle should be at a temperature of 60°—70° Fahr. When the acid is added the test bottle should be turned so as to wash down all the sample adhering to the sides of the neck, rotated at once and this continued until all the lumps of curd are dissolved. The hand mixing should never be slighted, and care should be taken not to throw the fat into the neck of the test bottle.

Cream of a high fat content and naturally a low percentage of curd, requires slightly less than the regular quantity of acid (17.5 c.c.) and this is equally true of samples containing an excess of bichromate of potash (preservative). Skimmilk, containing slightly more curd than whole milk, and samples preserved with formalin which hardens the nitrogenous bodies (proteids), need relatively more than the usual amount of acid.

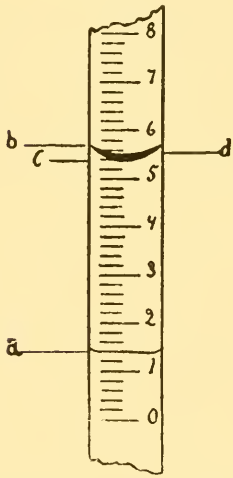
Whirling and Filling. The machine should be balanced, provided there is not a full battery, by a suitable arrangement of the bottles. It should be run for at least five minutes at a speed equal to the theoretical demands for an inner disc of the given diameter. The diameter of the disc is

understood to be twice the distance between the center of the disc and the point of union between neck of test bottle and bulb when it is whirling.

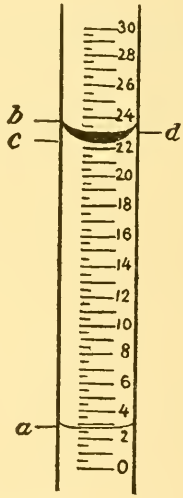
Diameter of disc. Inches.	Revolutions a minute.
10	1074
12	980
14	909
16	848
18	800
20	759

The test bottle should then be filled to the shoulder with hot water and whirled again for fully two minutes and longer if the fat does not separate *clear* and *oily*. After the final filling which should bring the fat well up into the neck of the test bottle, it should be whirled again for two minutes to perfect the column of fat.

Reading Results. The percentage can be read more safely and accurately by using a pair of dividers to measure the column of fat, than by trusting to the unaided eye.



*In measuring the fat column in the neck of a *milk* test bottle the reading shonld be made from a to b not to c or to d.



*In measuring the fat column in the neck of a *cream* test bottle the reading should be made from a to c not to b or to d. The size of the meniscus is magnified in this cut.

*Reproduced from Testing Milk and Its Products, published by Mendota Book Co., Madison, Wis.

In accordance with recent investigation it is considered more accurate to measure the column of fat in a *cream* bottle from the *bottom* of the meniscus (crescent) as indicated in the above cut. Such observations as we have made confirm this. The writer prefers to use only the 6 inch 30 per cent. Connecticut cream bottles taking one-half the usual amount (9 grams) where the cream tests over 30 per cent. The use of 9 inch cream test bottles having a smaller neck is increasing on account of the greater accuracy obtained.

The reading should be made immediately, before the fat begins to contract and settle, at a temperature of 120° to 140° Fahr. and the reading is equivalent to percentage when the normal amount of material (18 grams) is taken. Too rapid cooling of the samples may be checked by setting the bottle into a vessel of water heated to 130° Fahr.

The column of fat should be a clear yellowish liquid with a sharply defined upper and lower meniscus or crescent, with no white curd or charred material in or below the fat and no bubbles or foam on its surface. Discoloration of the fat and charring is due to excessive acid action, which may be caused by too strong, too much or too warm acid, too warm a sample or failure to mix at once, or the action of some preservative, especially bichromate of potash.

Light colored fat and the presence of undissolved curd may be caused by too weak, too little or too cold acid, too cold a sample, insufficient whirling or lack of proper heat, or the action of some preservative, especially formalin.

Bubbles or foam on the surface of the fat may be due to the use of hard water containing carbonates or sometimes to excessive heat in poorly constructed turbines.

Care of Glassware. The contents of the test bottles should be shaken out while hot to remove the deposit of lime sulfate, rinsed with clean water to remove the acid which interferes with the cleaning action of the soap, cleaned with hot soap suds preferably made by using some strongly alkaline soap powder, rinsed with hot water and allowed to drain.

Pipettes should be cleaned in a similar manner. The scale when indistinct can easily be restored by rubbing over with an oil shipping crayon.

Communications in regard to the dairy law may be addressed to

P. H. SMITH,
Mass. Agricultural Experiment Station,
Amherst, Mass.

CIRCULAR NO. 25. (Revision of No. 1) OCTOBER, 1909.

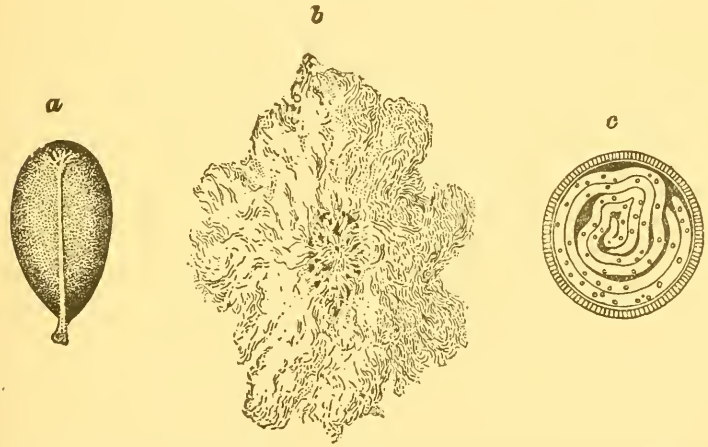
MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

COTTONSEED MEAL.

By J. B. LINDSEY.

Method of Manufacture. The seed of the cotton plant as it comes from the gin which removes the cotton fibre is still covered with a coat of white down, technically known as "linters." The "linters" being removed, the seed itself appears black in color, and irregular egg shape in form. The thick, hard, black seed coat or hull is filled with the coiled embryo (meat) which contains a large number of oil cells. Machines have



a. Seed entirely free from fibre (delinted) magnified three times. b. Seed covered with cotton (coma). c. Section of seed showing crumpled embryo (meat) filling the seed coats. The above drawings taken from Hicks in Year Book of the U. S. Department of Agriculture, 1895.

been invented to remove the hull and the residue or meat is cooked in large iron kettles, and while still hot is wrapped in hair cloth and subjected to a pressure of 3000 to 4000 pounds to the inch to remove as much of the oil as possible. The pressed cottonseed cake when ground results in the bright yellow cottonseed meal of commerce. A ton of seed furnishes about 1,000 pounds of hulls, 300 pounds of extracted oil and 700 pounds of meal.[1]

[1]The Cottonseed Industry by C. M. Dougherty in Year Book of U. S. Dept. of Agriculture 1901, pp. 284-298.

Composition.

As a Feed-Stuff. Cottonseed meal varies somewhat in composition particularly in protein and fat, depending upon the locality in which it is grown, season, and upon the possible addition of hulls. That obtained from seed grown in Texas, Arkansas, Tennessee and Missouri usually tests higher in protein than that produced in Georgia and the Carolinas, the latter being known as south-eastern meal. The following may be said to show the composition of meal of satisfactory quality:

	Per Cent.
Water,	7.00
Ash,	6.00
Protein,	41.00
Fiber,	6.30
Extract Matter,	30.70
Fat,	9.00

The extremes in case of protein are 36 and 47 per cent. and in case of fat, 7.50 and 12.00 per cent.

As a Fertilizer. The chief value of cottonseed meal for fertilizing purposes consists in its nitrogen content; it also contains noticeable percentages of phosphoric acid and potash. The following shows mean and extremes in case of nitrogen and the probable extremes for the two other ingredients:

	Per Cent.
Nitrogen,	5.75—7.50 6.56
Phosphoric acid,	2.00—3.00
Potash,	1.50—2.00

Agricultural Uses of Cottonseed Meal.

Cottonseed meal is a valuable and usually the most economical protein concentrate for dairy animals. It should not be fed by itself but mixed with other bulky feeds to distribute it. Rations containing cottonseed meal as a constituent may be had upon application.

In Massachusetts large amounts of cottonseed meal are used as a fertilizer, particularly for tobacco. Naturally the higher its nitrogen and the lower its fat percentage, the more valuable it is for this purpose.

Grading Cottonseed Meal. The Inter-State Cottonseed Crushers' Association at its annual meeting held at Memphis, May 19-20-21, 1909, established the following rules for grading cottonseed meal:

Rule 12, Section 1. *Choice cottonseed meal* must be finely ground, perfectly sound and sweet in odor, yellow, free from excess of lint, and by analysis must contain at least 8 per cent. of ammonia (6.56 per cent. nitrogen) or 49 per cent. of combined protein and fat.*

Section 2. *Prime cottonseed meal* must be finely ground, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint and by analysis must contain at least 7.50 per cent. of ammonia (6.18 per cent. nitrogen) or 46 per cent. of combined protein and fat.*

Section 3. *Good cottonseed meal* must be finely ground, of sweet odor, reasonably bright in color, and by analysis must contain at least 7 per cent. of ammonia (5.75 per cent. nitrogen) or 43 per cent. of combined protein and fat.*

Quality Deteriorated. It is quite natural, as has already been pointed out, that cottonseed meal should vary in chemical composition as well as in appearance, depending upon the season, method of handling, and locality in which it is grown It is evident that the meal sent into Massachusetts of late years has decreased somewhat in quality or has come from different shipping points as the following analyses made at this laboratory will show:

HIGH AND MEDIUM GRADES.

	1904.	1905.	1906.	1907.	1908.	1909.‡
No. of samples,	62	61	52	76	41	36
Nitrogen,	7.00	6.66	6.52	6.35	6.74	6.40
Protein,	43.60	41.60	40.68	39.73	42.12	40.01
Fat,	9.00	8.80	8.66	9.07	8.94	8.41

*The Station endorses the ammonia or nitrogen but not the combined protein and fat guarantee as a basis for settlement. A lot of meal may contain the requisite 49, 46 or 43 per cent of combined protein and fat, but through faulty extraction or for some other reason, not the necessary nitrogen, ammonia or protein equivalent. Thus, if a 49 per cent. combined guarantee should contain 11 per cent. of fat, it would contain only 38 per cent. of protein instead of the necessary 41 per cent. Inasmuch as cottonseed meal is purchased primarily for its nitrogen or protein, it is believed to be fairer to adhere to the nitrogen or ammonia content of the meal as a basis of settlement. In Massachusetts it is illegal to present a combined protein and fat guarantee.

†Average only 13 samples.

‡Spring collection.

In earlier years meals testing 45 per cent. of protein (7.2 per cent nitrogen) were quite common. Although it is stated on good authority that the 1908 crop of seed was of excellent quality and that much of the resulting meal would test 46 or more per cent. protein, the meal collected in Massachusetts rarely contained over 41 per cent (6.56 per cent nitrogen). It has been affirmed that many crushers took advantage of this condition to add sufficient linters to reduce the protein to 41 per cent. While the addition of 10 per cent of linters would probably not render the meal injurious to animals, such an admixture is not recommended. The linters or short cotton fibers cause the meal to have a fluffy, bulky appearance.

It is further believed that some jobbers at times make a practice of sending guarantee tags to be attached by the shippers representing the meal to have a higher per cent of nitrogen or protein than it actually contains. It is decidedly unfair and illegal for either jobber or shipper to attach 41 per cent guarantee tags to meal containing only 38 per cent protein. It injures the reputation of the seller and likewise destroys the confidence of the purchaser. Such a practice cannot be too strongly condemned. The price of the meal should vary in accordance with its nitrogen or protein percentage and its appearance. Meal testing 41 or more per cent protein should be held at an advance over 38 or 36 per cent meal, and the jobber should endeavor to educate the consumer to this method of purchase.

Concerning Rebate.

Local dealers as well as large consumers claim that if the meal purchased does not substantially conform to the guarantee placed upon it, they are entitled to a pro rata rebate. The Cotton Crushers' Association recognizes the justice of this claim, and have established the following method for settlement :

Rule 12, Section 4. Cottonseed meal not coming up to contract grade shall be of good delivery if within $\frac{1}{2}$ of 1 per cent of the ammonia content (.41 per cent nitrogen) or $2\frac{1}{2}$ per cent of combined fat and protein content of the grade sold or of the sale sample, but the settlement price shall be reduced at the rate of $\frac{1}{10}$ of the con-

tract price for each per cent of ammonia or $\frac{1}{49}$, $\frac{1}{46}$ or $\frac{1}{43}$ of the content of protein and fat as the case may be and proportionately for the fractions of the deficiency in ammonia.

Section 5. No claim for deficiency of protein and fat combined or of ammonia shall be made by buyers unless the deficiency shall exceed $\frac{1}{2}$ of one unit of protein and fat combined or $\frac{1}{10}$ of one unit of ammonia.

Method of Calculation. If a lot of cottonseed meal is guaranteed to test 41 per cent of protein (8 per cent of ammonia) and only tests 35.50 per cent (6.9 per cent of ammonia), it shows a deficit of 1.1 per cent ammonia. If the contract price was $28 a ton, according to the above rule $\frac{1}{10}$ of the price would be $2.80, and $\frac{1}{10}$ of that .28 which added to the $2.80 would be $3.08, which is to be deducted from the $28 in the form of rebate.

Nitrogen, Ammonia and Protein equivalents to be used in applying the above rule :

Nitrogen.		Ammonia.		Protein.
5.75	equals	7.00	equals	36.00
5.90	"	7.20	"	37.00
6.10	"	7.40	"	38.00
6.25	"	7.60	"	39.00
6.40	"	7.80	"	40.00
6.56	"	8.00	"	41.00
6.70	"	8.20	"	42.00
6.90	"	8.40	"	43.00

Methods of Sampling. In order to secure a representative analysis of any lot of feed, it is necessary that a correct sample be taken. Different bags of cottonseed meal have been found to vary noticeably in their content of nitrogen or protein and a sample taken from a single bag or from a few bags would by no means be representative of a car lot.

Rule 34 of the Cotton Crushers' Association: Two ounces or more from each sack shall constitute a sample of meal and must be drawn so as to fairly represent the entire contents of the bag. Twenty samples from each carload or fifty sacks from each 100 tons if not

shipped in car lots shall be sufficient to represent a shipment.

Samples of meal if of approximately the same grade and quality need not be kept separate but may be commingled. In all cases samples of cottonseed meal shall be, when drawn, immediately placed in a tin package which must be made and kept air-tight, and carefully marked, showing the number of samples taken, as well as car number and mark.*

Station Method of Sampling: The station takes a core sample from 20 different bags in case of car lots by means of a tube run the entire length of the bag. These samples are carefully mixed and the necessary quantity put into a bottle bearing a label on which is written all of the obtainable data. In case of 5 ton lots or less, 10 bags should be sampled.

Method suggested to local dealers and consumers: It naturally is not possible for the station upon request to send its representative to sample goods in all sections of the state. If the dealer or large consumer buys with the understanding that the meal shall conform to guarantee, and be of the proper color and texture as per the grading of the Crushers' Association, he should immediately notify the jobber on the arrival of the car and have him send a representative to assist in taking a sample, or take the same himself by previous agreement, as per Rule 34. Open 20 bags, and if a sampling tube is not available, thoroughly mix the contents of the top of each bag and remove a handful from each, placing on a clean paper. Mix the 20 handfuls and send to the station one-half pound of the mixture in a tight tin box or stoppered bottle by mail or prepaid express, together with all the necessary information such as name and number of the car, date received, of whom purchased, and number of bags sampled, enclosing also a guarantee tag. The station furnishes blank forms for such information. Samples improperly taken will not be tested.

Relation of the Station to Seller and Consumer.

The station is willing and ready in so far as its resources permit, to test samples of cottonseed meal when purchased in ton or more than ton lots providing the same are properly taken, and upon request will report the results of its analysis within a few days. It cannot act as analysts for importers and jobbers; neither will it test manufacturers' samples; such

*The portion of this rule relative to cargo shipments has been omitted.

work belongs to the commercial chemist. It is not considered the business of the station to interfere relative to the terms of settlement between seller and buyer in case the goods fall below the grading and guarantee, excepting upon the special request of one or both parties at interest. Whenever the meal tests substantially below the guarantee and the station is requested to advise concerning a fair method of settlement, it is willing to figure the rebate for either party according to the rules of the Inter-State Cottonseed Crushers' Association as quoted in this circular.

CIRCULAR No. 26. (Revision of No. 14) FEBRUARY, 1910.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

FERTILIZERS FOR POTATOES.

WILLIAM P. BROOKS, DIRECTOR.

There is general agreement that fertilizers rather than manure should generally be used for the potato. The principal reasons are:

1. The chances that the crop will be free from blight, rot and scab are greater on fertilizer. This does not of course mean that immunity from any of these troubles is certain if fertilizers only are used.

2. The period of growth is relatively short and the plant food supplied should be in highly available forms. High grade fertilizers are superior to ordinary farm manures in this particular.

Manure may be used for this crop with greatest safety and profit on the lighter soils deficient in organic matter and humus. The quantity should be moderate and it should be applied broadcast and plowed or deeply harrowed in rather than placed in hill or drill. It will usually pay to use some fertilizer in connection with manure.

Experiments with fertilizers for potatoes on the Station grounds on soils which are retentive in character indicate:

1. **Method of Application:** The application of all the fertilizers in the drill, making it cover a strip some 10 to 15 inches in width is likely to give a better crop than broadcast application of all the fertilizers used.

2. **The Nitrogen Supply:**

(a) When grown upon a clover or mixed grass and clover sod, a relatively low percentage of nitrogen in a potato fertilizer is sufficient.

(b) In order to make it safe to apply the entire amount of fertilizer needed for the crop at planting time, the nitrogen should be derived from materials possessing a varying rate of availability, such, for example, as nitrate of soda, sulfate of ammonia, dried blood and tankage.

3. **Phosphoric Acid Supply:** There is little doubt that the presence of a liberal amount of available phosphoric acid in fertilizers for potatoes is favorable to early maturity and whenever the tops usually make a rank growth, or where an early crop is important this element should be relatively abundant in the fertilizer.

4. **The Potash Supply:**

(a) The percentage of potash in a potato fertilizer should be relatively high. There is considerable evidence which tends to show that a relatively high percentage of potash in the fertilizer used for potatoes is favorable to the maintenance of healthy growth and the production of a sound crop.

(b) The potash of a potato fertilizer should usually be supplied in the form of sulfate rather than muriate. When these two salts have been compared, the sulfate has generally given the heavier yields and the better quality. On light soils, especially those rich in lime and in excessively dry seasons, the muriate may be the better of the two salts.

The Use of Lime and Wood Ashes: It has been clearly shown that potatoes are more subject to scab when grown in soils which are alkaline than in those which are moderately sour. The free application of lime will render most soils alkaline and this fact explains why the potato is so often seriously injured by scab when grown on freshly limed land. This practice should be avoided. A heavy application of wood ashes may have a similar effect in favoring the development of scab and it is usually preferable to derive the phosphoric acid and the potash needed for the potato from other fertilizers.

The Composition of Potato Fertilizers: It is believed that fertilizers for potatoes should under the different conditions specified have about the following composition:

A. When fertilizers only are to be used:—

1. On clover sod or soils rich in humus and relatively fertile:

	Per Cent.
Nitrogen,	2.5— 3.
Phosphoric acid,	8. —10.
Potash,	8. —10. in form of sulfate.

2. On lighter and poorer soils:

	Per Cent.
Nitrogen,	3.5— 4.5
Phosphoric acid,	6. — 8.
Potash,	8. —10.

B. For use in connection with manure:

1. On clover sod or soils rich in humus:

	Per Cent.
Nitrogen,	1.5— 2. mostly in soluble forms.
Phosphoric acid,	8. —10.
Potash,	12. —14.

2 On lighter and poorer soils:

	Per Cent.	
Nitrogen,	3. — 3.5	mostly in soluble forms.
Phosphoric acid,	6. — 8.	
Potash,	10. —12.	

Amounts recommended per acre:

A (either 1 or 2) 1500-2000 lbs.

B (either 1 or 2) 600-1000 lbs. varying with the amount of manure used.

HOME MIXTURES.

The judicious selection and purchase of unmixed materials usually makes it possible to obtain needed elements of fertility at lower cost than in the "potato specials." Home mixture of these materials is neither difficult nor expensive if the materials are of good grade and reasonably free from lumps. They have simply to be alternately added to a heap upon a solid floor in proper proportions and then shoveled over a few times, taking care to break such lumps as are present by pounding. Should any single ingredient appear to be lumpy, it will be best to pulverize it by itself before adding to the mixture. A gravel screen is sometimes convenient in connection with such work.

The following mixtures are suggested as likely to prove satisfactory under the conditions indicated:

A. For use where fertilizers only are employed:

1. On clover sod or soils rich in humus and in high fertility:

In each 100 pounds:

Nitrate of soda,	7 lbs.
Dried blood,	8 lbs.
Tankage,	15 lbs.
Acid phosphate,	50 lbs.
High grade sulfate of potash,	20 lbs.

Use 1500 to 2000 pounds per acre.

2. On lighter and poorer soils:

In each 100 pounds:

Nitrate of soda,	12 lbs.
Dried blood,	15 lbs.
Tankage,	20 lbs.
Acid phosphate,	35 lbs.
High grade sulfate of potash,	18 lbs.

Use 1500 to 2000 pounds per acre.

B. For use in connection with manure:

1. On clover sod or soils rich in humus:

In each 100 pounds:

Nitrate of soda,	8 lbs.
Dried blood,	5 lbs.
Acid phosphate,	60 lbs.
High grade sulfate of potash,	27 lbs.

Use 600 to 1000 pounds per acre, varying with quantity of manure used.

2. On lighter and poorer soils:

In each 100 pounds:

Nitrate of soda,	8 lbs.
Dried blood,	10 lbs.
Tankage,	20 lbs.
Acid phosphate,	40 lbs.
High grade sulfate of potash,	22 lbs.

Use 800 to 1200 pounds per acre, varying with quantity of manure used.

Conditions under which Muriate of Potash may be Substituted for Sulfate: If the soil on which potatoes are to be grown is of coarse texture and deficient in capacity to retain water and if experience indicates a considerable probability that the crop at some period in its growth will suffer from drouth, it may be wise to substitute muriate of potash for the high grade sulfate recommended in any of the above mixtures. As already indicated, the substitution of muriate for the high grade sulfate may be especially advisable if in addition to being light, the soil is naturally rich in lime.

Method of Applying: If the potatoes are to be planted by hand, good results may be obtained by opening the furrows and then scattering the material widely the full length of the furrow, making it cover not only the entire furrow, but a space a few inches in width on each side. If spread in this way, the fertilizer will not be so thick that it will be necessary to take any special steps to mix it with the soil. It will be sufficiently mixed in covering the seed. If planting is done by machine, the fertilizer attachment of the machine should be one which scatters the fertilizer over a relatively wide area. If such a machine cannot be used, it may be best to withold a portion of the fertilizer until the crop is three or four inches high, when it should be scattered along strips ten to twelve inches wide on either side of the row and cultivated in.

Circular No. 27. (Revision of No. 16). July, 1908.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

SEEDING MOWINGS.

By William P. Brooks.

The average product of hay to the acre in Massachusetts is reported to be only a little more than one ton. As good farmers are not satisfied with an average yield of less than three tons, it is self-evident that there is much mismanagement, or lack of intelligence in the management of mowings.

This paper will discuss seeding down to grass or mixed grass and clover. The topics to be especially considered are as follows: —

Preparatory fertilization.
Time and method of seeding.
Preparatory tillage.
Varieties of grass and clover to be used.

Preparatory Fertilization.

Manure. It is quite unnecessary to state to the average farmer that a liberal application of manure will bring the soil into good condition to produce profitable crops of hay and wherever sufficient manure is produced on the farm, or can be purchased and laid down upon the farm at a low cost, its use is to be advised. The liberal use of manure in preparing the soil for seeding to mowing will bring it into condition to produce a grade of hay made up principally of such grasses as timothy, red top and orchard grass, while the clovers are present in relatively small proportion. This is because manure supplies an abundance of nitrogen, which greatly favors the growth of grasses. These accordingly become so rank in their growth that the clovers are to some extent suppressed. While the fact that the free use of manure in preparing land for seeding will bring it into fine condition for the production of heavy yields of hay is well established, it is not as generally known as it should be that profitable hay production on fertilizers alone is possible. Indeed there can be no doubt that in most localities if the plant food must be purchased for the purpose under consideration, money can be more wisely used in buying fertilizers than in buying manure.

If manure is to be used in preparing for seeding, it is best to keep it relatively near the surface. It should be well worked in with a harrow rather than plowed under, providing its mechanical condition makes thorough incorporation with the soil by harrowing possible.

The Necessity for Lime.

In most parts of the state our soils appear to be relatively deficient in lime. In soils where this deficiency is marked, the necessity for liming will be indicated by the following conditions: —

1. Clovers will either fail absolutely or make a feeble growth.
2. Sorrel is likely to come in abundantly.
3. If red top and timothy are sown with the clovers, the red top will do much better relatively than the timothy.

The reasons for the above results briefly stated are: —

(*a.*) Red top and sorrel can thrive in acid soils.

(*b.*) Neither clover nor timothy will do well in such soils.

Wherever such results as are above named have been noted, a heavy application of lime will usually be found to be beneficial. Various forms of lime are available. Among the more important are fresh burned lime, air-slaked lime and fine ground lime.

Of these different forms, the fresh burned or lump lime exercises the most energetic action on the soil. Before application, it should be slaked, either by exposure in small heaps to the weather or by the addition of just enough water to cause it to crumble into a fine, dry powder. The rate of application likely to prove useful is about one ton to the acre. After slaking, the lime should be spread as promptly and as evenly as possible upon the rough furrow, and immediately deeply harrowed into the soil, for which operation, the disk or cutaway harrow is usually best. In determining whether it is better economy to purchase fresh burned lime or air-slaked lime, it should be remembered that a ton of the former is equivalent in its action on the soil in most cases to from 3,000 to 3,500 pounds of the latter.

Fine ground limes are put upon the market in sacks, and are the most convenient form, both for handling and for application; but they usually cost more in proportion to efficiency than fresh burned lime.

The effects of liming upon the character of the growth are very clearly shown in the cuts. The soil used in this experiment was taken from one of our fields which was supposed to need liming. A quantity sufficient to fill the two cylinders was first very thoroughly mixed and an equal amount was then placed in each. Both received

No Lime Lime

EFFECT OF LIMING.

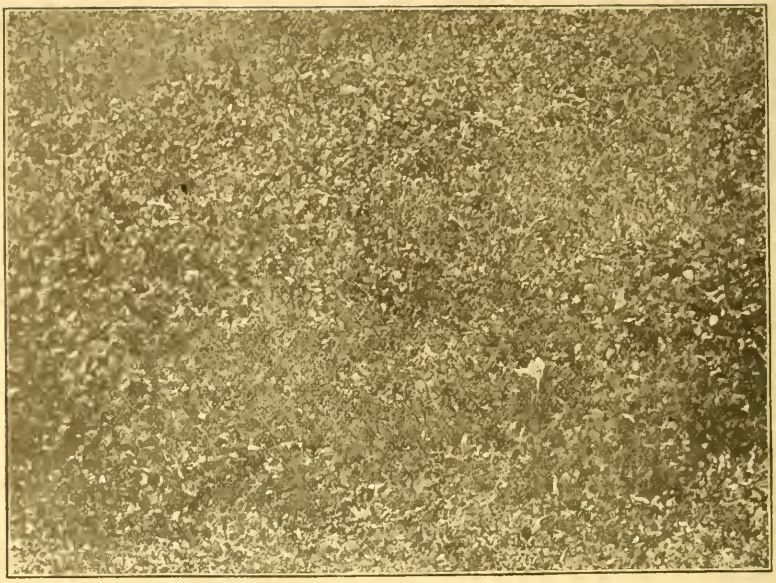
a general fertilizer, and in both were sown precisely the same kinds and quantities of seeds—timothy, red top and clover.

Fertilizers to be Used.

The selection of fertilizers for application to land which is to be seeded should, in all cases, be varied in accordance with the kind of hay desired. If hay containing a large proportion of clover is wanted, materials which supply relatively large amounts of potash and phosphoric acid, and relatively little nitrogen should be employed. If hay, largely timothy and relatively free from clovers is wanted, then the proportion of materials furnishing potash and phosphoric acid should be smaller, while the materials supplying nitrogen should be applied in relatively large proportion. There is considerable evidence to show that if timothy is desired, potash in the form of muriate is preferable to sulfate, while for clovers on many soils, and especially in wet seasons, the sulfate is preferable.

The cuts on pages 4 and 5 show the difference in crops of clover produced on the college farm respectively on the muriate and the high grade sulfate of potash, used in each case in connection with bone meal at the rate of 600 pounds to the acre.

The application of fertilizer in preparation for seeding should be varied also with the season. Materials supplying considerable nitro-



FERTILIZER ANNUALLY.

Per Acre, { Bone Meal, 600 pounds.
Murate of Potash, 250 pounds.

gen in available forms may safely and wisely be applied in spring seeding, but for late summer or autumn seeding, the application of such materials in any considerable amounts would be a mistake.

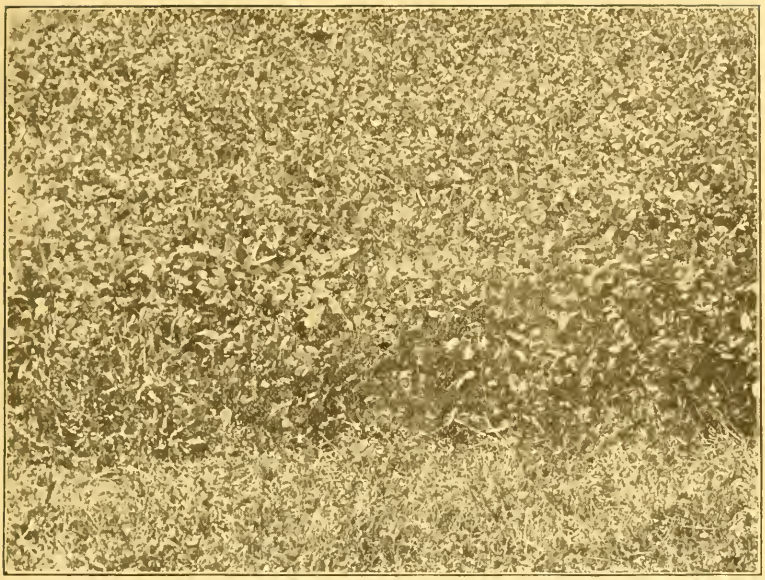
It should be understood that in presenting specific advice as to applications of fertilizers under different conditions, no attempt is made to give an exhaustive discussion of the subject. The materials advised have been used with excellent results on the college farm as well as by numerous private farmers.

Fertilizers in Connection with Manure.

As has been stated, manure is relatively rich in nitrogen, and the application of manure alone in liberal quantities will be favorable to the production of hay, made up largely of such grasses as timothy and red top. If it is desirable to increase the proportion of clover, either of the following fertilizer applications may be recommended: —

(*a.*) Per acre, in addition to the manure, muriate of potash or high grade sulfate of potash 150 to 175 pounds,—the former to be selected for the lighter soils, and in cases where it is desirable that the proportion of timothy be relatively large.

(*b.*) Per acre, muriate or high grade sulfate of potash 150 to 175 pounds, and basic slag meal 600 to 800 pounds.



FERTILIZER ANNUALLY.

Per Acre, { Bone Meal, 600 pounds.
High Grade Sulfate of Potash, 250 pounds.

This application will, it is believed, be especially favorable to clovers. Slag meal, besides supplying phosphoric acid, will furnish a considerable quantity of free lime which will help sweeten a sour soil, or hold in condition a soil where the excess of acid has first been neutralized by liming.

Fertilizer Alone.

A. For spring seeding, per acre: —

Basic slag meal,	800 to 1000 pounds
Muriate or high grade sulfate of potash,	175 to 200 "
Tankage or dry ground fish,	300 to 400 "

B. For summer seeding, per acre: —

Basic slag meal,	800 to 1000 pounds
Muriate or high grade sulfate of potash,	175 to 200 "
Tankage or dry ground fish,	200 to 300 "

And, if the soil is in a very low state of fertility, in addition

Nitrate of soda,	75 to 100 pounds

C. For fall seeding, per acre: —

Basic slag meal,	800 to 1000 pounds
Muriate or high grade sulfate of potash,	175 to 200 "

And, if the soil is in very low fertility, in addition

Nitrate of soda	75 to 100 pounds

If tankage or fish are relatively high in price it may be wise to substitute sulfate of ammonia for them, but in only one-half as large quantities.

In either of the above fertilizer combinations containing tankage, fish, or sulfate of ammonia, it will be best to apply the slag meal by itself, for if this be mixed with either, the free lime which the slag contains will cause a loss of ammonia. The other materials advised under A and B should be mixed together before application. All the materials advised under C should be mixed before application. The best results will usually be obtained by spreading all these fertilizers on the rough furrow and working them in thoroughly with disk or other deep working harrows. The nitrate of soda, it is true, does not require deep working in, and it is most safely used if spread only a short time before seeding, while the other materials will prove the most useful if they can be put on a few weeks before the seed is sown. It is doubtful, however, whether enough will be gained in the direction of greater effectiveness of the nitrate to pay the extra cost of separate application.

Where the land is seeded in the summer or fall with fertilizer as advised, it will not infrequently be found profitable to apply some nitrate of soda the following spring. Whether or not such application will prove profitable must be determined by the appearance of the grass at that time. If it shows comparatively light foliage and a moderate or feeble growth, a dressing of nitrate will be profitable, and to facilitate its distribution, it is advised that it be mixed with about double its weight of basig slag meal.

Time and Method of Seeding.

There is no season of the year, not even excepting winter, which has not been advocated by some one as the best season for seeding to grass, and indeed each season has its advantages. The limits of this circular will not permit a full discussiou of the subject.

Summer Seeding.

The writer is convinced that on all soils fairly retentive of moisture and in seasons not characterized by very unusual drought, the best results in seeding to mixed grass and clover will be obtained if the seed is put into the ground during dog days, and on farms where corn is cultivated, he strongly recommends seeding in the standing corn. The cultivation of the corn must of course be level. Just previous to seeding, the spike-tooth cultivator should be used, working as close to the hills or rows as possible. The seed should be sown when the corn is about waist high. Much care should be

taken to distribute the seed evenly, and it seems best in most cases to walk between every pair of rows aiming to cast the seed about three rows wide, but of course in very small quantity. By sowing in this way a very even distribution of the seed may be secured In showery weather, seed sown in this way will not need covering.

Spring Seeding. Grass and clover sown in the early spring usually start well, but there is much risk of damage to the young plants during the hot dry weather which is likely to prevail in midsummer. If sown alone in the spring, there is likely in most fields to be a rank growth of weeds spring up with the grasses and clovers. In most cases, therefore, a nurse crop (most frequently oats) is put in with the clover. In either case, the ranker and more rapidly growing weeds or grains make heavy drafts on the moisture of the soil, and when these are cut, the exposure of the young and tender grass and clover plants (up to that time shaded by the taller growth) to the full glare of the summer sun often seriously injures them. Principally for this reason the writer is not in favor of spring seeding.

Fall Seeding. Good results may be obtained by seeding at almost any time between the middle of August and the first of October, provided the soil is well drained and the lay of the land such that water will not stand upon it during the winter. Clovers may be sown with grass seeds up to about the 10th of September. If put in later than that they are not likely to make enough growth to become sufficiently well rooted to go through the winter safely. If the date of seeding must be late and clover in the mowing is desired, it is common to withhold the clover seed until the following spring, at which time, of course, the soil is somewhat compacted and covering the seed is impossible, as harrowing the ground would uproot the young grass plants. Clover sown in this way will, in some seasons, germinate well and make a good growth, but this method of seeding is attended by a great deal of risk of failure and at best the crop the first season where this method is followed will contain but little clover. In fall seeding, it is customary to sow the grasses and clovers without a nurse crop.

Covering the Seed. Shallow covering only is essential, and in case of summer seeding in the corn, no covering at all is needed in many cases, as the shade of the corn keeps the surface of the ground moist. The heavy pelting rains of dog days moreover will help to bury the seeds. In all other cases, the weeder, or the familiar home-made brush, will in most cases be the best implement for covering the seed, these implements to be followed in most cases by the roller, which will make the surface smooth and sufficiently compact so that moisture will rise to the surface.

Preparatory Tillage.

The fact is now much more generally appreciated than formerly that it pays to bring land into the best of tilth in preparation for seeding. Careful plowing followed by numerous harrowings will in almost all cases be necessary. The soil at the time of seeding should be fine and mellow at the top and moderately compact below. Wherever it is possible, ploughing should precede the seeding by a few weeks at least, and between the date of ploughing and seeding, the field should be harrowed a number of times. Fall ploughing is generally preferable to spring plowing if the land is to be seeded in the spring.

Varieties of Grass and Clover to be Used.

No attempt will be made here to consider the characteristics of the different species of grasses and clovers. The most generally useful mixture will be made up about as follows per acre: —

Timothy,	18 pounds
Fancy re-cleaned red top,	8 "
Alsike clover,	4 "
Mammoth red clover,	4 "

This mixture is suited for mowings on all medium and heavy soils which are occasionally broken up and put into hoed crops.

For lighter soils, and especially where it is desirable to leave the mowing down to grass for a considerable number of years, the following mixture is recommended per acre: —

Orchard grass,	15 pounds
Tall oat grass,	5 "
Italian rye grass,	5 "
Awnless brome grass,	5 "
Common red clover,	6 "

For medium soils, especially where it is desirable to leave the mowing down to grass for a number of years, the following mixture is recommended per acre: —

Orchard grass,	8 pounds
Italian rye grass,	3 "
Yellow oat grass,	4 "
Meadow fescue,	10 "
Red clover,	5 "
Alsike clover,	4 "

In the purchase of grass and clover seeds, it is of much importance to pay particular attention to the quality. It is wise to obtain samples and to examine them, or to have them examined by the experiment station with a view to determining, not only the germinating quality, but whether there is an admixture of weed seeds. In the purchase of clover, it is now especially important to be on guard against dodder. Dodder is a parasite which, if it once obtains a foothold in a field of clover, will soon render it valueless. Dodder seed, unfortunately, appears to be found with increasing frequency in samples of clover and alfalfa seeds offered in the markets.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

RULES RELATIVE TO TESTING DAIRY COWS.

GENERAL REQUIREMENTS.

The Massachusetts Agricultural Experiment Station, working in conjunction with the various pure bred cattle associations, will conduct, when possible, official tests of pure bred cows, on the following conditions :

1. Two weeks' notice of a desired test must be given the Station.

2. Charges for testing shall be as follows:

   a. The charge for a single day's test, *when made in a sequence with others of a similar character*, shall be $5.00. Additional days for the same party shall be at the rate of $2.75 per day. These prices do not include the tester's time while en route.

   b. The charge for a "seven-day" test shall be $25.00. An allowance of nine consecutive days will be made, which shall include the tester's time while en route. Additional days beyond the nine day limit will be charged for at the rate of $2.75 a day.

   c. The charge for a "thirty-day" test shall be $80.00, and 32 consecutive days will be allowed, which shall include the tester's time en route. Additional days beyond the 32 day limit will be at the rate of $2.50 a day.

   d. The owner of the stock must, at his expense, care for the supervisor during the test, and when necessary, convey him to and from the railroad station or car line.

* A revision of circulars Nos. 9 and 15.

3. The owner of each herd desiring tests must provide a satisfactory Babcock machine, the necessary acid and hot water, and a suitable box or cupboard fitted with a hasp for a padlock, in which the supervisor may keep his samples.

4. Only cows which aré entered in the herdbook of the breed to which they belong are eligible to advanced registry.

5. In case of long tests, supervisors will be changed every thirty days, if deemed advisable.

6. All reports of tests must be brought or sent to the Experiment Station by the supervisors. Such reports, after being verified, endorsed and copied, will be forwarded to the proper club. The station, however, reserves the right of using the data, if deemed advisable.

DUTIES OF THE SUPERVISOR.

1. The supervisor shall not be held responsible for the identity of any cow tested, but shall accept the statement of the owner or his representative as to her name and registration number. The supervisor, however, shall state whether the cow answers her registered description, if the same has been furnished him; otherwise, he will include in his report a brief description or sketch of each new animal tested.

2. The supervisor shall see the cow milked dry at the regular milking prior to beginning the test,* shall verify the fact with his own hands and note the time of the same. The last milking must occur at the same hour, one or more days later according to the length of the test.

3. The number of cows to which an inspector is limited shall be dependent upon the amount of work required and the facilities at hand. He shall not exceed five cows when milked four times daily, without special permission from the station. He shall allow only one of the cows entered to be milked at a time and shall personally oversee the entire milking.

* In case of Ayshires it is not necessary to see the cow milked dry before beginning test.

4. A cow must be milked out at a single sitting. In no case will it be allowable to go back and strip her a second time.

5. The supervisor shall verify the weight of the pail before each cow is milked. As soon as a cow is milked the supervisor shall take charge of the pail and its contents and keep it under his control until he shall have weighed the milk and taken the sample for the Babcock test. He must thoroughly mix the milk previous to taking the necessary sample and must retain the sample under absolute control until tested.

6. Disturbing conditions such as sickness, being in heat, change of milker, etc., must always be entered on the report.

7. When required, as indicated on the blanks furnished, the supervisor must also record the date of the cow's birth, when last calf was dropped, when the cow was served, when test was begun, statement of kind and amount of feed both grain and roughage, method of feeding, also the use of condiments, condition powders, or drugs of any kind.

8. In the case of yearly tests the supervisor shall at the beginning of the test record on blanks furnished him for the purpose a full description of the animal entered for test.

9. Any tampering with a cow under test or with the samples by the owner or an employee, or refusal to comply with the rules must be reported at once to the station by telephone. Lack of proper apparatus or facilities for doing satisfactory work should also be reported.

10. As soon as possible after the completion of the test or at least once each month, the supervisor shall bring or send to the station on the proper blanks a detailed report over his signature and affidavit. He shall also submit an itemized statement of time and expenses at each place, number of records sent in and breakage. In case of tests of over thirty days' duration he shall submit such a report on the first day of each month.

11. All the butter fat tests and weights of milk secured by a supervisor shall be recorded by him in a suitable record book, which he shall retain constantly in his possession until called for by the experiment station official in charge of the work.

THE TESTING OF SAMPLES.

1. Each sample must be tested in duplicate by the Babcock test; the separation must be clean (free from curd and charred material); and no variations in excess of 0.10 per cent. shall be allowed.

2. In a seven day test when any of the milk or a test sample is accidentally lost, the average of the corresponding milkings during the other six days shall be substituted for the missing weight or test, but such results must always be reported as estimations.

3. With all tests of a week or more duration, a seven day composite sample shall be taken, when required, by means of a sampling pipette (1 c. c. for every pound), preserved with bichromate of potash or some other preservative and forwarded in a full bottle to the station by prepaid express. Accompanying the sample shall be a statement of the total amount of milk and of fat produced during the seven days represented by the composite. Results by the station's test and by the inspector's data ought not to vary more than 0.15 per cent.

ADDITIONAL RULES WITH THE CHURN TEST.*

1. In case the churn test is employed in addition to the Babcock, milk samples *of the same amount* must always be taken so that the loss of fat in the samples can readily be calculated from the total weight of the samples and the average percentage of fat.

2. The skim milk should be weighed daily, carefully mixed and a composite taken by means of a sampling pipette.

3. The butter milk should be weighed, sampled, and if more than one churning, a composite taken by means of a sampling pipette.

4. The skim milk and butter milk should be tested in duplicate by the Babcock test and no variation in excess of 0.02 per cent allowed.

5. The finished butter should be weighed and sampled immediately by slicing the entire lump (not prints) by means of a thin case knife or spatula, and by taking small pieces (size of a walnut) from various parts of the different slices. Great care should be exercised to prevent loss of water. The sample, amounting to about one-half a pound, should be shipped to the station in a sealed Lightning fruit jar by prepaid express.

*Confirmed Butter Test. A. J. C. C.

SPECIAL RULES.

The owners of pure bred animals under test are advised to thoroughly familiarize themselves with the rules under which their respective associations are working. Our supervisors are instructed to refer all questions in regard to rules to the proper pure bred cattle associations. The information in this circular is simply intended to supplement the rules of the various associations and in no way to conflict with them. The supervisor is not at liberty to decide as to which stipulations contained herein are essential and which are not and any apparent variation between the instructions in this circular and those of the pure bred cattle associations should be referred at once to the Experiment Station.

YIELD OF MILK AND BUTTER FAT REQUIRED FOR ADVANCED REGISTRY.

	7 Days.		365 Days.	
	Milk. lbs.	Fat. lbs.	Milk. lbs.	Fat. lbs.
AYSHIRE.				
2 years old at commencement of test,	——	——	6,000	214.3
3 " " " " " "	——	——	6,500	236.0
4 " " " " " "	——	——	7,500	279.0
5 " " " " " "	——	——	8,500	322.0
Daily increase required,			2.74	0.12
GUERNSEY.				
2 years old at commencement of test,	——	——	6,000	250.5
3 " " " " " "	——	——	7,332.3	287.0
4 " " " " " "	——	——	8,665.6	323.5
5 " " " " " "	——	——	10,000.0	360.0
Daily increase required,	——	——	3.65	0.1
HOLSTEIN FRIESIAN.				
2 years old at calving,	——	7.2	——	250.5*
3 " " " "	——	8.8	——	287.0*
4 " " " "	——	10.4	——	323.5*
5 " " " "	——	12.0	——	360.0*
Daily increase required,	——	.00439	——	0.1
JERSEY.				
Under 2½ years at commencement of test,	——	12.0	6000.0	260.0
2½ to 4 years " " " "	——	——	8000.0	300.0
4-5 years " " " "	——	——	9000.0	350.0
5 years " " " "	——	——	10,000.0	400.0

Confirmed Butter Tests: 14 pounds of actual butter testing at least 80 per cent fat for 7 days, for 90 days or less an average of 2 pounds a day, for 365 days 500 lbs.

* Competition restricted to cows having been admitted to Advanced Register on 7 day test.

APPARATUS FURNISHED.

The inspector will be furnished with the following supplies or as many of these supplies as may be deemed necessary:

Spring balance,	1
Sampling pipettes,	2
Sample bottles,	12
Milk pipettes, 17.6 c. c.,	2
Milk test bottles, 10%	18
Acid measures, 17.5 c. c.,	2
Dividers,	1 pair.
Bottle brush,	1
Crayon,	1
Wire sieve,	1
Speed indicator,	1
Padlock,	1
Stick tags,	1 box
Preservative.	
Report blanks.	
Record book and stationery.	

CHURN TEST.*

Skim milk bottles, (.01% graduations),	6
Steel spatula,	1
Sealing wax and seal,	1

SECRETARIES OF BREEDERS ASSOCIATIONS.

Ayshire Breeders Association, C. M. Winslow, Brandon, Vt.

American Guernsey Cattle Club, W. H. Caldwell, Peterboro, N.H.

†Holstein-Friesian Association of America, F. L. Houghton, Brattleboro, Vt.

American Jersey Cattle Club, J. J. Hemingway, 8 West 17th St., New York, N. Y.

Communications pertaining to advanced registry work addressed to the Massachusetts Experiment Station should be sent in care of the undersigned,

PHILIP H. SMITH,
Mass. Agr. Exp. Station,
Amherst, Mass.

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* Confirmed butter test. A. J. C. C.

† Communications in regard to advanced registry should be addressed to Malcolm H. Gardner, Superintendent of Advanced Registry, Delavan, Wis.

CIRCULAR NO. 29. (Revision of No. 11.) OCTOBER, 1910.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

The Chemical Analysis of Soils.

BY WILLIAM P. BROOKS, Director.

Almost every day the station receives either inquiries regarding the chemical analysis of soils or samples forwarded for such analysis. The following letter received a short time ago fairly represents the attitude of most correspondents relative to such work.

> Gentlemen: I write for information for Mr. . . . . the owner of a large farm in . . . . . , Mass. He wishes to know if he can send you samples of soil for analysis; most likely would send 8 or 10 samples from different parts of his farm. In what form and in what quantity should he send, and what would be the expense for analysis of each package sent? He would also like to know what crops would produce the best results for each sample sent, and the best fertilizer for each sample and the quantity required. . . . . .

It will be noted that the gentleman in whose interest this letter was written believed:—

(1) That chemical analysis will show to what crops a soil is suited.

(2) That such analysis will determine what fertilizers should be applied and the quantity needed.

Our correspondence indicates that these views are very generally held, while another widely accepted belief is that the cause of crop disease will be revealed by a chemical analysis of the soil in which the crop is growing.

Although a chemical analysis of a soil is often of value, it is believed that these views are neither generally accepted by scientific men nor supported by the known facts of experience under the conditions usually met with in this state.

1. **The Crop Adaptation.** While the chemical condition of a soil is not altogether without influence in determining the crops to which it is suited, this, as a rule, at least within such range of soil variation as exists in this state, plays a much less important part than mechanical and physical peculiarities. The crops to which a soil is suited are determined chiefly by its drainage, its capacity to hold and to conduct water, its temperature and its aeration, and these in turn are determined by the mechanical structure of the soil and sub-soil. Variations in the proportions of gravel, sand, silt, and clay, and not in chemical composition, cause the usual differences in these respects. The varying proportions of these, therefore, usually determine the crops to which a soil is suited.

2. **Fertilizer Requirements.** The results of a chemical analysis of a soil do not, as a rule, afford a satisfactory basis for determining manurial requirements. The chemist, it is true, can determine what the soil contains, but no ordinary analysis determines with exactness what proportion of the several elements present is in available form for the crop. Indeed, there is no such thing as a constant ratio of availability. While one crop finds in a given soil all the plant food it requires, another may find a shortage of one or more elements. Further, on the very same field one crop may find an insufficient amount of potash, another may find enough potash for normal growth, but insufficient phosphoric acid; while a third may suffer only from an insufficient supply of nitrogen.

Most of our soils are of mixed rock origin, and, as a rule, possess similar general chemical characteristics, providing they have been farmed under usual conditions. The manurial and fertilizer requirements are determined more largely in most soils by the crop than by peculiarities in the chemical condition of the soil.

3. **Crop Diseases.** In some cases, the correspondent reports that his crop is diseased, and that he desires a chemical analysis in order to ascertain what is the cause. The chemical composition of the soil may in some instances exercise a controlling influence in determining a condition of health or disease, and is never unimportant from the standpoint of vigorous, normal and healthy growth; but in the case of most diseases, the immediately active cause is the presence of a parasitic fungus, and this fungus is usually capable of fixing itself upon the plant whatever may be the composition of the soil. A knowledge of the chemical composition of soils, therefore, will not make it possible to advise such manurial or fertilizer treatment as will insure immunity from disease.

CONDITIONS UNDER WHICH ANALYSES WILL BE MADE.

For the reasons which have been briefly outlined, the chemical analysis of soils does not, as a rule, afford results which have a value commensurate with the cost; and this station, therefore, will not make such analysis unless the soil differs widely from the normal in natural characteristics, or has been subjected to unusual treatment of such a nature as to probably greatly influence its chemical condition. In order that we may decide whether analysis seems called for, correspondents are urged to write before taking samples, and when doing so to state all the conditions as fully as possible, This statement should include a full description of the soil and as full a report as possible as to the manures and fertilizers applied and crops raised for a number of years previous to the date of writing. In all cases in which, on the basis of the information given, it appears that a chemical analysis promises results of value, such an analysis will be made, and for the present free of charge; but, as explained in the preceding paragraphs, such analyses appear to be only rarely worth while. It will usually be possible to give helpful advice in relation to the use of manures and fertilizers on receipt of a full statement as to the character and history of the soil and the crop which is to be raised, and such advice will always be gladly given.

In case analysis is regarded as desirable, full directions for taking and forwarding samples will be sent.

CIRCULAR NO. 30. JANUARY 1911.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY.

BALANCED RATIONS FOR DAIRY STOCK.

BY J. B. LINDSEY.[1]

1. COMPOSITION OF CATTLE FEEDS.

All cattle feeds, whether in the form of grains and their by-products, or as hay, corn silage and straw, are composed of the following groups of substances: —

Water. — The several grains and their by-products contain from 7 to 12 per cent of water; hay and straw, 12 to 16 per cent; field-cured corn stover, 30 to 40 per cent; and corn silage, 76 to 80 per cent.

Ash represents the mineral ingredients, and constitutes the ashes after the feed is burned. These ashes consist of lime, potash, soda, magnesia, iron, phosphoric and sulfuric acids.

Protein is a collective name for all of the nitrogenous matter; it corresponds to the lean meat in the animal, and may be termed "vegetable meat." It has the same elementary composition as animal flesh. When fed to animals as a component of the various feed stuffs, it serves as the exclusive source of flesh as well as a source of heat or energy and fat.

Crude fiber or cellulose is the coarse or woody part of the plant. It may be called the plant's framework. It is a source of heat or energy and fat.

[1] In co-operation with the State Board of Agriculture.

Non-nitrogenous extract matter represents the sugars, starch and gums. It is the principal source of heat or energy and fat for the dairy animal.

Fat includes not only the various oils and fats in all grains and coarse fodders, but also waxes, resins and coloring matters. It is frequently termed *ether extract*, because it is that portion of the plant soluble in ether. It serves as a source of heat or energy and fat in the body of the animal.

Carbohydrates is a term which is generally used to include both the fiber and the extract matter.

2. Digestibility of Cattle Feeds.

The several groups of nutrients above described, which make up the various cattle feeds, are valuable to the animal only in so far as they can be digested and assimilated. The concentrated feeds are considerably more digestible than the coarse fodders, as a single illustration will show: —

	100 Pounds Timothy Hay.			100 Pounds Gluten Feed.		
	Composition.	Per Cent Digestible.	Pounds Digestible.	Composition.	Per Cent Digestible.	Pounds Digestible.
Water,	15.0	–	–	8.5	–	–
Ash,	4.3	–	–	1.7	–	–
Protein,	6.3	48	3.0	26.2	85	22.3
Fiber,	28.4	58	16.5	7.2	76	5.5
Extract matter,	43.6	63	27.5	53.3	89	47.4
Fat,	2.4	61	1.5	3.1	83	2.6
Totals,	100.0	–	48.5	100.0	–	77.8

In the first and fourth columns are given the composition of average samples of timothy hay and of gluten feed. In the second and fifth columns are shown the percentages of the different groups which are digestible. Thus, of the 6.3 pounds of protein in timothy, 48 per cent are digestible, or 3 pounds; and of the 26.2 pounds of protein in 100 pounds of gluten feed, 85 per cent or 22.3 pounds, are digestible. Excluding the ash, which is not generally taken into account, it is shown that 100 pounds of timothy hay contain about 48 pounds of digestible or actual food material, and 100

pounds of gluten feed 78 pounds. It is evident, therefore, that the gluten feed is decidedly more valuable as a source of nutrition than the timothy hay.[1]

3. Nutritive Ratio of Cattle Feeds.

The numerical relation which the digestible protein bears to the other digestible organic nutrients (fiber, extract matter and fat[2]) is termed the nutritive ratio of the feed or ration. Timothy hay has, for example, 3 parts of digestible protein to 47.3 parts of other nutrients, or as 1 is to 15.8. This is termed a very wide nutritive ratio. Gluten feed contains 22.3 parts of digestible protein to 58.6 parts of other nutrients or as 1 is to 2.6. This may be termed a very narrow nutritive ratio or proportion. All feeds having a nutritive ratio of 1 to 5 or less may be said to have narrow ratios, those from 1 to 5 to 1 to 8 a medium ratio, and above 1 to 8 a wide ratio.

The cereals and non-leguminous coarse fodders have medium to wide ratios, leguminous coarse fodders medium ratios, and the leguminous seeds and concentrated by-products narrow ratios.

4. Combining Coarse and Concentrated Feeds (Balanced Rations).

Desirable rations for dairy stock should possess (*a*) palatability, (*b*) sufficient bulk, and (*c*) should contain 1 part of protein to 5.5 to 7 parts of the other digestible organic nutrients. If the ratio is much narrower than 1 to 5.5, the ration is likely to be too stimulating for continuous feeding, and the animal is likely to become thin in flesh. If the ratio is much wider than 1 to 7, the tendency will be for the animal to put on fat rather than to give milk. In both cases the ration may be said to be *out of balance*.

For both economical and physiological reasons it is necessary that a considerable portion of the daily ration of the dairy animal should be composed of coarse fodder or roughage, because such materials

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[1] On the basis of these figures one would assume that these two feed stuffs were valuable in the proportion of 48 to 78, or 100 to 162. This is not strictly true, however, for the reason that the more woody fiber a feed contains the more energy is required to digest it; further, the gluten feed contains much more protein than the timothy, which, for the purposes of growth and milk production, still further enhances its value. In fact, it has been shown that the relative production values of timothy hay and gluten feed are as 100 to 236, or as 1 to 2.36.

[2] The fat is converted into the energy equivalent of the starch or fiber by multiplying by 2.2; thus, 3 per cent of fat would have an energy equivalent of 6.6 per cent or parts of starch.

are easily and cheaply produced upon the farm, and because the digestive tract of the bovine is especially suited to utilize them. Most of these home-grown coarse feeds, however, are very high in carbohydrates and have a relatively low digestibility. It is necessary, therefore, to supplement them to an extent with the cereal grains, which, though relatively low in protein, are very digestible; and with the concentrated by-products, which, in addition to a relatively high digestibility, are quite rich in protein. A single illustration will make this clear. Many experiments have demonstrated that a 1,000-pound cow, producing daily 10 quarts of milk of average quality, needs approximately the following amounts of *digestible* nutrients: —

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds, . .	2-2 5	.5	13 or 13.5	16	1 to 5.6 or 7

Now, if this animal were fed daily as much of an *extra* quality of hay as she would consume (28 to 30 pounds), she would receive: —

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds, . .	1.3	.3	13	14.6	1 to 10.5

Such a ration is deficient both in total digestible nutrients as well as in digestible protein. If 7 pounds of the hay were replaced by an equal amount of corn meal, the hay and corn meal would furnish: —

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds, . .	1.4	.47	14.35	16.22	1 to 11

The corn meal being very digestible, but a one-sided or starchy feed, would sufficiently increase the total digestible nutrients, but not the protein. If 4 pounds of corn meal were replaced by 2 pounds of bran and 2 pounds of cotton-seed meal, the several feeds would supply: —

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds, . .	2.07	.60	13.20	15.87	1 to 6.6

The replacing of 7 pounds of hay with 3 pounds of corn meal rich in digestible matter and with 2 pounds each of bran and cotton-seed meal especially rich in digestible protein, furnishes a ration

containing less fiber and more starchy matter and protein than is contained in the hay. Such a ration contains the requisite amount of both total digestible matter and digestible protein, and may be said to be *properly balanced.*

5. Types of Balanced Rations.

Because of the high prices of all concentrated feeds, dairymen are frequently in doubt as to the kinds to be selected and the amount to be fed in order to secure the best returns for the money invested. Farmers selling cream to the creamery, or located where there is not a quick demand for milk, probably will not find it economical to feed over 3 to 5 pounds of purchased grain daily, and will use maximum amounts of hay and silage (1 to 1½ bushels of silage and what hay the animal will eat clean). If the silage is well eared, 1 and ½ pound each of cotton-seed meal and flour middlings, sprinkled over the silage to distribute it, will produce a fairly well-balanced ration, and prove helpful in maintaining the milk flow. If corn meal is a home product rather than silage, mix by weight ¼ bran, ½ corn and cob meal and ¼ cotton-seed meal (100 pounds bran, 200 pounds corn and cob meal and 100 pounds cotton-seed meal), and feed 5 to 6 quarts daily, together with one feeding of cut or shredded corn stover and what hay the animal will clean up.

Producers of market milk generally find it advisable to feed somewhat more grain, and a number of combinations are suggested which will produce satisfactory balanced rations when fed with what hay the animal will eat clean (18 to 24 pounds a day), or with 1 bushel of corn silage and 10 to 16 pounds of hay.

I.

125 pounds bran.
100 pounds flour middlings.
100 pounds gluten feed.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

II.

125 pounds bran.
100 pounds corn or hominy meal.[1]
100 pounds cotton-seed meal.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

III.

100 pounds wheat bran.
100 pounds gluten feed.
35 pounds cotton-seed meal.
Mix and feed 7 pounds (8 to 9 quarts) daily.

IV.

125 pounds wheat bran or malt sprouts.
100 pounds corn or hominy meal.
125 pounds gluten feed.
Mix and feed 7 pounds (6½ to 7 quarts) daily.

[1] Corn and cob meal if on hand can be used in place of corn or hominy meal.

V.

75 pounds wheat bran.
150 pounds corn and cob meal.
100 pounds cotton-seed meal.
Mix and feed 6 to 8 pounds or quarts daily.

VI.

100 pounds distillers' grains.
100 pounds malt sprouts
150 pounds corn meal.
50 pounds cotton-seed meal.
Mix and feed 7 pounds (7 to 8 quarts) daily.

VII.

150 pounds distillers' grains.
150 pounds standard middlings.
100 pounds corn or hominy meal.
Mix and feed 7 pounds or quarts daily.

VIII.

150 pounds wheat bran.
200 pounds gluten feed.
Mix and feed 7 pounds (8 to 9 quarts) daily.

IX.

200 pounds dried brewers' grains.
100 pounds corn meal.
50 pounds cotton-seed meal.
Mix and feed 7 pounds (9 quarts) daily.

X.[1]

300 pounds bran
100 pounds flour middlings.
100 pounds corn meal
100 pounds ground oats.
300 pounds gluten feed.
100 pounds linseed meal.
Mix and feed as desired.

The cost of a pound of the several mixtures is likely to vary from 1.45 to 1.6 cents. It is believed that the above selections are more economical on the basis of their content of nutritive material than most of the sugar feeds and other proprietary mixtures.

In general it may be said that the *amount of grain* to be fed daily depends (*a*) upon the size of the cow, (*b*) daily milk yield and (*c*) the local market value of the milk. The richer the milk, the more food is required to produce a given amount: and *vice versa*.

Seven pounds of the above mixtures is a fair average amount for cows weighing 800 to 900 pounds, which are yielding 10 quarts of 4 per cent milk. For every 2 quarts of milk yielded in excess of this amount the grain ration may be increased by 1 pound.

7. Rations for Young Stock.

Young dairy stock may receive 1 peck or more of silage daily, depending upon their size, in addition to what hay, corn stover or other coarse fodder they will eat clean; or the entire roughage may consist of hay. Grass and clover rowen form a very desirable feed

[1] Ration designed for cows on test; rather expensive for ordinary purposes.

for growing animals. In addition to the above, it is usually advisable to feed from 1 to 3 pounds daily of a grain mixture reasonably rich in protein and ash.[1] Any of the above mixtures will prove satisfactory. The writer has found mixtures by weight of ½ wheat bran and ½ flour middlings; or ½ bran, ¼ corn meal and ¼ flour middlings; or even ½ bran and ½ corn meal, quite satisfactory. A ration composed of late-cut hay and corn meal would not be desirable, it lacking both flesh and bone forming material (protein and ash).

J. B. LINDSEY.

AMHERST, January, 1911.

[1] If the roughage consists largely of grass or clover rowen, 2 pounds daily of a mixture of bran and corn meal, or even of corn meal alone, will prove satisfactory.

APPROVED BY THE STATE BOARD OF PUBLICATION.

Circular No. 31. April, 1911.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

Lime and Sulphur Solutions.

By G. E. Stone.

Lime and sulphur has been used for many years in various forms and for different purposes, although it is only comparatively recently that its value as a fungicide has been realized. The extensive use of this solution as a spray for the San José scale has incidentally demonstrated its great value as a fungicide. Our observations and experiments with the use of lime and sulphur when applied to trees in a dormant condition have convinced us that as a fungicide no preparation which has ever been used can be compared with it for efficiency in controlling different fungi. Up to the present time lime and sulphur has been largely used as a spray for fruit trees in a dormant condition, but in late years it has also been used in various modified forms as a summer spray with very encouraging results. Many trials have been made of the diluted concentrated preparations, and also of what is known as the "self-boiled lime and sulphur," but these methods are in a more or less experimental stage.

Lime and sulphur used as a spray on trees in a dormant condition is a positive preventive of peach leaf curl, Monilia and Cladosporium infection on trees. Its use holds in check the leaf spots of the apple, pear and plum, and will probably do the same for quinces and other fruit trees and shrubs. We also believe that it has a material effect on cankers, black knot and other common twig diseases. So effective is this treatment for leaf spots that many cases have been observed where only one spraying has been made and not a single spot could be found on the foliage of fruit trees in any part of the year. The diseases of fruit trees, however, are not as common in Massachusetts, or nearly so destructive, as elsewhere, and for this reason

it is impossible from our experience to state what effect the lime and sulphur would have on apple scab, apple rust and the fruit rots.

Experience has shown that the best concentrations of lime and sulphur are obtained by using about twice as much sulphur as lime, since this preparation gives the least sediment. Nothing but the best fresh stone lime, which is the purest, should be used in making lime and sulphur. Air slaked lime should not be used under any circumstances, and in many cases it is advisable to use hot instead of cold water in slaking the lime.

SELF-BOILED LIME AND SULPHUR MIXTURE.

By W. M. Scott.

Flowers of sulphur or sulphur flour,	8 pounds.
Fresh stone lime,	8 pounds.
Water,	50 gallons.

In making this mixture the best stone lime procurable should be placed in a barrel and slaked, using precautions not to drown the lime in slaking it. W. M. Scott recommends that enough water be applied to nearly cover the lime when slaking. As soon as the lime has commenced to slake and some heat has generated, apply the sulphur through a fine sieve to break up the lumps. The mixture should be stirred and more water added gradually, bringing it to a thin paste. As soon as the lime is well slaked, more water should be added to cool the mixture.

Since there is much difference in lime as regards the development of heat, it is difficult to specify any particular time to add the water for the purpose of cooling, but it should be done before the sulphur goes into solution and forms sulphides, which are injurious to peach foliage. Under ordinary conditions, the mixture should not be allowed to remain hot over ten or fifteen minutes after slaking. With the intense heat developed from slaking and constant stirring a uniform mixture of fairly finely divided sulphur and lime is obtained with only a small trace of sulphides in solution. It should be strained before use and is intended as a summer spray.

Mr. Scott has used this successfully for peach brown rot and scab. In this formula he also mixed two pounds of arsenate of lead, which proved effective in controlling plum weevil. Mr. Scott believes that the arsenate of lead is less likely to burn tender foliage when in combination with lime and sulphur than when used alone.

COMMERCIAL LIME AND SULPHUR CONCENTRATED SOLUTIONS.

There are a number of these solutions on the market which are apparently similar in composition. Their specific gravity varies from 30° to 34° Beaumé, and in using them it is necessary to dilute according to the strength of the solution and the nature of the foliage to which they are to be applied. The directions furnished by manufacturers for the dilution of their own product for different purposes can usually be relied upon.

LIME AND SULPHUR SOLUTION—Geneva Formula. *

Lime (pure,)	36 lbs.
Sulphur (high-grade, finely divided,)	80 lbs.
Water,	50 gals.

This is prepared by first moistening the sulphur and making it into paste. Then slake the lime in about 10 gals. of hot water, adding the lime gradually to prevent violent boiling and spilling over. Add the sulphur paste gradually during the slaking and stir constantly to prevent the formation of lumps. When the slaking is complete add the full amount of water, and boil for one hour. The boiling may be accomplished by the use of steam or by wood fires and kettles. In either case maintain the original volume of water. This concentrated solution is recommended by the Geneva Experiment Station, where extensive investigations have been made relative to the lime and sulphur solutions.

When the solution is made to 50 gals. it should have a density of from 24° to 25° Beaumé. The Geneva Experiment Station recommends that where the lime is 95% pure, 38 pounds should be used, and where only 90% pure, 40 pounds. According to their tests, when one part of pure lime and two parts of sulphur are boiled one hour, only slight amounts of sediment are present, whereas if the lime contains impurities, the amount of sediment is an indicator of the purity of the lime. The solution can be stored in filled, stoppered barrels for some time if the temperature does not fall below 5° F.

* For further information consult Bul. 329 and 330, Geneva, N. Y. Agr. Exp. Station.

The following table of dilutions is recommended by the Geneva Experiment Station :—

Reading on Hydrometer	Amount of dilution. Number of gallons of water to one gallon of lime sulphur solution.		
	For San Jose scale.	For blister mite.	For summer spraying of apples
Degrees Beaumé.			
35	9	12½	45
34	8¾	12	43¼
33	8¼	11½	41½
32	8	11	40
31	7½	10½	37¾
30	7¼	10	36¼
29	6¾	9½	34¼
28	6½	9	32¾
27	6	8½	31
26	5¾	8	29½
25	5¼	7½	27¾
24	5	n7	26
23	4½	6½	24¼
22	4¼	6	22¾
21	3¾	5½	21¼
20	3½	5	19¾
19	3¼	4¾	18¼
18	3	4¼	17
17	2¾	4	16
16	2½	3¾	15
15	1¼	3½	14
14	2	3	12¾

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. LINDSEY, CHEMIST.

AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS. (CHAPTER 388, 1911.)

Be it enacted, etc., as follows:

Statements to be printed on label accompanying the fertilizer.

SECTION 1. No commercial fertilizer shall be sold or offered or exposed for sale in this commonwealth without a plainly printed label accompanying it, displayed in the manner hereinafter set forth, and truly stating the following particulars:—

1. The number of pounds of the fertilizer sold or offered or exposed for sale.

2. The name, brand or trademark under which the fertilizer is sold, and, in the case of agricultural lime, its particular form.

3. The name and principal address of the manufacturer, importer or other person putting the fertilizer on the market in this commonwealth.

4. The minimum percentage of each of the following constituents which the fertilizer may contain: (a) nitrogen, (b) phosphoric acid soluble in distilled water, (c) available phosphoric acid, (d) total phosphoric acid, (e) potash soluble in distilled water; except that in the case of undissolved bone, untreated phosphate rock, tankage, pulverized natural manures, the ground seeds of plants, and wood ashes, when sold unmixed with other substances, the minimum percentage of total phosphoric acid therein may be stated in place of the percentages of soluble and available phosphoric acid; and except that in the case of agricultural lime the label shall truly state the following: (a) minimum and maximum percentage of total lime, (b) minimum and maximum percentage of total magnesia, (c) minimum percentage of lime and magnesia combined as carbonates, (d) minimum percentage of lime sulphate in gypsum or land plaster.

5. If any part of the nitrogen contained in the fertilizer is derived from pulverized leather, raw, roasted or steamed; or from untreated hair, wool waste, peat, garbage tankage, or from any inert material whatsoever, the label shall truly state the specific material or materials from which such part of the nitrogen is derived.

Concerning attachment of label.

SECTION 2. When any fertilizer is sold or offered or exposed for sale in packages, the label shall be affixed in a conspicuous place on the outside thereof. When any fertilizer, other than the product of gas-houses, known as gas-house lime, is offered or exposed for sale in bulk the label shall be affixed in a conspicuous place to the bin or other enclosure in which the fertilizer is contained but need not state the number of pounds thereof. And when any fertilizer other than gas-house lime aforesaid is sold in bulk the label shall be affixed in a conspicuous place to the car or other vehicle in which the fertilizer is shipped or delivered and shall state the number of pounds thereof. When any fertilizer is sold in packages furnished by the purchaser the seller shall furnish the labels therefor.

Definition of guaranteed analysis; Wagner method to be used for phosphatic slag.

SECTION 3. The provisions of the printed label required by this act relating to the constituents contained in any fertilizer shall be known and recognized as the guaranteed analysis of such fertilizer, and the available phosphoric acid in basic phosphatic slag shall be stated in the label thereof on the basis of the results of an analysis by the Wagner Method, so-called, until such time as the Association of Official Agricultural Chemists of North America shall adopt a method of analysis for basic phosphatic slag, after which the available phosphoric acid shall be stated on the basis of an analysis by the method of said association.

Definition of violation of previous sections.

SECTION 4. Any manufacturer, importer, or other person selling or offering or exposing for sale in this commonwealth a commercial fertilizer or brand of commercial fertilizer, any constituent part of which is of a smaller percentage than it is stated to be in the label of said fertilizer, and any manufacturer, importer, or other person selling or offering or exposing for sale in this commonwealth a fertilizer or brand of fertilizer with a label which is untrue in any particular, shall be deemed to have committed a violation of this act.

Certified copy of label to be filed. Cost of analysis fee and time of payment.

SECTION 5. No manufacturer, importer, or other person shall sell or offer or expose for sale in this commonwealth any commercial fertilizer until he shall have filed with the director of the Massachusetts Agricultural Experiment Station a copy certified by him to be a true copy of the label required by this act, excepting the item as to number of pounds, for every brand of fertilizer to be sold or offered or exposed for sale in this commonwealth, and shall have paid to the said director an annual analysis fee for every brand aforesaid as follows: eight dollars for nitrogen, eight dollars for phosphoric acid, eight dollars for potash contained or stated to be contained in any such brand of fertilizer, and twelve dollars for every brand of agricultural lime except gas-house lime. The certified copy of the label of every brand of fertilizer to be sold or offered or exposed for sale in this commonwealth shall be filed with, and the proper analysis fee for every such brand shall be paid to, the director of the Massachusetts Agricultural Experiment Station prior to the first day of January of the calendar year in which the brand is to be sold or offered or exposed for sale. But should a manufacturer, importer, or other person desire in any year to sell or to offer or expose for sale in this commonwealth any brand of commercial fertilizer in respect of which the requirements of this section as to the filing of a copy of the label thereof and the payment of the analysis fee therefor have not been complied with before the first day of January of said year, the said manufacturer, importer or other person may offer or expose for sale and sell the said brand in this commonwealth upon filing a certified copy as aforesaid of the label thereof and paying the full analysis fee therefor. No agent or other person shall be obliged to file a copy of the label of, or pay an analysis fee for, any brand of fertilizer for which a certified copy of the label has been filed and the analysis fee has been paid by the manufacturer or importer of such brand.

Any manufacturer, importer, or other person filing with the director of the Massachusetts Agricultural Experiment Station a false copy of the printed label of any fertilizer or brand of fertilizer shall be deemed to have committed a violation of this act.

Director to issue certificate of compliance when conditions are fulfilled.

SECTION 6. When both the certified copy of the label of any brand of fertilizer has been filed and the analysis fee therefor has been paid as provided in section five of this act, the director of the Massachusetts Agricultural Experiment Station shall issue or cause to be issued a certificate to that effect; and the certificate shall be deemed to au-

thorize the sale in this commonwealth, in compliance with this act, of the brand of fertilizer for which the certificate is issued up to and including the thirty-first day of December of the year for which it is issued.

Collection and analysis of samples and publication of results.

SECTION 7. Every commercial fertilizer and brand of commercial fertilizer sold or offered or exposed for sale in this commonwealth shall be subject to analysis by the director of the Massachusetts Agricultural Experiment Station or by his duly designated deputy or deputies. And the said director is hereby authorized and it is made his duty to make or cause to be made in each year one or more analyses of every fertilizer and brand of fertilizer sold or offered or exposed for sale in this commonwealth, and to collect the annual analysis fee provided for by section five of this act. The said director, his inspectors and deputies, are further authorized to enter upon any premises where any commercial fertilizer is sold or offered or exposed for sale to ascertain if the provisions of this act are complied with, and to take samples for analysis as provided for by this act. The analysis of all fertilizers shall be made by the methods adopted by the Association of Official Agricultural Chemists of North America, except that basic phosphatic slag may be analyzed by the Wagner Method, so-called, until a method of analysis therefor is adopted by said association. The said director shall have the right to publish or cause to be published in reports, bulletins, special circulars or otherwise, the results obtained by said analyses, and in connection therewith shall, in each case, state the cost of equivalent amounts of nitrogen, phosphoric acid and potash in unmixed materials when bought for cash on the market at retail. Said reports, bulletins, circulars, or other publications shall also contain such additional information in relation to the character, composition, value and use of the fertilizers analyzed as the said director in his discretion may see fit to include. The said director may at any time make or cause to be made for any person a free analysis of any commercial fertilizer or brand of commercial fertilizer sold or offered or exposed for sale in this commonwealth, but he shall not be obliged to make such free analysis, or to cause the same to be made, unless the samples therefor are taken and submitted in accordance with the rules and regulations which may be prescribed by him. The results of any analysis made in accordance with the provisions of this act, except a free analysis as aforesaid, shall be sent by the director to the person named in the printed label of the fertilizer analyzed at least fifteen days before any publication thereof.

Sampling of fertilizers.

SECTION 8. All samples of commercial fertilizers taken for analysis shall be of not less than substantially one and one-half pounds in weight, and every sample shall be taken, whenever the circumstances conveniently permit, in the presence of the person selling or offering or exposing for sale the fertilizer sampled, or of a representative of such person. Broken packages shall not be sampled, and all samples shall be taken from substantially ten per cent of the fertilizer to be sampled, except that in the case of a fertilizer sold or offered or exposed for for sale in bulk ten single samples shall be taken from as many different portions of the lot. All samples taken shall be thoroughly mixed and divided into two nearly equal samples, placed in suitable vessels, and marked and sealed. Both shall be retained by the director, but one shall be held intact by him for the period of one year at the disposal of the person named in the label of the fertilizer sampled.

Penalty for obstructing director or deputy. Prosecutions at discretion of director.

SECTION 9. Any person hindering or obstructing the director of the Massachusetts Agricultural Experiment Station, or any inspector or deputy of the said director, in the discharge of the authority or duty conferred or imposed by any provision of this act and any person violating any provision of sections one, two, three, four and five of this act shall be fined not less than fifty dollars and not more than two hundred dollars for each offence. It shall be the duty

of the said director to see that the provisions of this act are complied with, and he may, in his discretion, prosecute or cause to be prosecuted any person violating any provision of this act. But no complaint based upon an analysis of samples shall be made for any such violation, if the samples were taken otherwise than as provided in this act. And no complaint shall be made for a failure of any fertilizer or brand of fertilizer to meet the guaranteed analysis thereof if the analysis of such fertilizer made by the director, or by his deputy or deputies, shows the amounts of the constituents thereof to be substantially equivalent to the percentages stated in the label of the fertilizer.

Analysis fees turned over to treasurer. Accounts to be audited.

SECTION 10. All fees collected by the director of the Massachusetts Agricultural Experiment Station under the provisions of this act shall be turned over by him to the treasurer of the said station, and the amounts received and disbursed shall be kept in a separate account, and shall be audited and reported, as are other moneys placed in charge of the trustees of the Massachusetts Agricultural College. The money collected under the provisions hereof shall be used under the authority of the said director to meet the expenses incurred in carrying out the provisions of the act, and should there be a surplus, the surplus shall be used in the Massachusetts Agricultural Experiment Station, under the authority of its director, for experiments and research relative to soils, fertilizers and manures.

Definition of terms.

SECTION 11. In this act unless the context or subject-matter otherwise requires,

"Agricultural lime" includes all the various forms of lime intended or sold for fertilizing purposes.

"Available phosphoric acid" means the sum of the soluble and reverted phosphoric acid, except that, as applied to basic phosphatic slag, the term "available phosphoric acid" shall mean that part of the phosphoric acid made soluble by the Wagner Method, so-called, until such time as the Association of Official Agricultural Chemists of North America shall adopt a method for basic phosphatic slag, after which it shall mean that part of the phosphoric acid made soluble by the method of said association.

"Brand" means any commercial fertilizer distinctive by reason of name, trademark or guaranteed analysis or by any method of marking.

"Commercial fertilizer" includes every natural or artificial manure containing nitrogen or phosphoric acid or potash or lime, except the excrements and litter from domestic animals when sold in their natural state; but dried or partly dried manure, pulverized or ground, shall be included as a commercial fertilizer.

"Copy" means certified copy.

"Fertilizer" means commercial fertilizer.

"Importer" means a person who procures for sale in this commonwealth commercial fertilizers made in other states or countries.

"Label" means printed label.

"Lime" means calcium oxide (CaO).

"Magnesia" means magnesium oxide (MgO).

"Packages" includes sacks and bags and all other receptacles.

"Person" includes a corporation or partnership or two or more persons having a joint or common interest.

"Phosphoric acid" means phosphoric anhydrid (P_2O_5).

"Potash" means potassium oxide (K_2O).

SECTION 12. Sections eleven to seventeen inclusive of chapter fifty-seven of the Revised Laws and chapter two hundred and eighty-nine of the acts of the year nineteen hundred and seven are hereby repealed.

SECTION 13. This act shall take effect on the first day of December in the year nineteen hundred and eleven. (*Approved May 4, 1911.*)

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

An Act Relative to the Sale of Commercial Fertilizers

[Chap. 220, 1918]

Be it enacted, etc., as follows:

Director to issue certificate of registration when conditions are fulfilled. Director or deputy may refuse or cancel certificate if statements are misleading.

Section 1. Chapter three hundred and eighty-eight of the acts of nineteen hundred and eleven is hereby amended by striking out section six, and substituting the following:— *Section 6.* When the certified copy of the label of any brand of fertilizer has been filed, and the proper fees have been paid, the director of the Massachusetts Agricultural Experiment Station shall issue or cause to be issued a certificate to that effect; and the certificate shall be deemed to authorize the sale in this commonwealth, in compliance with this act, of the brand of fertilizer for which the certificate is issued up to and including the thirty-first day of December of the year for which it is issued. The director of the Massachusetts Agricultural Experiment Station or his authorized deputy may refuse to issue a certificate for any fertilizer or brand of fertilizer which does not contain at least one half of one per cent of nitrogen, or one half of one per cent of potash soluble in distilled water, or one per cent of phosphoric acid, or five per cent of lime, or five per cent of magnesia, or which contains its potash or phosphoric acid or lime or magnesia in forms substantially insoluble by the methods of analysis for commercial fertilizers prescribed by the Association of Official Agricultural Chemists of North America, or which does not possess substantial properties as a fertilizer. The said director or his deputy may also refuse to issue a certificate for any fertilizer under a name, brand, or trade mark which is untrue in any particular, or which, in his opinion, would be misleading or deceptive in any particular, or would tend to mislead or deceive as to the constituents or properties of said fertilizer. The director or his deputy may refuse to issue more than one certificate for any fertilizer under the same name or brand, or to issue a certificate for any fertilizer under a name or brand to the use of which the party is not lawfully entitled. Should a certificate be issued for any fertilizer and it be discovered afterward that the certificate itself, or the granting of it, or the manner of procuring it, was in any respect in violation of any provision of this act, the said director and his authorized deputy, shall have power to cancel the certificate. No commercial fertilizer or brand of fertilizer shall be sold or offered or exposed for sale until a certificate has been issued by the director or his authorized deputy, and any manufacturer, importer, or other person who shall sell, or offer or expose for sale a fertilizer or brand of fertilizer for which no certificate has been issued, or the certificate for which has been cancelled, shall be punished by a fine not exceeding two hundred dollars for each offence.

Penalty for obstructing director or deputy. Director may prescribe rules and regulations. Prosecutions at discretion of director.

SECTION 2. Section nine of chapter three hundred and eighty-eight of the acts of nineteen hundred and eleven is hereby amended by inserting after the word "with," in the tenth line, the words :—he may prescribe and enforce such rules and regulations relative to the sale of commercial fertilizers as he may deem necessary to carry into effect the full intent and meaning of this act,—so as to read as follows :—*Section 9.* Any person hindering or obstructing the director of the Massachusetts Agricultural Experiment Station, or any inspector or deputy of the said director, in the discharge of the authority or duty conferred or imposed by any provision of this act and any person violating any provision of sections one, two, three, four and five of this act shall be fined not less than fifty dollars and not more than two hundred dollars for each offence. It shall be the duty of the said director to see that the provisions of this act are complied with, he may prescribe and enforce such rules and regulations relative to the sale of commercial fertilizers as he may deem necessary to carry into effect the full intent and meaning of this act and he may, in his discretion, prosecute or cause to be prosecuted any person violating any provision of this act. But no complaint based upon an analysis of samples shall be made for any such violation, if the samples were taken otherwise than as provided in this act. And no complaint shall be made for a failure of any fertilizer or brand of fertilizer to meet the guaranteed analysis thereof if the analysis of such fertilizer made by the director, or by his deputy or deputies, shows the amounts of the constituents thereof to be substantially equivalent to the percentages stated in the label of the fertilizer.

Declaration of tonnage sold and payment of fee. Penalty for failure to comply with requirements of this section.

SECTION 3. In addition to the requirements of section five of chapter three hundred and eighty-eight of the acts of nineteen hundred and eleven, every manufacturer, importer or other person who sells or offers or exposes for sale in this commonwealth any commercial fertilizer shall, on or before the first day of January and July in each year, beginning with January, nineteen hundred and nineteen, file with the director of the Massachusetts Agricultural Experiment Station a sworn statement in such form as the director may prescribe setting forth the number of net tons of fertilizer sold by him in the commonwealth during the preceding six months, stating in each case the number of tons of every brand sold, together with a permit allowing the director or his authorized deputy to examine the books of the person filing the statement, for the purpose of verifying the same, and shall thereupon pay to the director a fee of six cents a ton of two thousand pounds for the fertilizers so sold, except that no such statement, permit or fee shall be required in respect of agricultural lime. The said director or his authorized deputy shall have power to cancel the certificate for any brand of fertilizer in respect to which the requirements of this section have not been complied with, and any manufacturer, importer or other person who shall sell or offer or expose for sale in this commonwealth a fertilizer or brand of fertilizer without having filed the statement and permit and paid the fee required by this section shall be punished by a fine not exceeding five hundred dollars for each offence. But no agent or other person shall be obliged to file a statement or permit, or pay the fee required by this section, for any brand of fertilizer for which the statement and permit have been filed and for which the fee has been paid by the manufacturer or importer of such brand. The director is hereby authorized and it is made his duty to collect the fee required by this section, and to turn over the same to be accounted for and disbursed in accordance with the provisions of section ten of said chapter three hundred and eighty-eight. [*Approved May 21, 1918.*

CIRCULAR No. 33. Superseding No. 24. APRIL, 1912

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Department of Plant and Animal Chemistry,

J. B. LINDSEY, Chemist.

CONTENTS.

I. AN ACT TO REGULATE THE USE OF UTENSILS FOR TESTING THE COMPOSITION OR VALUE OF MILK AND CREAM.[1]

Be it enacted, etc., as follows:

Glassware must be tested for accuracy, and so marked.

SECTION 1. No bottle, pipette, or other measuring glass or utensil shall be used in this commonwealth by any inspector of milk or cream, or by any person in any milk inspection laboratory, in determining, by the Babcock or other centrifugal machine, the composition of milk or cream for the purposes of inspection; or by any person in any milk depot, creamery, cheese factory, condensed milk factory or other place in determining, by the Babcock or other centrifugal machine, the composition or value of milk or cream as a basis for payment in buying or selling, until it has been tested for accuracy and verified by the director of the Massachusetts agricultural experiment station, or by his duly designated deputy or deputies. Every such bottle, pipette, or other measuring glass or utensil shall be submitted to the said director by the owner or user thereof, to be tested for accuracy before the same is used in this commonwealth for the purposes aforesaid. The owner or user shall pay to the said director for the use of the said station as a fee for making the test, a sum not exceeding five cents for each bottle, pipette, or other measuring glass or utensil tested.

[1] Chapter 218, Acts and Resolves of Massachusetts for 1912.

Any bottle, pipette, or other measuring glass or utensil that has been tested and verified as aforesaid shall be marked by the director or by his said deputy or deputies to indicate the fact, or if tested and found to be inaccurate may be marked by him or them to indicate that it is inaccurate. No bottle, pipette, or other measuring glass or utensil that has been marked by the said director, or by his duly designated deputy or deputies, to indicate that it is inaccurate shall be used in this commonwealth by any person in determining the composition or value of milk or cream.

Babcock machines subject to yearly inspection.

SECTION 2. Every Babcock or other centrifugal machine used in this commonwealth by any inspector of milk or cream, or by any person in any milk inspection laboratory for determining the composition of milk or cream for purposes of inspection, or by any person in any milk depot, creamery, cheese factory, condensed milk factory or other place for determining the composition or value of milk or cream as a basis for payment in buying or selling, shall be subject to inspection at least once in each year by the director of the Massachusetts agricultural experiment station or by an inspector or deputy of the said director. The owner or user of any such centrifugal machine shall pay to the said director for the use of said station as a fee for making such annual inspection the actual cost of such inspection for each machine inspected.

Any Babcock or other centrifugal machine used as aforesaid that is not, in the opinion of the director, or of an inspector or deputy of the said director, in condition to give accurate results, may be condemned by the director or by his inspector or deputy. No Babcock or other centrifugal machine that has been condemned by said director or by an inspector or deputy of the director as not in condition to give accurate results shall be used in this commonwealth by any person for determining the composition or value of milk or cream as aforesaid, unless the machine be changed to the satisfaction of the said director or of his inspector or deputy, and approved by him.

Operators must secure certificate of competency.

SECTION 3. No inspector of milk or cream, and no person in any milk inspection laboratory, shall manipulate the Babcock or other centrifugal machine for the purpose of determining the composition of milk or cream for purposes of inspection, and no person in any milk depot, creamery,

cheese factory, condensed milk factory, or other place in this commonwealth shall manipulate the Babcock or other centrifugal machine for the purpose of determining the composition or value of milk or cream as a basis for payment in buying or selling, without first obtaining a certificate from the director of the Massachusetts agricultural experiment station, or his duly designated deputy, that he is competent to perform such work. The fee for such certificate shall be two dollars, and shall be paid by the applicant therefor to the said director for the use of the said station. In case any holder of a certificate is notified by the director, or by his duly designated deputy, to correct his use of a Babcock or other centrifugal machine, the actual cost of making an inspection to ascertain if the said person has corrected his use of the said machine shall be paid by the said person or by his employer to the director for the use of the said station. No holder of a certificate whose authority to manipulate a Babcock or other centrifugal machine has been revoked by the director of the Massachusetts agricultural experiment station, or by his duly designated deputy, shall thereafter manipulate in this commonwealth any centrifugal machine for the purposes aforesaid.

Director of the Experiment Station empowered to issue and revoke certificates.

SECTION 4. The director of the Massachusetts agricultural experiment station and his duly designated deputy are hereby authorized to issue certificates of competency to such persons desiring to manipulate the Babcock or other centrifugal machine as, in the opinion of the director or his deputy, are competent to manipulate said machines. The said director or his deputy may make and enforce rules governing applications for such certificates and the granting thereof and may, in his discretion, revoke the authority of any holder of a certificate who, in the opinion of the director or of his deputy, or of an inspector of the said director, is not correctly manipulating any centrifugal machine as aforesaid, or is using dirty or otherwise unsatisfactory glassware or utensils.

Director authorized to test glassware, and inspect machines and see if provisions of Act are complied with.

SECTION 5. It shall be the duty of the director of the Massachusetts agricultural experiment station, and he is hereby authorized, to test or cause to be tested all bottles, pipettes and other measuring glasses or utensils submitted to him as provided in section one, to inspect or cause to be inspected at least once each year every Babcock or other centrifugal machine used in this commonwealth by an inspector of milk or cream, or by any person in any milk inspection laboratory, for purposes of inspection, or by any person in any milk depot, creamery, cheese factory, condensed milk factory, or other place for determining the composition or value of milk or cream as a basis for payment in buying or selling, and to collect or cause to be collected for the use of said station the fees or actual cost of tests and inspections provided for in this act. The said director, his inspectors and deputies are further authorized to enter upon any premises in this commonwealth where any centrifugal machine is used as aforesaid to inspect the same and to ascertain if the provisions of this act are complied with.

Violators of this Act to be punished by fines.

SECTION 6. Any person hindering or obstructing the director of the Massachusetts agricultural experiment station. or any inspector or deputy of the said director, in the discharge of the authority or duty imposed upon him or them by any provision of this act, and any person violating any of the provisions of sections one, two and three of this act shall be punished by a fine of not less than fifteen and not more than fifty dollars for each offense.

Director authorized to institute legal proceedings.

SECTION 7. It shall be the duty of the director of the Massachusetts agricultural experiment station to see that the provisions of this act are complied with, and he may in his discretion prosecute or cause to be prosecuted any person violating any provision of this act. But this act shall not be construed to affect any persons using any centrifugal or other machine or test in determining the composition or value of milk or cream when such determination is made for the information of such persons only, and not for purposes of inspection, or as a basis for payment in buying or selling.

SECTION 8. A sum not exceeding five hundred dollars yearly shall be allowed and paid out of the treasury of the commonwealth to meet the cost of prosecutions under this act, to be paid upon the presentation to the treasurer of the commonwealth by the director of the Massachusetts agricultural experiment station of proper vouchers therefor.

SECTION 9. The word "person" as used in this act shall include a corporation, association or partnership or two or more persons having a joint or common interest.

SECTION 10. Sections sixty-five to sixty-nine, inclusive, of chapter fifty-six of the Revised Laws, and chapter four hundred and twenty-five of the acts of the year nineteen hundred and nine are hereby repealed.

SECTION 11. This act shall take effect on the first day of July in the year nineteen hundred and twelve. [*Approved March 9, 1912.*

II. SALIENT POINTS IN THE ACT.

Persons included. The following persons are included within the meaning of the law: (a) operators who use the test as a basis of payment for milk and cream; (b) operators in milk depots, creameries or laboratories where the test is used in determining the fat content of purchased milk or cream with a view to ascertaining if it be of standard quality; (c) milk inspectors.

Certificates. The above mentioned operators must secure from the director of the experiment station or his authorized deputy a certificate of competency. This is done by applying for an examination. Upon receipt of the application an arrangement will be made with the applicant for a time and place for the examination. If the results of the examination are satisfactory, a certificate will be issued to the applicant. It is believed it will be more satisfactory, as a rule, for the applicant to come to Amherst by previous appointment for the examination. In exceptional cases, if the applicant desires that the examination be held elsewhere, an arrangement relative to time and cost will be made if possible. Such cost will include, in addition to the two dollars for the certificate, the traveling expenses and the extra cost of the time of the examiner.

Machines. All Babcock centrifugal machines must be well oiled and every part kept in good repair. The machine must be set on a firm foundation in order to keep it free from vibration. It must be level and run at the required speed. The correct speed for Babcock centrifugal machines of different diameters is considered to be that stated in Farrington and Woll's book, "Testing Milk and its Products," published by the Mendota Book Company, Madison, Wisconsin.

Inspection. Babcock centrifugal machines and other apparatus used in making the test will be inspected at least once each year, the expense being borne by the person or firm at whose plant the inspection is made. The use of a machine that is out of repair or not in condition to give accurate results, or the use of dirty or untested glassware, will be considered sufficient grounds for re-inspection, or may lead to the revoking of the certificate of the operator or prosecution at the discretion of the director of the experiment station.

Glassware. Glassware must be tested for accuracy by the Massachusetts experiment station before being used, and so marked as to indicate the fact. It must be kept clean and in condition to insure accurate results.

Communications in regard to this law should be addressed to

PHILIP H. SMITH,
Mass. Agricultural Experiment Station,
Amherst, Mass.

III. SUGGESTIONS FOR MAKING THE BABCOCK TEST.

PHILIP H. SMITH.

Attention is called to the following suggestions in regard to the manipulation of the Babcock test, the slighting of which, in the haste of commercial work, will tend toward inaccuracy.

Preservation of samples. Composite samples of milk and cream should be preserved in clean, wide-mouthed, tightly stoppered bottles; they should be well mixed after each addition to insure a uniform distribution of the preservative and its thorough incorporation with the

cream. The samples should be kept in a cool place out of the sun. Ground glass stoppered bottles are to be preferred, but owing to the expense they are not generally used. Bottles with tight fitting corks of first quality form the most satisfactory substitute.

The preservatives most commonly employed for keeping composite samples are corrosive sublimate, bichromate of potash and formalin. The two former are sold in tablets prepared especially for the purpose, and simply need to be powdered and dissolved in the sample; formalin (formaldehyde) is sold in 40 per cent. solutions, and the quantity needed for a composite can be easily added by means of a small dropper or pipette.

Corrosive sublimate tablets are to be preferred to other preservatives, as they interfere least with the action of the sulfuric acid in making the test. Where the total solids of milk samples are to be determined in addition to the percentage of fat, formalin can be used to advantage, as the amount necessary does not affect the accuracy of the test. Six to ten drops are sufficient to preserve a pint sample several weeks if the sample is kept in a cool place. An undue excess of any preservative should be avoided.

Sampling and pipetting.

A thorough preparation of the sample is of vital importance, and is best accomplished by gently rotating and by pouring back and forth from the mixing vessel. Shaking and forcible pouring is not permissable, as it is likely to cause partial churning and is sure to inclose a large amount of air, rendering the sample unfit for pipetting. All cream adhering to the sides and the stopper of the sample bottle should be incorporated, and the resulting mixture should not show any solid particles of fat. A small, fine wire sieve is of great help in detecting and correcting a lumpy condition.

After mixing, the sample should be pipetted *immediately* as the fat globules rise rapidly toward the surface. The pipette should be first rinsed with the sample, then filled again slowly, taking care to avoid air bubbles, held in a vertical position when lowering the liquid to the mark and read with the entire meniscus or crescent above the line. In transferring to the test bottle, smearing of the neck should be avoided as far as possible and the pipette blown clear.

Sour milk can be readily brought into a condition suitable for pipetting by the use of a wire sieve to break the clots or by neutralizing the acidity with a small pinch of powdered caustic alkali or 5

per cent. (by volume) of household ammonia. In the latter case the results must be increased to offset the dilution by the factor of 1.05.

Churned milk. In partly churned samples the lumps of butter can be temporarily incorporated by heating and pouring, or by dissolving in 5 per cent. (by volume) of ether. With the first method it is necessary to pipette while the sample is warm and it is advisable to weigh the test. It is extremely difficult to secure an accurate test of a badly churned sample.

Separator cream containing more than 25 per cent. butter fat cannot be pipetted directly with accurate results, for the reason that a cream pipette (18 c. c.) will not deliver the requisite amount (18 grams) because of the lower specific gravity and greater adhesiveness of the liquid. The experiment station does not advocate the use of 50 per cent. test bottles for rich cream, but prefers to use one-half amount (9 grams) of the weighed sample in the 30 per cent. 6 inch bottle where tests run over 25 per cent., multiplying the results by two. In pipetting thin cream it is well to use two pipettes alternately, allowing one to drain into the test bottle while the other is in use.

It is the general rule in western creameries to weigh all samples of cream in preference to pipetting. While at first this method may take longer, it is an excellent precaution, and with practice the operator can make the test nearly as fast as by pipetting. We have found, at the experiment station, that thin cream (25 per cent. or less fat) free from lumps of fat and uncurdled will give just as high results when pipetted (18 c. c.), provided the pipette is given ample time to drain into the test bottle.

Sour cream can be suitably prepared by the use of a sieve, but the inclosed gas prevents satisfactory pipetting and makes weighing of the test absolutely necessary, if accurate results are to be obtained.

Adding acid.

Before mixing, the acid and the contents of the test bottle should be at a temperature of 60°—70° Fahr. When the acid is added the test bottle should be turned so as to wash down all the sample adhering to the sides of the neck, rotated at once and this continued until all the lumps of curd are dissolved. The hand mixing should never be slighted, and care should be taken not to throw the fat into the neck of the test bottle.

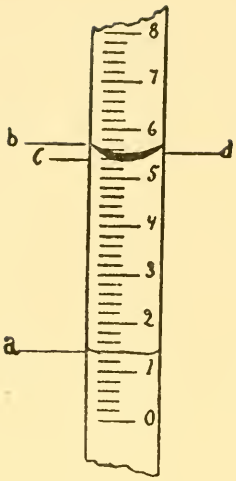
Cream of a high fat content and naturally a low percentage of curd, requires slightly less than the regular quantity of acid (17.5 c. c.) and this is equally true of samples containing an excess of bichromate of potash (preservative.) Skimmilk, containing slightly more curd than whole milk, and samples preserved with formalin, which hardens the nitrogenous bodies (proteids), need relatively more than the usual amount of acid.

Whirling and filling. The machine should be balanced, provided there is not a full battery, by a suitable arrangement of the bottles. It should be run for at least five minutes at a speed equal to the theoretical demands for an inner disc of the given diameter. The diameter of the disc is understood to be twice the distance between the center of the disc and the point of union between neck of test bottle and bulb when it is whirling.

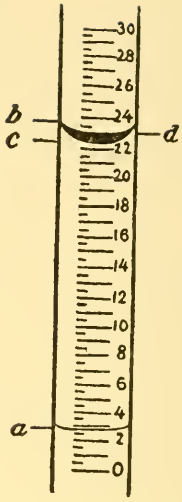
Diameter of disc. Inches.	Revolutions per minute.
10	1074
12	980
14	909
16	848
18	800
20	759

The test bottle should then be filled to the shoulder with hot water and whirled again for fully two minutes and longer if the fat does not separate *clear* and *oily*. After the final filling, which should bring the fat well up into the neck of the test bottle, it should be whirled again for two minutes to perfect the column of fat.

Reading results. The percentage can be read more safely and accurately by using a pair of dividers to measure the column of fat than by trusting to the unaided eye.



* In measuring the fat column in the neck of a *milk* test bottle the reading should be made from a to b, not to c or to d.



* In measuring the fat column in the neck of a *cream* test bottle the reading should be made from a to c, not to b or to d. The size of the meniscus is magnified in this cut.

In accordance with recent investigation it is considered more accurate to measure the column of fat in a *cream* bottle from the *bottom* of the meniscus (crescent) as indicated in the above cut. Such observations as we have made confirm this. The writer prefers to use only the 6 inch 30 per cent. Connecticut cream bottles, taking one-half the usual amount (9 grams), where the cream tests over 30 per cent. The use of 9 inch cream test bottles having a smaller neck is increasing on account of the greater accuracy obtained.

For eliminating the upper meniscus in reading cream, the experiment station has adopted a method advocated by the Indiana experiment station, in which a small amount of white mineral oil (sometimes called glymol or glycoline†), colored red with alkanet root is introduced into the neck of the bottle at the conclusion of the test and just before reading. The white mineral oil, being of a lower

* Reproduced from "Testing Milk and its Products," published by Mendota Book Co., Madison, Wis.

† Obtained of any wholesale drug house.

specific gravity than the butter fat, floats on top of the fat column and eliminates the meniscus, the upper part of the fat column appearing as a straight line.

The reading should be made immediately, before the fat begins to contract and settle, at a temperature of 120° to 140° Fahr., and the reading is equivalent to percentage when the normal amount of material (18 grams) is taken. Too rapid cooling of the samples may be checked by setting the bottle into a vessel of water heated to 130° Fahr.

The column of fat should be a clear yellowish liquid with a sharply defined upper and lower meniscus or crescent, with no white curd or charred material in or below the fat and no bubbles or foam on its surface. Discoloration of the fat and charring is due to excessive acid action, which may be caused by too strong, too much or too warm acid, too warm a sample or failure to mix at once, or the action of some preservative, especially bichromate of potash.

Light colored fat and the presence of undissolved curd may be caused by too weak, too little or too cold acid, too cold a sample, insufficient whirling or lack of proper heat, or the action of some preservative, especially formalin.

Bubbles or foam on the surface of the fat may be due to the use of hard water containing carbonates, or sometimes to excessive heat in poorly constructed turbines.

Care of Glassware. The contents of the test bottles should be shaken out while hot to remove the deposit of lime sulfate, rinsed with clean water to remove the acid, which interferes with the cleaning action of the soap, cleaned with hot soap suds, preferably made by using some strongly alkaline soap powder, rinsed with hot water and allowed to drain. Pipettes should be cleaned in a similar manner. The scale when indistinct can easily be restored by rubbing over with an oil shipping crayon.

CIRCULAR NO. 34. (Superseding No. 17.) JUNE, 1912

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST

DEPARTMENT OF PLANT AND ANIMAL CHEMISTRY

J. B. LINDSEY, CHEMIST.

AN ACT TO REGULATE THE SALE AND ANALYSIS OF FOOD STUFF USED FOR FEEDING LIVE STOCK AND POULTRY.

[Acts and Resolves for 1912, Chapter 527.]

Be it enacted, etc., as follows:

Definitions of Terms

SECTION 1. In this act, unless the context otherwise requires:—The term "commercial feeding stuff" shall include all feeding stuff used for feeding live stock and poultry and containing not more than sixty per cent of water, except whole seeds or grains, and the unmixed meals made directly from the entire grains of corn, wheat, rye, barley, oats, buckwheat, flaxseed, kafir, and milo, whole hays, whole straws, unground cotton seed hulls and unground corn stover when unmixed with other materials.

The term "cattle feed" shall include all materials used for feeding live stock and poultry.

"Brand" shall mean any commercial feeding stuff or cattle feed distinctive by reason of name, trade-mark or guaranteed analysis or by any method of marking.

"Crude protein" shall mean the percentage of nitrogen multiplied by the factor six and twenty-five one hundredths.

"Copy" shall mean certified copy.

"Feeding stuff" shall mean commercial feeding stuff.

"Importer" shall mean a person who procures for sale or distribution in this commonwealth commercial feeding stuff or cattle feed from other states or countries.

"Label" shall mean printed label.

"Package" shall include sacks and bags, tins, boxes, jars, and similar receptacles.

"Person" shall include a corporation or partnership of two or more persons having a joint or common interest.

"Tag" shall mean printed tag.

Statements to Be Printed on Label Accompanying the Feeding Stuff

SECTION 2. Every package, lot or parcel of commercial feeding stuff sold or offered or exposed or kept for sale or distributed within this Commonwealth shall have affixed thereto in a conspicuous place, as hereinafter set forth, a tag or label containing a legible and plainly printed statement in the English language clearly and truly certifying:

(*a*) the weight of the contents of the package, lot or parcel;
(*b*) the name, brand or trade-mark;
(*c*) the name and principal address of the manufacturer or person responsible for placing the commodity on the market;
(*d*) the minimum *per cent* of crude protein;
(*e*) the minimum *per cent* of crude fat;
(*f*) the maximum *per cent* of crude fibre;
(*g*) the specific name of each ingredient used in its manufacture.

Concerning Attachment of Label

SECTION 3. When any feeding stuff is sold or offered, exposed or kept for sale or distributed in packages, the tag or label shall be affixed in a conspicuous place on the outside thereof. When any feeding stuff is offered, exposed or kept for sale in bulk, the tag or label shall be affixed in a conspicuous place on the bin or other enclosure in which the feeding stuff is contained, but need not state the number of pounds thereof. And when any feeding stuff is sold or distributed in bulk the label shall be affixed in a conspicuous place on the car or other vehicle in which the feeding stuff is shipped or delivered or distributed and shall state the number of pounds thereof. When any feeding stuff is sold in packages furnished by the purchaser the seller shall furnish the tags or labels therefor. The provisions of the printed tag or label required by this act relating to the constituents contained in any commercial feeding stuff shall be known and recognized as the guaranteed analysis of such feeding stuff.

Registration of Guarantee Required

SECTION 4. Before any manufacturer, importer or other person shall sell, or offer, expose, or keep for sale, or distribute in this commonwealth any commercial feeding stuff, he shall file with the director of the Massachusetts agricultural experiment station, or his authorized deputy, for registration, a copy certified by him to be a true copy of the tag or label required by this act,

excepting the item as to the number of pounds, for every brand of feeding stuff to be sold or offered, exposed or kept for sale or to be distributed in this commonwealth. But no agent or other person shall be obliged to file a copy of the tag or label of any brand of feeding stuff, a copy of which has been filed by the manufacturer or importer of such brand and for which a certificate of registration has been issued. No feeding stuff or brand of feeding stuff shall be sold or offered, exposed or kept for sale or distributed in this commonwealth until the tag or label therefor has been registered by the director of the Massachusetts agricultural experiment station, or his authorized deputy, and a certificate of such registration has been issued by him.

Time of Registration

SECTION 5. A certified copy of the tag or label required by this act shall be filed with the director of the Massachusetts agricultural experiment station, or his authorized deputy, for registration prior to the first day of September in each year for every brand of commercial feeding stuff to be sold or offered, exposed or kept for sale or to be distributed in this commonwealth during the year beginning with said first day of September. The said director or his authorized deputy may thereafter permit a manufacturer, importer or other person to file a copy of the tag or label of a brand of feeding stuff, and may register the same for said year in accordance with the rules and regulations which may be prescribed by the said director.

Director to Issue Certificates Authorizing Sale After Feeding Stuffs Are Registered

SECTION 6. When the certified copy of the tag or label of any brand of commercial feeding stuff has been filed as provided by this act, the director of the Massachusetts agricultural experiment station, or his authorized deputy, shall register such tag or label if he finds the same to be in accordance with the requirements of this act, and shall issue, or cause to be issued, a certificate of such registration, and the said certificate shall be deemed to authorize the sale in this commonwealth, in compliance with this act, of the brand of feeding stuff for which the certificate is issued, up to and including the thirty-first day of August of the year for which it is issued.

Director May Refuse to Register Feeding Stuffs if Statements Are Misleading

SECTION 7. The director of the Massachusetts agricultural experiment station or his authorized deputy may refuse to register any commercial feeding stuff under a name, brand, or trade-mark which, in his opinion, would be misleading or deceptive, or which would tend to mislead or deceive as to the materials of which the feeding stuff is composed. The director or his said deputy may refuse to register more than one feeding stuff under the same name or brand, or to register any feeding stuff under a name or brand to the use of which the applicant for registration is not lawfully entitled. Should any feeding stuff be registered in this commonwealth and it be, discovered afterward that any provision of this act was violated in obtaining such registration or that such registration is in any respect in violation of any provision of this act, the director of the Massachusetts agricultural experiment station, and his authorized deputy, shall have power to cancel such registration and the certificate issued therefor. No manufacturer, importer, or other person shall sell or offer or expose or keep for sale or distribute in this commonwealth any commercial feeding stuff, registratiod whereof has been cancelled by the director or his authorizen deputy.

Director or Deputy Authorized to Collect and Analyze Feeding Stuffs

SECTION 8. Every commercial feeding stuff and cattle feed, or brand thereof, sold or offered, exposed or kept for sale or distributed in this commonwealth shall be subject to analysis by the director of the Massachusetts agricultural experiment station, or by his designated deputy or deputies, and the said director is hereby authorized and it is made his duty to make or cause to be made in each year one or more analyses of every brand of feeding stuff sold or offered, exposed or kept for sale or distributed in this commonwealth, and he is hereby given free access in person and by deputy to all places of business, mills, buildings, carriages, cars, vessels and other receptacles of whatsoever kind used in the manufacture, sale, storage or delivery of any feeding stuff or cattle feed in this commonwealth, or in the importation or transportation of any feeding stuff or cattle feed for sale or distribution in this commonwealth. The director and his deputies are further authorized to open any receptacle containing or supposed to contain any feeding stuff or cattle feed for sale or distribution as aforesaid, and to take samples for analysis, as provided by this act. The methods of analyses of all feeding stuffs and cattle feeds shall be those

in force at the time by the Association of Official Agricultural Chemists of North America.

Results of Analyses to Be Published

SECTION 9. The said director shall have the right to publish or cause to be published in reports, bulletins, special circulars, or otherwise the results obtained by said analyses, and said reports, bulletins, circulars, or other publications, shall contain such additional information in relation to the character, composition, value and use of the feeding stuffs or cattle feed analyzed as the director may, in his discretion, see fit to include. The said director, in his discretion may at any time make or cause to be made for consumers a free analysis of any brand of feeding stuff or cattle feed sold or offered or exposed or kept for sale or distributed in this commonwealth; but all samples for such free analysis shall be taken and submitted in accordance with the rules and regulations which may be prescribed by the director. The results of any analysis of a commercial feeding stuff made in accordance with the provisions of this act, except a free analysis as aforesaid, shall be sent by the director, at least fifteen days before any publication thereof, to the person named on the tag or label of the feeding stuff analyzed.

Sampling of Feeding Stuffs

SECTION 10. All samples for analysis of any commercial feeding stuff or cattle feed shall be taken, whenever the circumstances conveniently permit, in the presence of at least one witness, and no action shall be maintained for a violation of the provisions of this act, based upon an analysis of a sample taken from less than five separate original packages, unless there be less than five separate original packages in the lot, in which case parts of the official sample shall be taken from each original package. If the feeding stuff or cattle feed is in bulk, parts shall be taken from not less than five different places in the lot: *provided*, that this shall not exclude sampling from bulk when the feeding stuff or cattle feed is not exposed sufficiently to take parts from five different places, in which case parts shall be taken from as many places as practicable. All samples thus taken shall be placed in suitable vessels, marked and sealed. A part of each sample shall be held by the said director or his deputy at the disposal of the person named on the tag or label of the feeding stuff sampled for fifteen days after the results of the analysis have been reported as provided in Section Nine.

SECTION 11. No commercial feeding stuff or cattle feed or brand thereof that has been mixed or adulterated with any

substance of substances injurious to the health of live stock or poultry shall be sold or offered or exposed or kept for sale or distributed in this commonwealth.

Violation of This Act to Be Punishable by Fine

SECTION 12. Any manufacturer, importer, or other person who shall sell or offer, expose or keep for sale, or distribute in this commonwealth, any commercial feeding stuff without the tag or label required by this act, or with a tag or label that has not been registered, or with a tag or label the registration of which has been cancelled by the director of the Massachusetts agricultural experiment station or his authorized deputy, or who shall file with the said director or his authorized deputy for registration a false copy of the tag or label of any feeding stuff or brand of feeding stuff or who shall impede, obstruct or hinder the director or any of his deputies in the discharge of the authority or duty conferred or imposed by any provision of this act, or who shall sell or offer, expose or keep for sale or distribute in this commonwealth any feeding stuff which contains a smaller per cent of crude protein or crude fat, or a larger per cent of crude fibre than is certified in the tag or label of such feeding stuff to be contained therein, or who shall fail properly to state the specific name of every ingredient used in its manufacture, or who shall sell, or offer, expose or keep for sale or distribute in this commonwealth any feeding stuff or cattle feed or brand thereof which has been mixed or adulterated with any substance or substances injurious to the health of live stock or poultry shall be deemed guilty of a violation of this act and upon conviction any such manufacturer, importer or other person shall be fined not more than one hundred dollars for the first violation, and not less than one hundred dollars for each subsequent violation.

Director Required to Enforce Provisions of This Act

SECTION 13. It shall be the duty of the director of the Massachusetts agricultural experiment station to see that the provisions of this act are complied with, and he may prescribe and enforce such rules and regulations relative to the sale of commercial feeding stuff or cattle feed as he deems necessary to carry into effect the full intent and meaning of this act. He may in his discretion prosecute or cause to be prosecuted any person violating any provision of this act, and no complaint shall be made or prosecuted for any such violation except with the authorization or approval of the said director.

SECTION 14. To defray the cost of collecting samples, making analyses, and of otherwise carrying out the provisions of this act, a sum not exceeding six thousand dollars shall be allowed annually from the treasury of the commonwealth, payable in quarterly payments into the treasury of said station. All moneys received and disbursed under this act shall be kept in a separate account and shall be audited and reported as are other moneys placed in charge of the trustees of the Massachusetts Agricultural College. In case at any time there should be a surplus, the surplus shall be used in the Massachusetts agricultural experiment station, under the authority of its director, for experiments and research relative to the feeding of farm animals.

SECTION 15. Chapter one hundred and twenty-two of the acts of the year nineteen hundred and three, chapter three hundred and thirty-two of the acts of the year nineteen hundred and four, and all acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 16. This act shall take effect on the first day of September in the year nineteen hundred and twelve. (*Approved April* 25, 1912.)

Communications in regard to the law should be addressed to the undersigned, who has been appointed by the Director as deputy to carry out the provisions of the act.

PHILIP H. SMITH,

Massachusetts Agricultural Experiment Station,

Amherst, Mass.

CIRCULAR NO. 35. MARCH, 1913.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

POULTRY MANURES, THEIR TREATMENT AND USE.

The total number of fowls kept in the state is estimated at two and one-half millions. The average night droppings of medium breeds according to determinations made in this station must amount to 40 pounds per fowl per year. On this basis the amount of poultry manure easily collectible from the fowls of the state annually is 50,000 tons. If the plant food in a ton of average fresh poultry manure be purchased at current prices in fertilizers, the outlay would amount to nearly $7.50. Observations and experiments indicate that as poultry manure is frequently handled it suffers a loss of one-half or more of the nitrogen it contains when voided before it reaches the land. If a loss of one-half correctly represents the average, the total money value of nitrogen annually wasted from our poultry manures must amount to about $160,000 It is the aim of this circular to show how this loss may be prevented.

General character and composition of poultry manures.

Poultry manures are particularly rich in nitrogen and their general characteristics are such that they readily decompose. As a result of decomposition the manure heats and there is a rapid and large loss of moisture and of ammonia.

The composition is subject to wide variation, due to some extent to differences in feeding, but in far greater degree to methods of handling and keeping.

The following tables present the results of recent analysis made in our laboratory.*

*Credit for these analyses is due Mr. H. D. Haskins and L. S. Walker, Chemists in the fertilizer division of the station.

TABLE 1.

COMPOSITION OF POULTRY MANURES.

Hen Manure	Moisture %	Nitrogen %	Potash %	Phos. Acid %	Lime %
C (about 2 weeks), . .	67.62	1.36	.43	1.11	1.33
P " " . .	68.58	1.07	.44	1.10	2.78
L " " . .	74.96	1.21	.43	1.22	1.71
B-1 (1 night), ...	69.76	1.91	.33	1.00	.53
B-2 (2 or 3 weeks), . .	60 61	2.30	.48	1.09	1.40
B-3 (6 to 8 weeks) . .	48.82	1.90	.63	2.07	1.93
G-1 (1 night), ...	66.69	1.58	.42	.50	1.46
G-2 (3 nights), ...	64.06	1.13	.39	.62	1.89
Pigeon, ...	25.01	3.90	1.06	2.15	.96
Duck, ...	61.62	1.12	.49	1.44	1.12
Goose, ...	67.06	1.12	.51	.53	.26

TABLE 2.

COMPOSITION ON BASIS OF EQUAL DRY MATTER.

Hen Manure	Dry Matter %	Nitrogen %	Potash %	Phos. Acid. %	Lime %
C (about 2 Weeks), . .	32.	1.34	.42	1.096	1.314
P " " . .	32.	1.09	.44	1.120	2.831
L " " . .	32.	1.486	.52	1.499	2.101
B-1 (1 night), ...	32.	2.021	.31	1.058	.56
B-2 (2 or 3 weeks), . .	32.	1.868	.38	.86	1.137
B-3 (stored 6 or 8 weeks),	32.	1.19	.39	1.294	1.206
G-1 (1 night)	32.	1.517	.31	.47	1.402
G-2 (3 nights), ...	32.	1.006	.34	.55	1.682
Average, ...	32.	1.44	.39	.99	1.53

Table 1 shows the composition of the material just as it was collected and taken to the laboratory. Table 2 shows the composition of the different samples of hen manure all reckoned upon the same basis of dry matter in 100 pounds.

Samples B–1, 2 and 3 are richer than the others in nitrogen, because the fowls received more animal food. Potash varies relatively little. Phosphoric acid varies widely and must be greatly affected by the amount of bone in the animal food given to the fowls.

The comparison between the amounts of nitrogen shown in Table 2 in samples B–1, 2 and 3 and between samples G–1 and 2 is particularly instructive. *It illustrates the fact that hen manure unmixed with absorbents or chemicals suffers very rapid loss of nitrogen.* Sample B–2 differs from B–1 only in the fact that the interval between the removal of droppings from beneath the roosts was longer. The season of this experiment was March, and the droppings were frozen a part of the time. During warmer weather the loss must have been yet greater. G–2 though accumulating only during three nights seems to have lost relatively more nitrogen than B–2, perhaps because the house was much warmer than the one from which samples B came; although this seems an insufficient explanation for the difference.

Examination of Table 1, especially comparison of the samples B–1 and B–2 shows that the fact that nitrogen has been lost is obscured by the further fact that there has been an even larger loss of water. The percentage of nitrogen in B–2 (Table 1) is larger than in B–1, but only because the former is dryer. Table 2 shows that there has been a large actual loss.

Methods of Preservation.

The free use of fine dry loam, or the admixture of such materials as kainit, acid phosphate, muriate of potash or land plaster, or of a combination of some of these will effectively prevent loss of nitrogen. Loam alone must be used in quantities so large as considerably to increase cost of handling. Either kainit, muriate of potash or acid phosphate alone is effective, but the mixture especially with the first holds the material too moist for convenient handling. Plaster is of little value as an absorbent of ammonia and if largely used the mixture may form hard, dry cakes.

The writer recommends fine, very dry earth in moderate quantities on the dropping boards and daily removal. To each 100 pounds of fresh droppings, add a mixture made up as follows:

Kainit,	15 lbs.
Acid Phosphate,	20 lbs.

Sprinkle this in proper proportion over each lot of fresh material as it is added to the accumulating stock, and mix before use.

Such a mixture will give a combination of fertilizer elements in proportions well suited for most crops.

What not to do. Do not mix wood ashes or lime with poultry manure as both of them are strongly alkaline and will release the ammonia which causes a greater loss than if the poultry manure were left in its natural state. Coal ashes if practically free from wood ashes, may be used in place of dry earth as an absorbent: but the mixture should be supplemented with kainit and acid phosphate.

The use of poultry manure. The fact should be kept in mind when planning for the use of poultry manure, that its constituents are quickly available. It should be remembered, moreover, that the material is naturally so strong that in close contact with either seeds, foliage, or delicate rootlets in large quantities, it will burn and injure. Such a mixture as has just been recommended would usually best be used by spreading either broadcast or very widely in the hill or drill. It should give excellent results for mowings, lawns and in the garden

If to be used for potatoes, the writer would prefer using 4 pounds of high grade sulfate of potash in place of the 15 pounds of kainit.

The quantity of poultry manure applied must naturally be varied with soils and crops, but it should be remembered that such manures well preserved, or such mixtures of poultry manures and chemicals as have been suggested are much stronger and richer than ordinary manures and should be used in smaller quantities. From about one and one-half to two and one-half (1½ to 2½) tons per acre will be the usual range in quantity. When poultry manure is used without potash salts or acid phosphate it is best applied as a top-dressing, because it is richest in available nitrogen. If it is to be used for garden or field crops, it should always be balanced by the use of kainit, sulfate or muriate of potash, and acid phosphate.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

POULTRY MANURES, THEIR TREATMENT AND USE.

BY WILLIAM P. BROOKS.

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than in B-1, but only because the former is drier. Table 2 shows that there has been a large actual loss.

Methods of Preservation. The free use of fine dry loam, or the admixture of such materials as kainit, acid phosphate, muriate of potash or land plaster, or of a combination of some of these will effectively prevent loss of nitrogen. Loam alone must be used in quantities so large as considerably to increase cost of handling. Either kainit, muriate of potash or acid phosphate alone is effective, but the mixture especially with the first holds the material too moist for convenient handling. Plaster is of less value as an absorbent of ammonia and if largely used the mixture may form hard, dry cakes.

Dry sawdust has been successfully used with acid phosphate and kainit by the Maine Experiment Station. In bulletin 216, that Station recommends using with each 30 pounds of fresh droppings (their estimate of the yearly amount of night droppings from one hen):

10 pounds sawdust,
16 pounds acid phosphate,
8 pounds kainit.

The writer recommends:

1. Where poultry is kept upon a small scale and where fine dry earth can be readily obtained that this be sprinkled in moderate quantities on the dropping boards whenever the accumulation is removed, which should be daily. To each 100 pounds of fresh droppings add a mixture of chemicals as follows:

(*a*) Where the material will be used as top-dressing for grass lands or for lawns:

Acid phosphate, 20 pounds.
Kainit, 15 pounds.

(*b*) Where the mixture will be used for field crops such as corn or in the vegetable garden:

Acid phosphate, 50 pounds,
Kainit, 25 pounds.

In either case sprinkle the mixture in proper proportion over each lot of fresh material as it is added to the accumulating stock and mix before use.

Mixture (*a*) with 65 pounds of dry earth (estimated amount added) will weigh 200 pounds, and if we do not take into account the small amount of plant-food elements which may be found in the earth, it should have about the following composition:

Nitrogen, 0.95 per cent.
Phosphoric acid, 2.00 per cent.
Potash, 1.14 per cent.

Provided the droppings in the original quantity are similar to sample B-1, one ton of this mixture will supply plant-food about as follows:

Nitrogen, 19 pounds,
Phosphoric acid, 40 pounds,
Potash, 23 pounds.

Mixture (*b*) with 70 pounds of earth added gives a total weight of 245 pounds. This will contain:

Nitrogen, about 0.8 per cent.
Phosphoric acid, about 3.5 per cent.
Potash, about 1.5 per cent.

One ton of this mixture will supply about:

Nitrogen,	16 pounds,
Phosphoric acid,	70 pounds,
Potash,	30 pounds.

2. Where poultry is kept upon a large scale obtaining and handling earth in as large quantities as are necessary will greatly increase the labor and the cost of applying the manure. Under such circumstances, therefore the writer is inclined to indorse the Maine system. Placing this upon the same basis as the other, the proportions would be as follows:

Fresh droppings,	100 pounds,
Acid phosphate,	50 pounds,
Kainit,	25 pounds,
Dry sawdust,	30 pounds.

This proportion of sawdust is slightly lower than that recommended in the Maine bulletin. The total weight is 205 pounds, but there is in practically all cases some loss of moisture and it is sufficiently accurate for practical purposes to estimate the weight of the mixture at 200 pounds. On this basis the composition would be as follows:

Nitrogen,	0.95 per cent.,
Phosphoric acid,	4.25 per cent.,
Potash,	1.79 per cent.

One ton of this mixture will supply:

Nitrogen,	19 pounds,
Phosphoric acid,	85 pounds,
Potash,	36 pounds.

What not to do. Do not mix wood ashes or lime with poultry manure as both of them are strongly alkaline and will release the ammonia which causes a greater loss than if the poultry manure were left in its natural state.

The use of poultry manure. The fact should be kept in mind when planning for the use of poultry manure that its constituents are quickly available. It should be remembered, moreover, that the material is naturally so strong that in close contact with either seeds, foliage or delicate rootlets in large quantities it will burn and injure. Such mixtures as have been recommended are usually best used by spreading either broadcast or very widely in the hill or drill. It will not be found easy to make the materials sufficiently fine for application with a fertilizer drill, but they can be successfully applied with such a fertilizer distributor as the Greenwood or by the use of a manure spreader. The quantity of poultry manure to be applied must naturally be varied with soils and crops, but it should be remembered that such manure well preserved with such mixtures as have been suggested are much stronger and richer than ordinary manures and should be used in smaller quantities. From about $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre will be the usual range in quantity.

If poultry manure is to be used for potatoes the writer would recommend substituting 8 pounds high grade sulfate of potash in place of the 25 pounds of kainit recommended in the 2d and 3d mixtures. Poultry manures if unmixed or with the chemicals in mixture No. 1 can probably be most profitably used as a top-dressing for grass because of the high percentage of nitrogen contained in them.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

GREEN MANURING AND COVER CROPS.

BY WILLIAM P. BROOKS.

Green manuring is the practice of cultivating a crop for soil improvement. The crop is usually, but not always, plowed in while green. A cover crop is one grown largely for soil protection, but it may at the same time serve all the purposes of a green manure crop. On the other hand, during the period of its growth a green manure crop is a cover crop.

The practice of using crops for soil protection and improvement has received much more attention in recent years than formerly, largely because its possible benefits and the conditions essential to their realization are better understood. It is not yet as general as it should be. The objects of this circular are:

1. To briefly indicate the possible benefits from the use of green manure and cover crops, and the principal reasons therefor.
2. To consider the special characteristics, value and adaptation of each of the principal crops.
3. To state the conditions under which the introduction of these crops is to be advised.

1. POSSIBLE BENEFITS

Erosion prevented. The protection of the soil against damage by wind which carries away the finer and better particles, and water which washes fields which have any considerable slope. In other words, to prevent erosion.

Plant-food saved. The conservation of soluble plant-food compounds. Plant-food compounds soluble in water tend to wash through the soil (and of course most largely on those which are of coarse and open texture) to lower levels, or they are carried away through natural or artificial drainage channels. The danger of this loss is of course greatest in seasons of abundant rainfall and it goes on most largely in fields which are bare. If the soil be kept full of hungry rootlets of a growing crop the amount of loss through this source is greatly reduced.

Weeds prevented. Green manure and cover crops may be made of much use in preventing the growth of weeds and the ripening of weed seeds, and also in some cases they may be made very helpful in exterminating certain kinds of weeds with which a field may have become infested.

Soil enriched in nitrogen. Those green manure or cover crops which belong to the family of legumes (pod bearers) are capable, under the right conditions, of assimilating nitrogen from the air. They do this through the agency of bacteria that live in nodules on their roots. Through the cultivation of legumes it is possible, therefore, to increase the sum total of nitrogen in the soil. The vegetable matter produced by such crops as clover, peas, beans and vetches is rich in nitrogen and when it decays, this element, in the form of ammonia or nitrates, is gradually rendered available to a following crop.

Plant-food made available. The availability of the mineral food constituents of the soil is increased. The increase is due:

1. To the action of the living roots which exercise a solvent action on the mineral particles of the soil.
2. To the increased biological activity (bacteria and other micro-organisms) favored by shade and the increased proportion of organic matter in the soil.
3. By the solvent action of carbonic acid and other organic acids produced in the decay of the added vegetable matter.

Humus increased. Improved physical condition due to the admixture of vegetable matter and the gradual increase in the amount of humus. This means better capacity to retain and to conduct moisture.

Subsoil mellowed. In the case of the deep rooted green manure or cover crops the subsoil is to a considerable extent opened and mellowed so that following crops root more deeply. To some extent, also, such crops transfer material gathered by their deep roots in the subsoil toward the surface.

2. PRINCIPAL CROPS

Desirable characteristics. Among characteristics which especially fit a crop for cover or green manure are the following: ability to thrive broadcast; rapid growth; deep and vigorous root system; freedom from injury by frosts. If the crop, besides possessing the characteristics named, is a legume it will prove most valuable because in one respect it surpasses all others, viz., it has the ability to gather nitrogen from the air which none of the others possesses.

Non-Legumes

None of the crops of this class have the capacity to gather nitrogen from the air.

Winter rye. Suited to light soils, one of the most useful of the green manure crops outside of the legumes, grows late in the autumn and begins growth very early in the spring, especially valuable for preventing waste of nitrates during the fall, winter and spring rains, and

because it affords cover and protection in winter, preventing both damage from wind and washing; produces a large amount of vegetable matter sufficiently early in the season to be plowed under and followed by a crop to be harvested. Seed broadcast, 2 to 3 bushels per acre.

Buckwheat. Suited to light soils, characterized by extremely rapid growth in warm weather, killed by frosts, valuable especially in preventing growth or subduing weeds and producing a large amount of vegetable matter within a short period of time. Seed broadcast, 1 bushel per acre.

White mustard. Suited to the lighter soils, characterized by rapid growth and hardiness, valuable for nitrogen conservation, will make a good growth before cold weather if put in after early potatoes or sown in corn at the time of the last cultivation. Seed 5 to 6 pounds per acre if sown in corn; one-half that quantity alone broadcast.

Rape. Suited to medium soil. There are two classes—Spring, represented by Dwarf Essex, and Winter. The latter is not hardy in most parts of Massachusetts. Where it can be grown, especially valuable, it starts into growth extremely early in spring and furnishes a large amount of vegetable matter in season to plow under for most crops. Dwarf Essex rape may be sown after harvesting an early crop, being very hardy, continues to grow until late in the autumn, especially valuable for nitrogen conservation. Seed broadcast 3 to 5 pounds per acre.

Legumes

All the crops included in this class have the capacity to gather nitrogen from the air. They will do this, however, to an important extent only when the following conditions are met:

1. The soil must be neutral or alkaline.
2. It must be stocked with bacteria of the right kind or they must be supplied. In the case of legumes which have commonly been grown in the locality the appropriate bacteria are usually abundant. When a legume new to a locality is to be grown the bacteria should be supplied either in the form of a culture or by the use of loam from a field where they are abundant. Cultures are now commercially prepared and if of good quality are generally to be preferred to soil.*
3. It must not contain a large amount of nitrogen in the form of available compounds. If it does the legume will take most of its nitrogen from the soil and will not draw upon the air to any considerable extent.

* Cultures may be obtained of the "Department of Microbiology," Mass. Agricultural College, Amherst. A charge of 25 cents is made, which covers cost and postage on sufficient for one bushel of seed.

The soy bean. Suited to the better loams, is not hardy and is not well suited for prevention of erosion or conserving nitrogen, will furnish a large amount of vegetable matter within a comparatively short period of summer weather, does best if planted in drills. About ½ bushel of seed per acre.

The cow pea. Suited to light and medium loams, endures drouth and hot weather exceedingly well, not hardy, but will furnish a large amount of vegetable matter in a relatively short period of summer weather, does best in drills and requires about ½ bushel of seed per acre.

3. CONDITIONS WHEN GREEN MANURING IS ADVISABLE

The statement of possible benefits of green manuring quite clearly indicates by inference the conditions under which the introduction of a green manure crop is advisable, but at the same time it includes references to so many and so important advantages that the reader may be in danger of over-estimating its value. There is no question that it can produce the beneficial effects referred to but there are conditions under which these effects would be secured at too great cost. Under the following conditions there can be no question that green manuring will be profitable:

1. When the green manure crop can be produced without the sacrifice of a crop to be harvested, or during a period when the field would otherwise be unoccupied, when it will help prevent loss of nitrates, erosion and infestation by weeds.
2. Green manuring will be especially important on soils made up largely of sand or clay and naturally deficient in humus.
3. Green manuring, especially with legumes, will be unusually beneficial on soils naturally deficient in available nitrogen compounds.
4. It is especially beneficial in orchards: preventing erosion, furnishing organic matter and keeping down weeds.
5. The introduction of a green manure crop in cases where a crop to be harvested must be sacrificed will self-evidently be in place only on the cheaper lands.

When not advisable. On the other hand where a farm is stocked to its capacity, green manuring will seldom or never be advisable. Many of the green manure crops have large food value. It will be found more profitable to feed clover to the animals of the farm than to turn it in in most cases, and where the excrements are carefully saved and returned to the land practically all the effects of green manuring will be realized.

4. The legume must be allowed to attain nearly full development if the gain in nitrogen is to be large, since during the early stages of its growth the nitrogen which it requires comes in large measure from the soil.

Vetches. There are two classes of cultivated vetches—spring and winter. The winter vetches are much more valuable than those belonging to the other class. The hairy or sand vetch is the most valuable variety. It is suited to medium loams, found especially valuable in orchards, useful both in preventing erosion and in gathering and conserving nitrogen and should usually be sown with winter rye. Broadcast 1 bushel of seed per acre.

Field peas. Suited to medium or fairly heavy loams, quite hardy and useful for nitrogen gathering, should be grown with a grain crop. Broadcast $1\frac{1}{2}$ to 2 bushels of seed per acre.

Crimson clover. Best suited to medium loams, may be cultivated either as a winter annual or annual, not quite hardy enough to make it reliable as a winter annual in most parts of Massachusetts, though it occasionally goes through the winter. Where it does this, it is one of the most valuable cover and green manure crops. Sown in August it makes a thick mat of leaves, serves to conserve nitrogen and prevent erosion, starts its growth very early the following spring and can be turned under in season to be followed by a crop which is to be harvested; where hardy particularly valuable in orchards. Seed broadcast about 15 to 20 pounds per acre.

Common and mammoth red clovers. Suited to a wide variety of soils, but do best in medium loams; if sown the latter part of July or early in August make sufficient growth in autumn to prevent erosion and conserve nitrogen, start into growth fairly early the following spring but will not mature in season to be followed by such crops as corn and potatoes. These clovers are very deep rooted, may often be very profitably used for combined forage and green manure, much used in orchards. Seed broadcast 8 to 10 pounds per acre.

Sweet clover. Distinct from the true clovers, like them in many respects but not nearly as valuable for forage, suited to a wide variety of soils if drainage is perfect, particularly deep rooted, sown in July will prevent erosion and conserve nitrogen, starts into growth extremely early the following spring and will furnish a large bulk of vegetable matter which may be turned under in season to be followed by crops to be planted about the same time with corn. There are two varieties, white and yellow; the white is the more valuable for green manuring. Seed broadcast about 20 pounds per acre.

The soy bean. Suited to the better loams, is not hardy and is not well suited for prevention of erosion or conserving nitrogen, will furnish a large amount of vegetable matter within a comparatively short period of summer weather, does best if planted in drills. About ½ bushel of seed per acre.

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because it affords cover and protection in winter, preventing both damage from wind and washing; produces a large amount of vegetable matter sufficiently early in the season to be plowed under and followed by a crop to be harvested. Seed broadcast, 2 to 3 bushels per acre.

Buckwheat. Suited to light soils, characterized by extremely rapid growth in warm weather, killed by frosts, valuable especially in preventing growth or subduing weeds and producing a large amount of vegetable matter within a short period of time. Seed broadcast, 1 bushel per acre.

White mustard. Suited to the lighter soils, characterized by rapid growth and hardiness, valuable for nitrogen conservation, will make a good growth before cold weather if put in after early potatoes or sown in corn at the time of the last cultivation. Seed 5 to 6 pounds per acre if sown in corn; one-half that quantity alone broadcast.

Rape. Suited to medium soil. There are two classes—Spring, represented by Dwarf Essex, and Winter. The latter is not hardy in most parts of Massachusetts. Where it can be grown, especially valuable, it starts into growth extremely early in spring and furnishes a large amount of vegetable matter in season to plow under for most crops. Dwarf Essex rape may be sown after harvesting an early crop, being very hardy, continues to grow until late in the autumn, especially valuable for nitrogen conservation. Seed broadcast 3 to 5 pounds per acre.

Legumes

All the crops included in this class have the capacity to gather nitrogen from the air. They will do this, however, to an important extent only when the following conditions are met:

1. The soil must be neutral or alkaline.
2. It must be stocked with bacteria of the right kind or they must be supplied. In the case of legumes which have commonly been grown in the locality the appropriate bacteria are usually abundant. When a legume new to a locality is to be grown the bacteria should be supplied either in the form of a culture or by the use of loam from a field where they are abundant. Cultures are now commercially prepared and if of good quality are generally to be preferred to soil.*
3. It must not contain a large amount of nitrogen in the form of available compounds. If it does the legume will take most of its nitrogen from the soil and will not draw upon the air to any considerable extent.

* Cultures may be obtained of the "Department of Microbiology," Mass. Agricultural College, Amherst. A charge of 25 cents is made, which covers cost and postage on sufficient for one bushel of seed.

4. TREATMENT OF THE GREEN MANURE CROP

It is a common practice to turn under crops grown as green manures as soon as their growth is completed, but even in the case of those which are killed by autumn frosts, if protection from wind and washing is especially needed, it may be preferable to leave the crop on the surface until the following spring. It is not believed there will be any great loss in manurial value if this practice be followed because the crop on the surface in winter weather will not decay to a sufficient extent to render its constituents soluble. In deciding upon the time for working a green manure crop into the soil it should be remembered that this should be done a few weeks at least before the seed of the following crop is to be sown. The presence of a large amount of undecayed vegetable material a few inches below the surface is unfavorable to the germination and early growth of a following crop. Time should be allowed for the vegetable matter to settle and in part decay and for the capillary connection between the portion of the soil turned over and the undisturbed soil below to have become re-established. In a majority of instances it seems better to turn a green manure crop under rather than to leave it on the surface. A plow turning a large furrow slice is best suited to the work and a disk coulter is desirable. If the crop is tall, a chain fastened to the middle of the evener long enough so that the end will drag in the furrow about opposite the mould-board may be used with advantage. A chain so used divides the standing crop and bends it forward just ahead of the plow so that it is covered much better than would be possible without it. In some cases the chain is looped in such a way as to accomplish the same result. In the case of a crop killed by winter frosts but allowed to remain upon the surface until spring, it is best to go over the field with a disk harrow, cutting up the stems and working the material somewhat into the soil before attempting to plow.

5. SHOULD GREEN MANURE CROPS BE FERTILIZED

While a moderate degree of benefit may follow the introduction of green manure crops without the application of any fertilizer, its full benefits will not be realized on soils which are much exhausted without the application of materials that furnish, at least, moderate quantities of the mineral elements of plant food, for which purpose basic slag meal and a potash salt applied broadcast, after plowing, and deeply worked in, will prove among the most useful.

Further, it will not be possible to greatly enrich the soil in nitrogen from the air through the growth of legumes unless lime be first applied in the case of all soils which are acid, because the nodular bacteria cannot multiply to any great extent, nor actively assimilate nitrogen in soils which are sour.

CIRCULAR No. 38. FEBRUARY, 1914

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

CABBAGE, CAULIFLOWER, TURNIP, RAPE, AND OTHER CRUCIFERS.

WILLIAM P. BROOKS.

Soils.

The crops in this group thrive in quite a variety of soils, but none will do well if water be near the surface or the soil inclined to be wet. Well tilled loams in good fertility should be selected, the lighter for English turnips and Swedes or for early cabbage, and medium loams for cauliflower. Under irrigation success is possible on very light soils if highly manured or fertilized. With deficient drainage or over-wet soils these crops are peculiarly liable to the disease known as clubfoot. These crops should not be grown two successive years on the same land nor come into any rotation more frequently than one year in four or five.

Lime Necessary.

These crops will fail or do poorly in any soil which is sour in marked degree. If blue litmus paper in contact with the moist soil turns red it should receive an application of lime. The rate of application must, of course, be varied to suit different conditions, but in general for the lighter soils which are sour the application of about one ton per acre of air-slaked lime or marl, or one and one-half tons of fine ground limestone is desirable, while for the heavier soils about fifteen hundred pounds of hydrated (water-slaked) lime is likely to be beneficial.*

Prevention of Clubfoot.

The disease known as clubfoot (root) or sometimes "fingers and toes," is due to the growth of a fungus in the cells of the roots. It causes the distorted root swellings, often of enormous size, familiar to most who have grown these crops. No cure or certain prevention when soil has become infected is known. Rotation of crops, no one of this group to be put upon any given field oftener

* For fuller discussion of use of Lime see Bulletin No. 137.

than once in four years, and a rather free use of lime, will help secure immunity. After soil has been brought into condition by one good initial liming a yearly application of a mild lime at the rate of five hundred pounds per acre should be sufficient. If slag meal be used for all crops in the rotation (except potatoes if they be included), it is probable that a second liming will be unnecessary.

The Use of Manures. The crops of this family will repay liberal manuring, and barnyard or stable manures are well suited to all except turnips or Swedes for table use. For these it is best to avoid the too free use of such manures, as the roots are less smooth, stronger in flavor and more liable to be attacked by worms. For all these crops manures from animals fed refuse from any of them should be avoided as such manures will be likely to carry disease germs. This is particularly true of hog manure or manures on which hogs run, because these animals are often fed waste vegetables, which usually means those which are diseased, and which, therefore, carry the germs of disease. Manures should, in general, be plowed in or deeply disked under.

Fertilizer Needs All crops of this family are dependent in a very unusual degree upon a liberal supply of phosphoric acid in highly available forms. Acid phosphate, dissolved bone and basic slag meal prove highly beneficial. When manure is freely used no other fertilizer than a phosphate may be necessary. These crops are less dependent upon artificial potash supply than most, and it may be doubted whether potash in addition to manure will be called for. Some nitrate to push the plants rapidly from the start makes it easier to prevent serious injury from lice and some other insects, and is always desirable in connection with moderate applications of manure, especially for early crops.

Fertilizers for Use with Manure. In connection with a medium dressing of manure use for cabbage or cauliflower a mixture made up as follows :

Acid phosphate,	6 parts.
High grade sulfate of potash.	1 part.
Nitrate of soda,	2 parts.

This mixture will contain nitrogen 3.44, available phosphoric acid 10.66 and potash 5.55 per cent.

Apply broadcast just before plants are set and use from eight to twelve hundred pounds per acre.

For brussels sprouts, kohl-rabi and kale about the same application will be useful.

For rape use one-half to two-thirds the above amounts.

If one grows these crops on a small scale only it will often be preferable to use a ready mixed fertilizer having about the composition of the mixture of chemicals recommended. There is usually no saving in cost when chemicals must be purchased in small quantities, and of course this practice involves rather more trouble.

When Fertilizers only are Used.

When fertilizers only are to be used for these crops it is believed that they should show about the same general composition as the mixture above recommended for use with manure; but a rather higher percentage of nitrogen will be useful except after clover, alfalfa or other legumes, or on soils in high fertility or containing a large proportion of humus, such as reclaimed muck or peat. A portion of the nitrogen in a fertilizer for this use should be derived from materials less soluble and more quickly available than nitrate of soda, such as cyanamid, tankage or bone. A part of the phosphoric acid also may be in less soluble form than acid phosphate, and it is believed an application of basic slag meal will be highly desirable. This has the double advantage of furnishing available phosphoric acid and a large amount of lime (mostly, it is true, in neutral compounds), thus reducing, as has been pointed out, the necessity for a separate application of lime in preparation for these crops. It is believed that when the slag is used it will be found best to apply it by itself on the rough furrow to be deeply worked in by disking, and if some time before putting in the crop so much the better. The previous fall will be the best time. The useful application will probably range from 600 to 1200 pounds per acre according to soil and crop. It will be desirable, especially with soils low in fertility, to mix sulfate of potash with the slag at the rate of 100 pounds per acre.

In connection with this preparatory application of slag meal and potash a mixture of chemicals made up in the following proportions is recommended:

Acid phosphate,	4 parts.
H. G. sulfate of potash,	1 "
Nitrate of soda,	2 "
Cyanamid,	2 "
Tankage,	4 "

This mixture will have about the following chemical composition: nitrogen 6.5%, phosphoric acid 8.8% and potash 3.8%. It may be used in amounts varying from 1000 to 1600 pounds per acre.

It may be here again remarked that if only small areas are to be fertilized it will probably be most satisfactory to buy a mixed fertilizer of the desired composition.

Application of the Fertilizers.

Whether fertilizer is to be used with manure or alone it will be best in most cases to apply the mixture broadcast just before setting the plants or sowing seed; though in work upon a small scale it is probable that lesser amounts of fertilizer can be made to give fairly satisfactory crops if a part at least is reserved for application in wide circles about the plants after they are set, to be worked in with the cultivator. The harrow will sufficiently work under a broadcast application of such mixtures as are recommended.

CIRCULAR No. 39 (Revision of No. 31). FEBRUARY, 1914.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

LIME AND SULFUR SOLUTIONS.

By G. E. STONE.

Lime and sulfur has been used for many years in various forms and for different purposes, although it is only comparatively recently that its value as a fungicide has been realized. The extensive use of this solution as a spray for the San José scale has incidentally demonstrated its great value as a fungicide. Our observations and experiments with the use of lime and sulfur when applied to trees in a dormant condition have convinced us that no preparation which has ever been used can be compared with it for efficiency in controlling different fungi. For many years lime and sulfur has been largely used as a spray for fruit trees in a dormant condition, but of late it has also been used in various modified forms as a summer spray with very encouraging results. Many trials have been made of the diluted concentrated preparations, and also of what is known as the "self-boiled lime and sulfur," but the methods are in a more or less experimental stage.*

Lime and sulfur used as a spray on trees in a dormant condition is a positive preventive of peach leaf curl and Monilia and Cladosporium infection on peach twigs. Its use holds in check the leaf spots of the apple, pear, plum, quince and other fruit trees and shrubs. We also believe that it has a material effect on cankers, black knot and other common twig diseases. So effective is this treatment for leaf spots that in many cases after only one spraying not a single spot could be found on the foliage of fruit trees during any part of the season.

Self-Boiled Lime and Sulfur Mixture.

For some purposes, especially summer spraying, self-boiled lime and sulfur mixtures are useful. One of the best rules is the following:

* The diluted lime and sulfur has not proved equal to Bordeaux for spraying potatoes. —Geneva Agri. Exp. Station (N. Y.), bul. 347, F. C. Stewart and G. T. French.

W. M. Scott's Formula.

Flowers of sulfur or sulfur flour,	8 pounds.
Fresh stone lime,	8 pounds.
Water,	50 gallons.

In making this mixture the best stone lime procurable should be placed in a barrel and slaked, using precautions not to drown the lime in slaking it. W. M. Scott recommends that enough water be applied to nearly cover the lime when slaking. As soon as the lime has commenced to slake and some heat has generated, apply the sulfur through a fine sieve to break up the lumps. The mixture should be stirred and more water added gradually, bringing it to a thin paste. As soon as the lime is well slaked, more water should be added to cool the mixture.

Since there is much difference in lime as regards the development of heat, it is difficult to specify any particular time to add the water for the purpose of cooling, but it should be done before the sulfur goes into solution and forms sulfides, which are injurious to peach foliage. Under ordinary conditions, the mixture should not be allowed to remain hot over ten or fifteen minutes after slaking. With the intense heat developed from slaking and constant stirring a uniform mixture of fairly finely divided sulfur and lime is obtained with only a small trace of sulfides in solution. It should be strained before use.

Mr. Scott has used this successfully for peach brown rot and scab. In this formula he also mixed two pounds of arsenate of lead, which proved effective in controlling plum-weevil. Mr. Scott believes that the arsenate of lead is less likely to burn tender foliage when in combination with lime and sulfur than when used alone.

Concentrated Lime and Sulfur Solutions.

There are a number of these solutions on the market which are apparently similar in composition. Their specific gravity varies from 30° to 34° Baumé, and in using them it is necessary to dilute according to the strength of the solution and the nature of the foliage to which they are to be applied. The directions furnished by manufacturers for the dilution of their own product for different purposes can usually be relied upon.

Home Made Lime and Sulfur Solutions.

Experience has shown that the best concentrations of lime and sulfur are obtained by using about twice as much sulfur as lime, since this preparation gives the least sediment. Nothing but the best fresh stone lime should be used in making lime and sulfur. Air slaked lime should not be used under any circumstances, and in many cases it is advisable to use hot instead of cold water in slaking the lime.

LIME AND SULFUR SOLUTION—Geneva Formula.*

Lime (pure),	36 pounds.
Sulfur (high grade, finely divided),	80 pounds.
Water,	50 gallons.

This is prepared by first moistening the sulfur and making it into paste. Then slake the lime in about 10 gallons of hot water, adding the lime gradually to prevent violent boiling and spilling over. Add the sulfur paste gradually during the slaking and stir constantly to prevent the formation of lumps. When the slaking is complete add the full amount of water, and boil for one hour. The boiling may be accomplished by the use of steam or by wood fires and kettles. In either case maintain the original volume of water. This concentrated solution is recommended by the Geneva Experiment Station, where extensive investigations have been made relative to the lime and sulfur solutions.

When the solution is made to 50 gallons it should have a density of from 24° to 25° Baumé.† The Geneva Experiment Station recommends that where the lime is 95% pure, 38 pounds should be used, and where only 90% pure, 40 pounds. According to their tests, when one part of pure lime and two parts of sulfur are boiled one hour, only slight amounts of sediment are present. Sediment indicates impurity of the lime used. The solution can be stored in filled, stoppered barrels for some time if the temperature does not fall below 5° F.

* For further information consult Buls. 329 and 330, Geneva (N. Y.) Agri. Exp. Station.

† To obtain accurate degrees Baumé a hydrometer may be used such as furnished by Bausch & Lomb, Rochester, N. Y., for about $1.00.

The following table of dilutions is recommended by the Geneva Experiment Station :—

Reading on Hydrometer. Degrees Baumé.	Amount of Dilution. Number of gallons of water to one gallon of lime-sulfur solution. For San José Scale.	For Blister Mite.	For Summer Spraying of Apples.
35	9	12½	45
34	8¾	12	43¼
33	8¼	11½	41½
32	8	11	40
31	7½	10½	37¾
30	7¼	10	36¼
29	6¾	9½	34¼
28	6½	9	32¾
27	6	8½	31
26	5¾	8	29½
25	5¼	7½	27¾
24	5	7	26
23	4½	6½	24¼
22	4¼	6	22¾
21	3¾	5½	21¼
20	3½	5	19¾
19	3¼	4¾	18¼
18	3	4¼	17
17	2¾	4	16
16	2½	3¾	15
15	1¼	3½	14
14	2	3	12¾

Dr. C. A. Peters and A. W. Brooks* have recently shown that some of the commercial lime and sulfur occasionally thickens up owing to an organism closely related to Beggiatoa. This organism does not spoil the solution chemically, but it does for use, since it clogs the nozzle. The organisms can be disintegrated by heat, or filtered out.

* Microorganisms in Commercial Lime-Sulfur, Journal of Industrial and Engineering Chemistry, Vol. 5, No. 12, December, 1913.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

DOWNY MILDEW OF CUCUMBERS.

(Peronoplasmopara cubensis (B. & C.) Cl.)

By George E. Stone.

Downy mildew, which is not difficult to distinguish from other leaf fungi, is most likely to occur on greenhouse cucumbers in August and September, and has never been observed by us in greenhouses in the winter. The fungus occurs on the under side of the leaf, causing whitish or yellowish angular spots on the leaves (see Fig. 1), and these spots are more prominent on greenhouse than on field cucum-

Fig. 1. Showing characteristic spotting of cucumber leaf by downy mildew (Peronoplasmopara)

bers. Ordinarily, an attack of this mildew lasts but a few weeks, and causes only an insignificant spotting of the leaf. Reproduction is by means of small spores, which retain their vitality longest in a moist atmosphere.

Downy mildew was first observed on material received from Cuba in 1868, and was later noted in Wisconsin in 1882. In 1888 it was found on cucumber leaves obtained from Japan, and in 1889 it was found in New Jersey, causing injnry under glass, at which time it was also common on field cucumbers. During the same year it was reported abundant in Florida and Texas. In 1890 it appeared in Massachusetts and again in 1892, when it was found on greenhouse and field crops. In New Jersey it was common in 1891, 1892 and 1893, and in Connecticut and New York about the same time.

In 1895 it appeared in Ohio, and later caused considerable injury in that state both to greenhouse and field crops. In 1899 it was noted in England; in Brazil, in 1900; in Russia, Austria-Hungary, Java and East Africa in 1902, and in Italy in 1903, showing that the disease has been quite cosmopolitan in its progress. Since its appearance in this country it has been generally distributed and quite destructive to field crops of cucumbers, although from 1892 until 1900 it was not observed in Massachusetts, to our knowledge. Since 1900, however, it has appeared annually on field crops and occasionally in greenhouses, where its appearance has caused little alarm.

It has been shown that this fungus is perennial in the south and travels north every season, apparently about the time cucurbitaceous crops mature. It usually makes its appearance in Massachusetts about the middle of August, although sometimes a little earlier; but in 1913 there was a bad infection on greenhouse cucumbers in the Boston district in May, June and July, which caused much loss, especially in unheated houses, where the air often becomes very damp. This is the first time downy mildew has been observed here earlier than August, and this attack may have some connection with the unusually warm winter of 1912—1913.

While the downy mildew is capable of doing considerable injury to greenhouse crops, it is not difficult to hold the disease in check if proper attention is paid to the moisture in the house. In no case should moisture be allowed to remain on the foliage for more than two or three hours, and even in the warm months steam should occasionally be turned on to dry out the house and change the air. All mildews and leaf blights are encouraged by moisture on the foliage, lack of light during the period of plant development, and stagnant air. In our experiments, in which we have grown cucumbers and melons under glass every month in the year, we have never had the slightest infection from mildew when the plants were syringed properly; i. e., only on bright mornings when the leaves will dry quickly. While cucumbers can be grown without syringing, the risk from red spider during the spring and summer months is necessarily great.

After the middle of September or October first there is little danger of infection, therefore it is better to start the winter crop at this time rather than in August. A slight attack of downy mildew does little or no harm, and if cucumber growers always used the same judgment as lettuce growers, an infection would seldom prove serious. It has been shown that spraying with Bordeaux mixture constitutes an effective preventive in the field, and sulfur and oil painted on the pipes in the greenhouse has proved beneficial.

This unlooked for attack of downy mildew in the early summer months makes it apparent that in future all cucumber growers should be on the lookout for early infection.

Circular No. 41. April, 1914.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

THE CONTROL OF ONION SMUT.

By George E. Stone.

Onion smut has been known in Massachusetts for about forty years, Mr. Benjamin P. Ware having referred to the injury caused by this fungus in the Massachusetts State Board of Agriculture Report for 1869—70. The smut germs infect the seedlings at a very early stage, the disease taking the form of dark-colored or sooty masses, and as the onion matures the black areas of pustules may be noticed on the leaves and bulbs. Since infection takes place in the early stages of the seedling, onion sets being immune, any method which will kill the spores on the seed or in the soil must be beneficial. Where onions are grown year after year on the same land the smut shows a marked tendency to increase, but even here it can be controlled by the use of proper remedial measures.

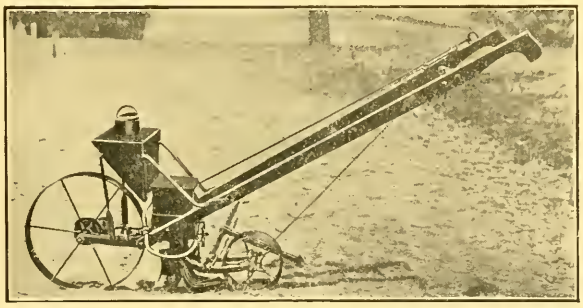

Fig. 1. Showing Planet Jr. cultivator with formalin drip.

Positive results have been obtained by applying per acre 100 pounds sulfur thoroughly mixed with 50 pounds air-slaked lime in the drills, and ground lime, drilled in with a fertilizer drill, at the rate of 75 to 100 bushels, is also good. But by far the best results have been obtained from the use of formalin, which may be applied at the rate of one ounce to one gallon of water (1-128), or in even weaker solutions. Some onion growers in the Connecticut valley, where the crop is grown extensively and with great success, occasionally use the formalin stronger than the amounts recommended, but this results in injury to the crop. 1-100 parts, which is sometimes used, is capable of killing almost anything, and in our opinion is too strong to apply to seed.

By the aid of certain devices, formalin can be easily and cheaply applied when the seed is sown. Tests have shown that about 1200 feet of drill can be treated with one gallon of formalin solution. One of the first devices used for this purpose was made by the writer, and consists of a tank attachment. At the bottom is fastened a block tin tube about a quarter of an inch in diameter, to which is attached a valve to regulate the flow of the formalin, and as the tube is flexible and at the same time more or less rigid, it can be bent in any position desired and held securely. The tank, which holds one gallon, may be attached to any onion sower (see fig. 1) by means of strips of iron. Although not fastened to the iron frame, the tank stays in place and can be easily removed.

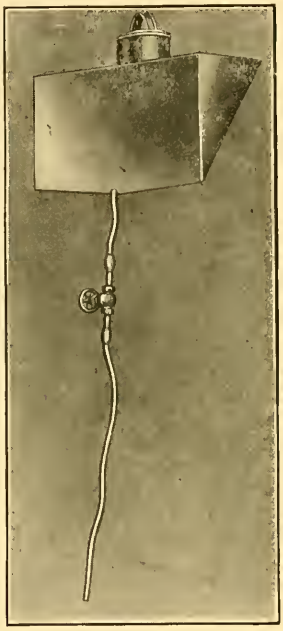

FIG. 2. Formalin tank, block tin pipe and valve. (See Fig. 1.)

In figure 2 the tank and tube are shown detached from the sower. A special feature of the tank consists in the ease with which it can be drained, the middle of the tank being lower than the ends. A larger tank may be used if necessary, as the weight of the formalin is not enough to affect the easy handling of the machine. The flow of the formalin solution in a tank of this shape is nearly uniform, there being little difference in the amount flowing when the tank is full and when nearly empty.

Figures 3 and 4 show more recent devices of this nature. The tanks are in both cases made of galvanized iron and have a capacity

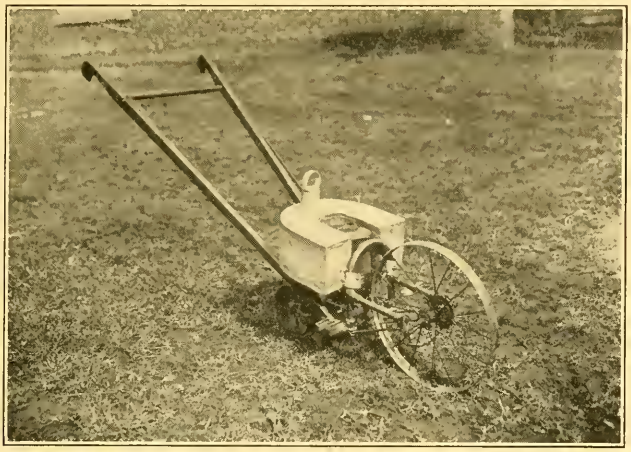

FIG. 3. Horse-shoe form of tank. A tank similar to this might be readily adapted to any two-row seed sower.

of two gallons. An improvement over the earlier apparatus consists in an iron rod attached to the valve and leading to the handles of the

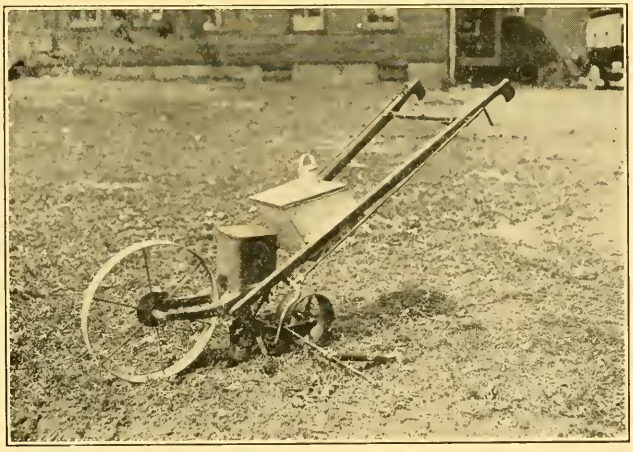

FIG. 4. Showing tank suspended between the handles of the sower.

sower, by means of which the operator can adjust the flow at will. The horse-shoe form of tank shown in figure 3 has the largest use in the Connecticut valley.

In the treatment of onion smut only enough liquid need fall to cover the seed and moisten a little of the surrounding soil.

Very satisfactory results have been noted from the use of the formalin drip in this state. Some land so infested with the smut as to make it impossible to grow profitable crops of onions has produced clean crops after treatment by this method. In one case the smut was so severe that the land had to be abandoned, but it now rents for $50.00 an acre as onion land. The apparatus can easily be made up by any local plumber, and on the whole the formalin treatment constitutes one of the most effective methods for the control of onion smut, and has resulted in saving many thousands of dollars each year to onion growers.

NOTE.—Formaldehyde solution, u. s. p., 40 per cent. volume, can be obtained from the Perth Amboy Chemical Works, 100 William St., New York City, at the following rates:

In 400 lb. barrels,	9c	per lb.
In 250 lb. barrels,	9¼c	per lb.
In 125 lb. kegs, f. o. b. New York,	9½c	per lb.
In 60 lb. kegs,	11c	per lb.
In 1 lb. bottles, 50 to a case,	19c	per lb.

CIRCULAR No. 42 (Revision of No. 26). APRIL, 1914.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

FERTILIZERS FOR POTATOES.

WM. P. BROOKS.

Manures Compared with Fertilizers.

Fertilizers are in general regarded as superior to manures for this crop. Principal reasons:

1. The period of growth is short; the plant food supply should therefore be in highly available forms. High grade fertilizers are superior to farm manures in this particular.

2. The chances that the crop will be free from blight, rot and scab are greater on fertilizers.

3. Manures of good quality supply nitrogen in relatively large amounts, so great that on the better soils the growth of vine is apt to be excessive on manure.

The above statements do not necessarily lead to the conclusion that manures should never be used. They may give excellent crops, especially on the lighter soils, deficient in humus and low in fertility; but the quantity applied should be moderate and applied broadcast, to be plowed or deeply harrowed in rather than placed in hill or drill, and it will usually pay to use some fertilizer in connection with the manure.

Relation of Crop to Lime.

Lime is alkaline in chemical character, and one of the most common and serious diseases from which potatoes suffer—ordinary scab, caused by the development of a fungus in the surface tissues of the tuber—is favored by an alkaline condition of the soil.

An acid condition, while not protecting the crop in case of serious infection, is not favorable to the scab fungus. The application of lime, then, in any considerable quantity the same year that potatoes are planted is unwise. This does not mean that soil on which potatoes are to be grown should never be limed. Where the soil is inclined to be excessively acid and clover fails to do well, lime may be used in moderation, but should be applied, if possible, some two or three years before the land will be occupied by potatoes.

Powdery scab, on the other hand, is apt to be more serious where soils are acid; and if this new disease gains a foothold and proves to be as difficult to control as now seems likely, we may be forced to use lime in order to hold it in check, as otherwise it may become more injurious than the ordinary scab.

Selection of Fertilizers.

The first problem which will confront the potato grower is the decision as to whether he will use one of the ready-mixed "Special" potato fertilizers, or, on the other hand, buy materials and make his own mixture. There are considerations favorable to both plans. Some of the principal points favorable to the ready-mixed fertilizers are:

1. Some labor at a season apt to be crowded with work is saved.

2. Such fertilizers are usually in good mechanical condition.

3. In remote country places particularly they are easier to obtain.

4. Selection may be somewhat easier, although it is not possible to buy under the name "potato fertilizer" with certainty of obtaining the type of fertilizer needed, for there is enormous variation between different so-called "potato fertilizers." In our last fertilizer bulletin the analyses of ninety different brands

of potato fertilizers are given. The percentages of plant-food elements in such fertilizers made by reliable firms varied as follows: Nitrogen, .93% to 5.03%; phosphoric acid (available), 4.44% to 9.57%; phosphoric acid (total), 5.31 to 12.81%; potash, 2.01% to 11.20%.

FACTORY MIXED FERTILIZERS.

If, then, a "potato special" is to be used it is essential to have a clear idea about what composition is desirable. It is not enough to call simply for a potato fertilizer.

As a result of experiments and observation I am inclined to recommend:

A. When fertilizers only are to be used.

1. On clover sod or soils rich in humus and relatively fertile:

	Per cent.
Nitrogen,	2.5— 3.
Phosphoric acid,	8 —10.
Potash (in form of sulfate),	8 —10.

2. On lighter and poorer soils:

Nitrogen,	3.5— 4.5.
Phosphoric acid,	6 — 8.
Potash,	8 —10.

B. For use in connection with manure.

1. On clover sod or soils rich in humus:

Nitrogen (mostly in soluble forms),	1.5— 2.
Phosphoric acid,	8 —10.
Potash,	12 —14.

2. On lighter and poorer soils:

Nitrogen (mostly in soluble forms),	3 — 3.5
Phosphoric acid,	6 — 8.
Potash,	10 —12.

Of such fertilizers, when used alone, 1500 to 2000 pounds per acre; those to be used with manure, 600 to 1000 pounds per acre.

HOME MIXTURES.

The judicious selection and purchase of unmixed materials usually makes it possible to obtain needed elements of fertility at lower cost than in "potato specials," but this is in part because the trade in unmixed materials is almost exclusively on the basis of cash payments, while the trade in mixed fertilizers is to a considerable extent on a credit basis—crop time. It is the part of wisdom before deciding on the purchase of materials to obtain quotations for cash on a "potato special" of the desired composition and to compare these with quotations on materials which will give a fertilizer of the same general composition, plus the necessary charge for the labor of mixing. It is, moreover, no doubt in some cases necessary to make some allowance on account of shrinkage in unmixed materials caused by torn or overthin bags; but it is possible that there may be some shrinkage also on the "special" mixed goods from the same causes. The labor of mixing is neither difficult nor expensive.

The Sources of the Different Plant-food Elements.

In deciding what materials to use for making the potato fertilizer the principal points to be considered are cost and suitability for the crop. It is not possible to give formulas which shall be permanently best. Relative prices of sources respectively of nitrogen, phosphoric acid and potash vary from year to year, and even in some cases from month to month. The end to be aimed at is, of course, the same in the case of all plant-food elements, viz.: to obtain the greatest possible number of pounds of available plant-food for the money expended. The ton price is no indication as to whether a fertilizer is dear or cheap. Fertilizers of the highest ton price are sometimes the cheapest.

The Nitrogen Supply.

In order to make it safe to apply the entire amount of fertilizer needed for the crop at planting time the nitrogen should be derived from materials possessing a varying rate of availability, such, for example, as nitrate of soda, sulfate of ammonia, cyanamid, dried blood and tankage.

Nitrate of soda is immediately available. Sulfate of ammonia, cyanamid and dried blood require a little time and are about equally available. Tankage is slower in its action. The proportion of cyanamid must be small, for otherwise there may be loss of ammonia from organic materials or sulfate of ammonia if these constitute a part of the mixture. Such loss, however, is not probable if the mixture contains also a considerable proportion of acid phosphate, for this will be likely to combine with the excess of lime in the cyanamid. As a consequence of such combination the phosphoric acid of the acid phosphate may be somewhat decreased in solubility, but it will still be available.

Other materials which may be considered as sources of nitrogen are dry-ground fish, cottonseed meal and bone meal, but the first is usually high in price and the others are not as a rule as suitable or available as the materials named.

Phosphoric Acid.

There is no doubt that the presence of a liberal amount of phosphoric acid in a fertilizer for potatoes is favorable to early maturity, and wherever an early crop is important or where there is a tendency to excessive growth of vine, this element in soluble form should be relatively abundant in the fertilizer. Acid phosphate should be mainly depended upon, but a small proportion of the phosphoric acid in the form of tankage, fish or bone is not undesirable. Basic slag meal is absolutely unsuitable for potatoes on account of the excess of lime it contains.

Potash.

The potash of a potato fertilizer should, I believe, usually be supplied in the form of sulfate rather than muriate, although on light soils, especially those rich in lime, and in excessively dry seasons the muriate may be preferable. On the soils of the college farm wherever these two salts have been compared the sulfate has generally given a slightly heavier crop, and the quality, as indicated by the percentage of starch, and mealiness and flavor when cooked, has been superior.

A very large number of comparisons between these two salts has been made. The average of the trials on the different fields has in all cases been a larger yield on the sulfate, the difference in its favor ranging from one bushel per acre in one case to 53 bushels in another. The average of the 51 different comparisons between these two salts for potatoes shows for the muriate a yield of 207.4 bushels per acre; for the high grade sulfate, 218.6 bushels. The average difference, therefore, in favor of the sulfate is 11.2 bushels, a quantity which is much more than sufficient to cover the difference in cost between the two salts.

The quality of the tubers on the sulfate, moreover, is superior. The difference is indicated by the following figures, which represent the average of three experiments: Potatoes raised on sulfate of potash, water 78.11%; on muriate, 79.86%. Per cent. of starch in potatoes raised on sulfate, 14.99%; on muriate, 13.68%.

Wood ashes are not a good source of potash for potatoes on account of their alkaline character.

FORMULAS FOR USE IN HOME MIXING.

The following materials and proportions are suggested for use under different conditions:

A. Where fertilizers only are to be employed:

1. On clover sod or soils rich in humus and in high fertility.

In each 100 pounds—

Nitrate of soda,	7 lbs.
Sulfate of ammonia,	4 "
Cyanamid,	4 "
Tankage,	15 "
Acid phosphate (14%),	50 "
High grade sulfate of potash,	20 "

Use 1500 to 2000 pounds per acre.

This mixture will have about the following composition: Nitrogen, 3.4%; phosphoric acid, 8.5%; potash, 10%.

2. On lighter and poorer soils:

In each 100 pounds—

Nitrate of soda,	12 lbs.
Sulfate of ammonia,	8 "
Cyanamid,	5 "
Tankage,	20 "
Acid phosphate (14%),	35 "
High grade sulfate of potash,	20 "

Use 1500 to 2000 pounds per acre

This mixture will have about the following composition: Nitrogen, 5.4%; phosphoric acid, 6.9%; potash, 10%.

In putting these materials together it is recommended that the cyanamid and acid phosphate be mixed first, as it is believed that this will be certain to prevent any loss of ammonia from the sulfate of ammonia and tankage which are later added.

B. For use in connection with manure:

1. On clover sod or soils rich in humus:

In each 100 pounds—

Nitrate of soda,	8 lbs.
Sulfate of ammonia,	4 "
Acid phosphate (14%),	60 "
High grade sulfate of potash,	28 "

Use 600 to 800 pounds per acre, varying with quantity of manure used.

This mixture will have about the following composition: Nitrogen, 2.04%; phosphoric acid, 8.4%; potash, 14%.

2. On lighter and poorer soils:

In each 100 pounds—

Nitrate of soda,	8 lbs.
Sulfate of ammonia,	6 "
Tankage,	20 "
Acid phosphate (14%),	40 "
High grade sulfate of potash,	26 "

Use 800 to 1200 pounds per acre, varying with quantity of manure used.

This mixture will have about the following composition: Nitrogen, 3.64%; phosphoric acid, 8.4%; potash, 13%.

Method of Application. If the potatoes are to be planted by hand, good results may be obtained by opening the furrows and then scattering the materials widely the full length of the furrow, making it cover not only the entire furrow, but a space a few inches in width on each side. If spread in this way, the fertilizer will not be so thick that it will be necessary to take any special steps to mix it with the soil. It will be sufficiently mixed in covering the seed. If planting is done by machine, the fertilizer attachment of the machine should be one which scatters the fertilizer over a relatively wide area. If such a machine cannot be used, it may be best to withhold a portion of the fertilizer until the crop is three or four inches high, when it should be scattered along strips ten or twelve inches wide on either side of the row and cultivated in.

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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

CUTWORMS.

BY H. T. FERNALD, PH. D.

The general term "Cutworms" refers to the larvae of the Noctuids or owlet moths, but all Noctuid larvae are not necessarily cutworms. There are two classes of cutworms, those which feed on weeds, vegetables, and flowers, and which are the ones herein treated, and those which feed on the leaves and buds of trees, which are not usually abundant enough in Massachusetts to cause serious injury.

The cutworms attack almost any succulent and juicy plant, such as grass, clover, corn and wheat, garden vegetables and flowering plants.

LIFE HISTORY.

The moths lay their eggs, 200-500 in number, in masses of rank vegetable growth, usually on the stalk, though sometimes on the leaves. This occurs about the last of August or the first of September and about the last of September or the first of October the young caterpillars begin to feed on the plant upon which the eggs were laid. After they have grown to about three-fourths of an inch in length, they go into a dormant state for the winter in the ground and remain there until spring. They then come to the surface and eat whatever plant food they may find until full grown, this being generally between the last of June and the last of July. The following features are possessed by nearly all the species and by these they may be recognized. They are from 1 1-4 to nearly 2 inches in length; have sixteen feet, the three anterior pairs being sharp, the five posterior pairs blunt and stout and armed with minute hooks for clasping; they have the appearance of being stout with an inclination to taper at both ends and they are usually dull-colored, greasy-looking, dingy-brown, gray or greenish, with some light and dark longitudinal lines and sometimes with oblique dashes. The head is large, shiny and usually of a red or reddish brown color. The first ring or collar bears a darker colored, shiny, horny plate as also does the last segment of the body.

When full grown the caterpillars cease feeding and work their way into the soil for a depth of four to six inches, and there form an oval cell by rolling and twisting about until it is smooth and compact and then change to brown, conical pupae.

Usually in August, the moths emerge from these pupae and fly at night feeding upon the nectar of flowers and other sweet exudations from trees or plants.

The life history of this insect is completed about the last of August when the eggs are laid for the new generation.

HABITS.

The presence of cutworms becomes noticeable in a field as soon as the plants are set out or when the seeds have begun to sprout. Plants all through the field will have fallen or will have disappeared. If examined they will be found to have been cut off at the surface or a little below the surface of the ground by the cutworms and this injury continues until the worms are full grown.

ENEMIES.

Because of their large size and hairless bodies these insects are an easy prey to many enemies. The robin is especially effective as it destroys more than any other bird. Poultry, especially chickens, destroy many of them and if trained to follow the plow they will do effective work. The beetle larvae known as the cutworm lion and the cutworm dragon, as well as the toad, help much to keep this insect pest in check.

REMEDIES.

There are two kinds of remedies to be applied to this insect; preventive and destructive. Of the former *clean culture* is the most important. As the moths usually deposit their eggs in rank growth, it is advisable where the land is not seeded down to keep it clean and not let it grow up to weeds. Fall plowing will in many cases prove quite beneficial, provided it is done early.

If on preparing a field for planting any crop liable to attack, cutworms are noticed as abundant, complete the preparation of the field, then spray some clover heavily with Paris green, and then cut the clover and scatter it here and there over the field. The cutworms coming up after food will feed on this and be poisoned.

After a crop is in a different treatment is necessary. In such cases prepare a bran mash made of fifty pounds of bran or middlings, one pound of Paris green, two quarts of molasses to sweeten, and water to make a dough or mash. Place a little of this at the base of each plant in the latter part of the afternoon, and keep fowls away. The cutworms coming up to feed at night will find in this mash a food they prefer because of its sweetness, to the plant stem and will feed on it instead. In this way nearly all of these pests will be destroyed and it is not often necessary to repeat this treatment.

CIRCULAR NO. 44. JULY, 1914.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.
AMHERST.

Suggestions for Judging the Agricultural Value and Adaptation of Land.

WILLIAM P. BROOKS.

A person familiar with such matters will be able to form a very accurate opinion as to the productive capacity and adaptation of land by examination on the spot. The knowledge that such a person will be able to obtain as to the agricultural value of a piece of land for any particular purpose by such examination will be more exact and more reliable than the indications afforded by chemical analysis. For the formation of an accurate judgment considerable experience is essential, but it is hoped that the suggestions which follow will make the matter at least sufficiently clear for a fairly satisfactory estimate. Among the more important factors which should be observed may be named the following :

1. The depth and color of the surface soil.
2. The level of the water table and the conditions affecting drainage.
3. The texture of the soil.
4. The general appearance and texture of the subsoil.
5. The character of the natural or spontaneous vegetation.

1. The Depth and Color of the Surface Soil.

The term surface soil is commonly used to indicate that portion of the topsoil which in uplands, at least, is almost always distinctly different in color from the soil below. In the case of soils which have been plowed and cultivated it is generally used to designate that part of the soil which is turned over by the plow. The darker in color the surface soil and the greater its depth, the more productive, as a rule, the land will be found to be. The usual cause of the darker color of the surface soil is the presence of organic matter or humus. The larger the amount of such matter in upland soils, the better, for it is highly favorable to good texture and productiveness. It is possible to determine the proportion of organic matter in a soil with approximate accuracy, even without laboratory facilities. The following method is suggested :

Take small quantities of soil to the full depth to which the surface soil extends in a considerable number of different places.

Put these samples together, mix them thoroughly, and of this mixture take about one pint for the test.

(a) Spread this sample out in a shallow pan and place it where it will be quite hot, but not sufficiently so to burn. If convenient it may be set on top of a covered boiling kettle of water, as there would then be no possibility of overheating. The sample should first be weighed. It should then be heated until it is believed that all the water has been driven off, but it should be re-heated after the first weighing and if it is found that it has continued to lose in weight it should be heated again. The heating process should be continued until two successive weights are practically the same.

(b) The pan of thoroughly dried soil should be placed over a a live fire, brought to a red heat, and held there until no smoke or active combustion can be seen. The material should then be removed and when it is cool weighed. After this weight is recorded it should be subjected to intense heat again and re-weighed. This alternate heating and weighing should be continued until no further loss of weight takes place.

(c) The difference in weight between the dried soil and the soil after it has been intensely heated will represent with substantial accuracy the amount of organic matter. It is desirable that the soil should contain at least four or five per cent of such matter, and seven or eight will be yet better.

2. The Level of the Water Table and the Conditions Affecting Drainage.

The term water table designates the level of the standing water in the soil. It can be determined by opening holes to sufficient depth in different representative parts of the field. If the water table is comparatively near the surface holes opened with a crowbar will answer the purpose, but if it lies too low to be reached in this way they may be opened by the use of a post-hole digger or spade, or if it can be obtained a soil auger may in some cases be most convenient. The important point in connection with examination for the water table is to ascertain whether it lies too near the surface to permit good root development. For most crops conditions will be, in general, satisfactory if the water table at the time when seeds are put in is not nearer than some five or six feet below the surface. It may lie considerably lower than this during the hottest and dryest part of the year without disadvantage and, of course, very early in the spring or in seasons of excessive rainfall it may lie nearer the surface. Thoroughly satisfactory results with most crops cannot, however, be expected if the water table during any part of the growing season for a crop stands for any considerable length of time nearer than some five feet below the

surface. The grass crop is an exception and heavy yields of fairly good quality may be obtained with the water table considerably nearer the surface.

In the climate of Massachusetts there is a considerable excess of rainfall as compared with the evaporation of water from the surface. The total annual rainfall in most parts of the state is about forty-four inches. Evaporation from the land surface varies greatly, but it is not likely to be much more than half the above amount. There remains then a layer of water some twenty inches in depth to be disposed of by drainage. A study of the water table will show whether the natural drainage channels are sufficient to carry away this water. If the water table, in cases where it is raised by excessive rainfall to within a short distance of the surface, does not fall to the level which has been indicated as desirable within two or three days it shows that the natural drainage is not as free and effective as it should be. In such cases it is important to observe whether conditions are such that artificial drainage can be put in without excessive cost. Soils in which the water table naturally stands too high for the best crop results, if artificially drained are likely to be more productive and more valuable for many crops than soils which do not need artificial drainage.

3. THE TEXTURE OF THE SOIL.

The texture of the soil is determined largely by the relative proportions of particles of different sizes, although the shape of the particles and the proportion of organic matter also have an effect. The texture of the soil is important chiefly because of its relations to the capacity of the soil to retain water and to conduct water from below upwards by capillary attraction. To form a judgment as to soil texture the soil should be examined by eye, by touch and by making it into a dilute mixture with water and allowing it to settle :

Appearance : If the texture of the soil is so coarse that the individual particles can clearly be distinguished, if each stands out as a distinct grain of considerable size, the soil will be relatively deficient in ability to hold and conduct water. It will be a light soil.

On the other hand, if the individual particles are so small they cannot be clearly distinguished with the naked eye, but are brought out by a good pocket lens, the soil allows water to pass through it rather slowly, retains a relatively large proportion and in periods of drought is likely to bring water from the lower and more moist strata toward the surface by capillary attraction. Crops on such soils will be much less influenced by periods of extreme drought and heat than on soils of coarser texture. If, however, the particles are so excessively fine that it will require a

high power of the microscope to distinguish them as individuals the soil is likely to be too impervious both to water and air. Such soils are usually characterized as heavy.

The Feel of the Soil: A very good idea as to the character of the particles which make up the soil, and therefore as to its general texture and quality, can be obtained by examination with the fingers. Place a little of the soil in the most sensitive part of the palm of the hand and rub it with the sensitive tips of the fingers. If it is found to contain particles which tend to cut and scratch the soil will be light. On the other hand, if it has a soft, smooth feel it will have much better capacity to retuin water. Here again, if on making the soil quite moist and rubbing it in the palm of the hand it is found to have almost the feeling of paste it probably contains a large proportion of clay and must be classed as heavy. If a little of the soil be rolled between thumb and fingers, while held close to the ear, a grating sound will be heard if it contains much coarse sand.

Settling in Water: Additional knowledge as to the relative proportions of coarse and fine particles in the soil can be obtained by stirring it up with a relatively large amount of water. The water should be slowly added as in making paste and all the lumps broken up. To the thick mixture a sufficient amount of water should be added to make the whole very fluid. This mixture of soil and water should be turned into a glass cylinder and allowed to settle. The coarser particles will go to the bottom first and by examination through the glass the relative proportions of coarse and fine can be quite accurately determined. A tumbler may be used but a higher glass is preferable. If almost all the particles go to the bottom at once the soil must be made up principally of sand. If the water clears gradually, but remains turbid for a considerable number of hours, there must be considerable silt or clay. If clay predominates it will be many days before the water will become entirely clear. In general, soils made up principally of the finer grades of sand and silt, with only moderate quantities of clay, have the best texture and give the best results in agricuture.

4. The General Appearance and Texture of the Sub-Soil.

A suitable texture in the sub-soil to a depth of some five or six feet, at least, is almost as important as in the surface soil. In general it should be similar. It is far better, however, that the sub-soil be more compact and of finer texture than the surface soil than that it should have the opposite characteristics. A sub-soil that is very open, and contains loose gravel or course sand in large porportion is to be avoided for most crops. The methods of examination should be the same as for surface soil.

5. The Character of the Natural or Spontaneous Vegetation.

To the practiced eye the vegetation which grows spontaneously in any given locality affords clear indications as to the character and general agricultural value of the soil. In attempting to give a basis for judgment, dependent upon observation of the natural vegetation, it seems best to speak of the plants which should be observed under the following classes :

Grasses and clover, sedges and rushes, miscellaneous herbaceous plants, weeds, and trees.

Grasses and Clovers : Among the commonest grasses which indicate a soil of very low agricultural value are the beard or poverty grasses (*Andropogon scoparius* and *furcatus*). Where these grasses are almost the only herbaceous vegetation it is certain that the soil is very low in capacity to retain moisture, and its productive value will be very small. Among other grasses which indicate relatively light and dry soils are : Sweet vernal, (in some localities known as June grass) (*Anthoxanthum odoratum*), and meadow soft grass (*Holcus lanatus*). The soils, however, where these grasses predominate is likely to be of consfderably better quality than those where the beard grasses occupy most of the ground.

Among grasses which indicate a much better and moister soil may be mentioned Kentucky blue grass (*Poa pratensis*) and meadow fescue (*Festuca elatior*). Orchard grass (*Dactylis glomerata*) while it will thrive upon lighter soils than the two last named, indicates a fairly good soil.

Among grasses which indicate soils rich in organic matter and inclined to be wet, blue-joint (*Calamagrostic canadensis*) and foul meadow (*Poa triflora*) are among the most common. The presence of a large proportion of white clover (*Trifolinm repens*) in the turf is an indication of soil of good quality and fairly retentive of moisture.

On the other hand, rabbit-foot clover and yellow clovers (*Trifolium arvense* and *Trifolium agrarium*) indicate light and relatively dry and poor soils.

The presence of sweet clover (*Melilotus alba*) indicates a soil of good quality and usually one which is relatively rich in lime.

Sedges and Rushes : The sedges are plants which to the ordinary observer closely resemble grasses. They can, however, readily be distinguished from grasses, The latter have joined, round, hollow stems and leaves in two ranks. Sedges have three sided stems, usually solid, and the stem leaves are arranged in three ranks. Most of the sedges thrive best in moist soils and where they are abundant it is certain that artificial drainage will improve

the soil for almost any purpose, and even for the production of hay.

Rushes are also somewhat grassilike but are yet more easily distinguished from grasses than sedges. Their stems are pithy or hollow, but not jointed. Their flowers are produced in clusters and are small and greenish or brownish in color. Rushes like sedges prefer moist or wet soils and indicate the necessity of artificial drainage.

Miscellaneous Herbaceous Plants: The herbaceous plants which grow along the fence rows or in unimproved land should be carefully noted : The small golden-rods and sun-flowers indicate relatively light, comparatively dry and poor soils, so too do bush clovers (*Lespedeza*), mullein and lupines. The asters indicate soils having better capacity to retain moisture. The presence of vetches in abundance, and the fact that the common yellow dock flourishes and attains a large size, indicate that the soil is more retentive of moisture and of better quality. Horse-tail (*Equisetum arvense*) indicates a light soil.

Among other classes of plants whose presence and abundance, especially if the individual specimens are of good size, indicate soil of good retentive capacity and of good quality are some of the larger species of the parsley family, the mints, and some of the species of the nettle family. Heaths such as the checkerberry, cranberry and huckleberry indicate a soil likely to be deficient in lime.

The presence of bluets (*Houstonia*), the greenish mosses and of ferns in abundance is an indication that the soil is probably sour.

The Japanese farmers are accustomed to say that in wild land where the most common color of the flowers of the natural vegetation is yellow the soil is poor, but if the prevailing color of the flowers of the natural vegetation is blue the soil is sure to be comparatively good. Although this classification is not entirely safe it will generally apply under conditions prevailing in Massachusetts.

The Weed Growth: In attempting to form an estimate of the character and productive value of cultivated land the varieties of weeds and their size and vigor should be noted. There are, of course, innumerable kinds of weeds and no attempt is made to mention all ; only a few of the more common which afford clear indications as to soil quality will be named :

Wormwood (*Artemisia absinthium*) indicates a light and relatively dry soil. Pigweeds of different species (*Amaranthus* and *Chenopodium*) indicate rich soil with greater capacity to retain moisture. The smart weeds (*Polygonum*) indicate a soil which is inclined to be moist and usually relatively rich. " Pusley " or purslane (*Portulaca oleracea*) flourishes in rich soils inclined to be

light rather than heavy. Where sorrel is abundant the soil is likely to be sour. Shepherd' spurse (*Capsella Bursa-pastoris*) thrives best in medium and rich loams.

Tree Growth: Among trees which indicate soils of rather poor quality, and inclined to be very light and deficient in moisture may be mentioned the white birch, scrub oak, scarlet and yellow oaks, and the pitch pine. The white pine, hemlock and chestnut indicate soils of considerable better quality and with better capacity to retain moisture. The elm, ash, and white and black oak, the walnut and the red maple indicate soils with good capacity to retain moisture and with good productive capacity. In localities where the chestnut is the prevailing tree the soil will be found to be deficient in lime. Such trees as the black birch, yellow birch and beech flourish in a strong retentive soil fairly rich, at least, in lime and humus. The witch-hazel, although hardly large enough to be called a tree, may be mentioned here. It is popularly regarded as indicating a soil of good quality. The black alders and willows thrive in soils which, at times, at least, are wet and which will usually need artificial drainage.

LEADING CHARACTERISTICS SUMMARIZED.

Some of the more marked among the characteristics (which may readily be noted) of soils of different characters may be summarized as follows :

Characteristics of Inferior Soils : The soils which are light and dry, and on which it is practically certain that crops would frequently suffer from lack of moisture, will usually present some or all of the following easily observed characteristics :

If there are trees, the scrub oak, pitch pine, white birch, Juniper or red cedar are likely to be prominent. Beard grasses in scattered tufts or forming a rather open turf will be abundant. The flowers in general will be yellow. The smaller golden-rods, sunflowers and mullin are likely to occur. Lupines and sand violets are abundant in some sections. Examination of the soil will show that even at the surface it is of relatively light color, containing very little humus. The surface soil is shallow. When tested by touch both the surface soil and sub-soil will be found to be made up largely of relatively coarse, gritty particles.

Soils of this character if they can be enriched in humus and irrigated at moderate cost may give profitable returns. They are suited particularly to such crops as thrive at relatively high temperatures such as beans, cucumbers, melons and tomatoes. They may also be fairly suited for asparagus, but this crop will be very subject to rust unless it can be irrigated. Rye and buckwheat may do fairly well. If in doubt as to what crops may be grown on a given soil the best course to follow is to ascertain what farmers in that neighborhood are successfully raising on similar soils.

Characteristics of Good Soil : The soils which are at least of fairly good quality will usually present some or all of the following characteristics :

Among the trees will be found such varieties as the white pine, hemlock, chestnut, sugar maple and white, black, red and pin oaks. If there is turf it will be relatively close, made up of such species as sweet vernal, Kentucky blue grass and white clover. The prevailing color of the flowers will be other than yellow. Violets (not sand or birdfoot) asters and vetches are likely to be found. The surface soil will be comparatively dark in color, indicating a good amount of humus, and it will be deep. The subsoil will be moderately compact and both it and the surface soil will be made up largely of fine particles having a smooth feel to the touch.

Soils with these characteristics will be suited to most of the crops cultivated in Massachusetts, particularly, corn, onions, potatoes, squashes, apples, pears, peaches, currants and strawberries.

Characteristics of the Strongest and Best Soils : The soils which contain most active and potential fertility, and which have good capacity to retain moisture usually show some or all of the following characteristics :

If trees are present, among them the elms, ash, oaks of large size, the beech, walnuts, and red maple are likely to be found. If there be turf it will be close, luxuriant, made up largely in most parts of the state of Kentucky blue grass, fescues and white clover. Vetches, smart weeds and dock are likely to be found. The flowers will be mostly blue. The surface soil will be dark in color and deep, and both it and the sub-soil will be fine in texture, containing, at least, a fair amount of clay and a large proportion of silt.

Such soils, if the drainage is good, will give satisfactory crops of almost all kinds. They will be particularly suited for grass, oats, celery and, in general, for crops which thrive best at relatively low temperatures, and with uniform and abundant supply of moisture. Plums and quinces should do well. Strawberries will thrive if organic matter is abundant.

The Soils of Our Marshes and Swamps :

The soils of marshes and swamps exhibit characteristics so different from those of the uplands, to which especially the previous discussion of soil characteristics applies, that a few words in relation to them seem called for :

The soil in a typical marsh or swamp is usually made up of muck or peat resting upon a compact bottom. The depth of the muck or peat varies from a few inches to many feet. The muck and peat are made up principally of vegetable matter, in a very advanced state of decay in muck, but possessing more of the characteristics of the original plant tissues in peat. These soils are in general very wet. If they can be relieved of surplus water by artificial drainage and well worked to allow aeration they may be made highly productive. Those are of most value which have a considerable admixture of the very finest grades of sand, silt and clay, and with the vegetable matter quire fully decayed. Such soils will be found especially valuable for grass, celery and late potatoes. These soils are usually sour. They are relatively rich in nitrogen, but are likely to need applications of lime and potash.

CIRCULAR No. 45. (Revision of No. 29). JULY, 1914.

Massachusetts Agricultural Experiment Station.

AMHERST

The Chemical Analysis of Soils.

BY WILLIAM P. BROOKS, Director

Almost every day the station receives either inquiries regarding the chemical analysis of soils or samples forwarded for such analysis. The following letter received a short time ago fairly represents the attitude of most correspondents relative to such work.

> Gentlemen: I wish for information for Mr..... the owner of a large farm in..... ....., Mass. He wishes to know if he can send you samples of soil for analysis; most likely would send 8 to 10 samples from different parts of his farm. In what form and in what quantity should he send, and what would be the expense for analysis of each package sent? He would also like to know what crops would produce the best results for each sample sent, and the best fertilizer for each sample and the quantity required. .....

It will be noted that the gentleman in whose interest this letter was written believed:—

(1) That chemical analysis will show to what crops a soil is suited.

(2) That such analysis will determine what fertilizers should be applied and the quantity needed.

Our correspondence indicates that these views are very generally held, while another widely accepted belief is that the cause of crop disease will be revealed by a chemical analysis of the soil in which the crop is growing.

Although a chemical analysis of a soil is often of value, it is believed that these views are neither generally accepted by scientifiic men nor supported by the known facts of experience under the conditions usually met with in this state.

1. **The Crop Adaptation.** While the chemical condition of a soil is not altogether without influence in determining the crops to which it is suited, this, as a rule, at least within such range of soil variation as exists in this state, plays a much less important part than mechanical and physical peculiarities. The crops to which a soil is suited are determined chiefly by its drainage, its capacity to hold and to conduct water, its temperature and its aeration; and these in turn are determined by the mechanical structure of the soil and sub-soil. Variations in the proportions of gravel, sand, silt, and clay, and not in chemical composition, cause the usual differences in these respects. The varying proportions of these, therefore, usually determine the crops to which a soil is suited.

2. **Fertilizer Requirements.** The results of a chemical analysis of a soil do not, as a rule, afford a satisfactory basis for determining manurial requirements. The chemist, it is true, can determine what the soil contains, but no ordinary analysis determines with exactness what proportion of the several elements present is in available form for the crop. Indeed, there is no such thing as a constant ratio of availability. While one crop finds in a given soil all the plant food it requires, another may find a shortage of one or more elements. Further, on the very same field one crop may find an insufficient amount of potash, another may find enough potash for normal growth, but insufficient phosphoric acid; while a third may suffer only from an insufficient supply of nitrogen.

Most of our soils are of mixed rock origin, and, as a rule, possess similar general chemical characteristics, providing they have been farmed under usual conditions. The manurial and fertilizer requirements are determined more largely for most soils by the crop than by peculiarities in the chemical condition of the soil.

3. **Crop Diseases.** In some cases, the correspondent reports that his crop is diseased, and that he desires a chemical analysis in order to ascertain what is the cause. The chemical composition of the soil may in some instances exercise a controlling influence in determining a condition of health or disease, and is never unimportant from the standpoint of vigorous, normal and healthy growth; but in the case of most diseases, the immediately active cause is the presence of a parasitic fungus, and this fungus is usually capable of fixing itself upon the plant whatever may be the composition of the soil. A knowledge of the chemical composition of soils, therefore, will not make it possible to advise such manurial or fertilizer treatment as will insure immunity from disease.

CONDITIONS UNDER WHICH ANALYSES WILL BE MADE.

For the reasons which have been briefly outlined, the chemical analysis of soils does not, as a rule, afford results which have a value commensurate with the cost; and this station, therefore, will not make such analyses unless the soil differs widely from the normal in natural characteristics, or has been subjected to unusual treatment of such a nature as to probably greatly influence its chemical condition. In order that we may decide whether analysis seems called for, correspondents **are urged to write before taking samples**; covering the points indicated below. If we decide that the analysis promises results of interest and value to the public, as well as to the individual, the work will be done and without charge.

INFORMATION NEEDED.

Description of the soil.

(a) Color.

(b) Depth.

(c) Feel.

(d) Most Common Trees.*

(e) Most Common Plants.*

(f) Most Common Grasses and Clovers.*

(g) Most Common Weeds.*

(h) If Manured or Fertilized: What and How Much Applied.†

(i) What Crops Recently Grown and With What Results?†

TAKING SAMPLE.

Dig holes 8 inches square in different parts of the field to a depth a little below where the surface soil ends.** From each take a slice one-half inch thick from one side, mix all these samples very thoroughly, and of the mixture send 1 pint in a clean closed jar or can.

Address: Director's Office,
Mass. Agr'l Exp. Station,
Amherst, Mass.

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* Send specimens if not sure of name.
† Give the information for as many years as possible.
**See circular No. 44.

CIRCULAR No. 46. SEPTEMBER, 1914

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

Directions for Sending Fruits for Identification.

By J. K. SHAW.

The Department of Pomology receives each year many specimens of orchard fruits for identification. This service is gladly undertaken and might be more satisfactorily performed if certain rules for the selection, packing and forwarding of the specimens were more commonly observed. It is the purpose of this circular to set forth such rules for the guidance of those desiring to submit specimens for identification or for any other purpose.

1. At least two specimens of each variety should be sent.

Whenever possible a larger number should be included. This may conveniently be done if the fruits are small.

2. The specimens should be typical of the variety.

They should not be the largest nor the most highly colored and especial care should be taken to select those of characteristic form.

3. It is best that they should be sent two or three days before reaching prime eating condition.

Fruits do not fully develop their varietal characteristics until they are completely ripened. Therefore at this stage identification is easier and more certain.

4. Wrap each fruit (or in the case of grapes and small fruits each cluster) separately in soft paper. Use several layers.

5. If more than one variety is sent attach a number to each specimen.

This may be done by fastening a tag to the stem or where this is impossible by marking, plainly, the wrapper. Keep a memorandum of this so you will be sure to remember which is which on receiving our reply.

6. Whenever possible include a shoot or twig from each variety sent.

This should include two years growth, that of the present and of last season. The age may be readily determined by locating the second annual ring from the tip. Free growing shoots should be chosen. In the case of peaches, grapes and small fruits a portion of the present seasons growth is sufficient. The attached leaves should be included if in season. If the shoot is too long to pack easily it may be cut in sections. It should have a tag bearing the same number as the corresponding fruit specimens and be carefully wrapped in soft paper in such a manner as to avoid as far as possible, bruising the leaves. Do not bend or break the shoots in packing them.

7. Pack the wrapped fruits and shoots in a strong box with an abundance of soft crumpled paper, cotton or similar soft material.

Great care should be observed in this to see that the fruits cannot be injured by pressure against each other, the enclosed shoots or the sides of the box. Be sure that all is **packed snugly** leaving no possibility of vacant space developing in the more or less rough handling sure to be encountered in transportation. Choose a box of ample size so that there will be room for an **abundance of soft packing material.** It should be of wood, strong cardboard or best of all corrugated paper. Do not use wood veneer nor light pasteboard boxes. Tie the package with plenty of strong cord.

8. By the same mail write us advising of the shipment and giving for each variety as far as possible the following information (a) the approximate age of the tree, (b) where the tree came from, (c) the soil type whether sandy, loamy or clay and whether moist or dry, (d) cultural conditions espcially whether in sod or under cultivation. If you have any suspicion of the name of the variety mention it. The blank on page 4 may be used for this purpose.

If sent by express this information may be enclosed in the package. It is contrary to the postal regulations to send it by parcel post.

9. Address the parcel to the Department of Pomology, Massachusetts Agricultural College, Amherst, Mass. Be sure to put your own name on the package so we may know from whom it is received,

The Identification of Nursery Stock.

There is much complaint of the failure of nursery stock to be true to name. Orchardists are frequently desirous of knowing whether or not newly purchased stock or other young trees are what they are claimed to be. To determine this involves usually the identification of the variety in the absence of fruit, a task that is difficult and in many cases well-nigh impossible.

We can attempt such work only in the case of apple varieties and cannot guarantee accuracy in all cases, nevertheless we are glad to receive specimens and render the best service possible. Also such specimens may be of value to us in the work of the Experiment Station.

Persons desiring to submit shoots for examination should carefully observe the instructions given under paragraph 6. It is necessary to send two years growth of a free growing shoot and especial care should be taken to forestall injury to the leaves. It is well to send a few typical leaves **from the present season's growth,** smoothly packed between layers of soft paper in the bottom of the package in addition to those attached to the shoot. If no fruits are enclosed it is well to dampen the packing material slightly. Instructions given under paragraphs 5, 7, 8 and 9 should be followed.

Leaf characters are of great value in identifying varieties and it is impossible in most cases to do much without them. However if one is desirous of submiting dormant shoots we will be glad to receive them and do what we can. It is often possible to determine whether or not a tree is correctly named even though in cases of substitution, accidental or otherwise, it is impossible to tell what the variety is. Dormant shoots should include two years growth of a free growing shoot and be tightly wrapped to check drying out.

Information Blank to Accompany Fruit Specimens.

Name of sender Date

Address

Kind of fruit Number of specimens

Where grown

Age of tree

Source of tree

Soil

Cultural conditions

Possible variety name

Method of shipment

Remarks

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

The Feeding Value of Apple Pomace.

BY J. B. LINDSEY.

There is often considerable discussion in the agricultural press and among farmers concerning the value of apple pomace as a food for dairy and beef cattle. With a view to getting a few positive data, this station instituted a number of experiments, the results of which are here briefly stated.

(a) Composition of Apple Pomace (Per Cent.)

	Water.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
Sample I, . . .	81.40	.73	.94	3.00	13.03	.90
Sample II, . .	80.20	.60	1.01	3.19	13.73	1.27
Corn silage for comparison	80.00	1.10	1.70	5.40	11.10	.70

It will be seen from the above figures that apple pomace is a carbohydrate feed similar to corn silage. It contains about the same amount of water, rather less protein and fiber, and a larger proportion of extract matter. Whether the extract or starchy matter in the pomace is as valuable, pound for pound, as that contained in the corn, has not been thoroughly demonstrated.

(b) Digestibility of Apple Pomace.

The value of a feed cannot always be measured by its composition. A food is valuable as a source of nutrition only in so far as its various constituents can be digested and assimilated. This station has made two different experiments to ascertain the digestibility of the pomace, and the detailed results are to be found in the seventeenth report of this station. The summary follows :

Summary of Experiments (Per Cent.)

	Numb'r of Single Trials.	Dry Matter.	Ash.	Protein	Fiber.	Extract Matter.	Fat.
Apple pomace (first experiment), . .	3	72.5	54.7	—	61.6	84.5	47.2
Apple pomace (second experiment), .	3	70.6	42.8	—	67.3	84.3	43.4
Average, . .	6	71.5	48.7	—	64.4	84.4	45.3
Dent corn silage (for comparison), . .	17	64.0	—	52.0	62.0	69.0	85.0
Flint corn silage (small varieties), . .	11	75.0	—	65.0	77.0	79.0	82.0

The results show the total dry matter in apple pomace to be about as digestible as in the best grades of silage. The protein content of the pomace is small—about 1 per cent—and it has not been possible, by present methods, to ascertain its digestibility. Judging from the composition and digestibility of the pomace, one would feel justified in assuming that, pound for pound, it should approach in feeding value an average quality of corn silage.

(c) *Experiments with Dairy Animals.*

While this station has not carried out any exhaustive comparative tests with pomace and other coarse feeds, it has fed the pomace a number of seasons to dairy animals. The material was drawn fresh from the mill, and placed in a large pile under cover. A noticeable quantity of juice gradually drained from it, but it kept in good condition for two months The animals received from 15 to 30 lbs. daily, ate it readily, and the results were quite satisfactory. In one case two cows were fed alternately, four weeks at a time, on grain and hay, and on grain, hay and pomace; 25 pounds of pomace were compared with 5 pounds of hay. During the pomace period the animals produced 1,153 pounds of milk, and gained 24 pounds in live weight ; during the hay period, 1,138 pounds of milk and lost 6 pounds in weight. On this basis 5 pounds of pomace were more than equivalent to 1 pound of hay. Judging from this feeding test, and from the composition and digestibility of the pomace, it seems probable that 4 pounds, when fed in what is termed a "balanced ration," would be equal in feeding value to 1 pound of good cow hay.

The Vermont Experiment Station has fed apple pomace for four years, using in all 20 cows in the several trials. The pomace was shoveled into the silo, leveled off, and kept in good condition without further care. In some cases it was placed on top of the corn silage after the latter had settled. The quantity fed varied from 10 to 35 pounds daily, with no unfavorable effects. As a result of the several experiments, the Vermont station concludes that the pomace is equivalent in feeding value to an equal weight of average corn silage,* and that it is without injurious effect on the flavor of milk and butter.

Farmers are cautioned not to feed too large quantities at first, but to begin with 10 pounds daily, and to gradually increase the quantity to 30 pounds, taking a week or more in which to do it. In this way, danger of a sudden milk shrinkage or of the animals getting "off feed," as is sometimes reported, may be avoided. Judging from all the data available, it is believed that farmers living in the vicinity of cider mills will find it good economy to utilize the pomace as a food for their dairy stock.

As roughage, 30 pounds pomace may be fed, or 15 pounds pomace and 15 pounds of corn silage, together with what hay the animal will eat, which will usually be from 10 to 16 pounds daily. In addition, 5 to 10 pounds of a grain mixture will be necessary, the amount depending upon the size of the animal and her milk yield. Pomace may also be fed to dry cows, steers and to sheep.

Some desirable grain mixtures to be fed with roughage :

I.

100 pounds bran.
100 pounds flour middlings.
100 pounds gluten feed.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

II.

100 pounds bran.
100 pounds corn or hominy meal.[1]
100 pounds cottonseed meal.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

III.

100 pounds wheat bran.
200 pounds gluten feed.
35 pounds cottonseed meal.
Mix and feed 7 pounds (7 quarts) daily.

IV.

100 pounds wheat bran or malt sprouts.
100 pounds corn or hominy meal.
150 pounds gluten feed.
Mix and feed 7 pounds (or quarts) daily.

* There is doubt in the mind of the writer whether pomace would prove equal to well-preserved and well-eared corn silage. It certainly would approach it in feeding value, and ought to be fully utilized.

[1] Corn and cob meal if on hand can be used in place of corn or hominy meal.

V.

75 pounds wheat bran.
150 pounds corn and cob meal.
100 pounds cottonseed meal.
Mix and feed 6 to 7 pounds (7 qts.) daily.

VI.

100 pounds distillers' grains.
100 pounds malt sprouts.
150 pounds corn meal.
50 pounds cottonseed meal.
Mix and feed 7 pounds (7 to 8 qts.) daily.

VII.

150 pounds distillers' grains.
150 pounds standard middlings.
100 pounds corn or hominy meal.
Mix and feed 7 pounds (or quarts) daily.

VIII.

150 pounds wheat bran.
200 pounds gluten feed.
Mix and feed 7 pounds (8 to 9 qts.) daily.

IX.

200 pounds dried brewers' grains.
100 pounds corn meal.
50 pounds cottonseed meal.
Mix and feed 7 pounds (9 quarts) daily.

X.[2]

300 pounds bran.
100 pounds flour middlings.
100 pounds corn meal.
100 pounds ground oats.
300 pounds gluten feed.
100 pounds linseed meal.
Mix and feed as desired.

XI.

1.5 pounds gluten feed.
1.5 pounds cottonseed meal.
4.0 pounds dried beet pulp.[3]

XII.

3 pounds distillers' grains.
4 pounds dried beet pulp.[3]

The cost of a pound of the several mixtures is likely to vary from 1.4 to 1.6 cents. It is believed that the above selections are more economical on the basis of their content of nutritive material than most of the sugar feeds and other proprietary mixtures.

In general, it may be said that the *amount of grain* to be fed daily depends (a) upon the size of the cow, (b) daily milk yield, and (c) the local market value of the milk. The richer the milk, the more food is required to produce a given amount, and *vice versa*.

Six to seven pounds of the above mixtures is a fair average amount for cows weighing 800 to 900 pounds, which are yielding 10 quarts of 4 to 5 per cent milk. For every two quarts of milk yielded in excess of this amount the grain ration may be increased by one pound.

[2] Ration designed for cows on test: rather expensive for ordinary purposes.

[3] Beet pulp should be moistened with two or three times its weight of water before feeding.

CIRCULAR No. 48. DECEMBER, 1914

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

Beet Residues for Farm Stock

BY J. B. LINDSEY.

1. DRIED BEET PULP.

Dried beet pulp represents the residue in the manufacture of sugar from sugar beets. It is first run through presses to reduce its water content as much as possible, and then put into kilns where it is thoroughly dried by direct heat. It is coarse and of a gray color.

Molasses beet pulp is the pressed plain pulp mixed with the residuum beet molasses and dried. It is said that another method of making molasses pulp consists in mixing a definite amount of molasses with the dried plain pulp.

Composition of Beet Pulp.

	Plain Pulp.	Molasses Pulp.	Corn Meal for Comparison.
Water,	9.08	8.48	11.00
Ash,	3.02	6.93	1.30
Protein,	8.90	11.16	9.80
Fiber,	18.76	10.16	2.00
Extract matter,	60.59	62.76	72.00
Fat,	.65	.51	3.90
Total,	100.00	100.00	100.00

It will be noted that the plain pulp contained about 9 per cent of water, a relatively large amount of fiber, and practically no fat. In chemical composition it differs from corn meal in having much more fiber, less extract matter and much less fat. The percentage of sugar present is small, the larger part of the extract matter being in the form of the hemi-celluloses. The molasses pulp contained considerably more ash, due to the large amount of mineral matter in the molasses. The fiber content was noticeably less than that of the plain pulp, due to the replacing of the pulp by the molasses, which was without fiber. They are, however, carbohydrate feeds of the same chemical type of composition as corn.

Pounds of Digestible Matter in a Ton.

	Protein.	Fiber.	Extract Matter.	Fat.	Totals.
Plain pulp,	92.56	311.42	1,005.79	—	1,409.77
Molasses pulp,	140.62	162.56	1,129.68	—	1,432.86
Corn meal for comparison,	132.00	—	1,322.00	70.00	1,524.00

The above figures show that a ton of the corn meal with substantially 11 per cent of water contains about 8 per cent more digestible organic nutrients than a ton of the plain beet pulp having 9 per cent of water. One would not, therefore, expect to note a marked difference in the effect of these several feeds when used as a component of grain rations intended for milk production.[1]

Beet Pulp as a Substitute for Corn Silage.

Wing[2] compared the wet pulp with corn silage, feeding 50 to 100 pounds daily, together with 8 pounds of grain and 6 to 12 pounds of hay, and concluded that the dry matter in the pulp was of equal value, pound for pound, with the dry matter found in

[1] Calculations on the basis of net energy values show the corn meal to have 45.6 per cent more energy than the plain pulp. This is due to the loss of energy assumed to be required to digest the fiber in the pulp, and, according to Kellner, to the extra energy required for its mastication. Kellner states that the dried pulp has about the same energy value as bran, but noticeably less than the cereals and oil cakes. Probably the larger the amount of dried pulp fed the greater would be the difference in its feeding effect as compared with corn meal.

[2] Bulletin No. 183, Cornell Experiment Station.

the silage. The milk-producing value of wet beet pulp [1] as it comes from the factory, according to Wing, is, pound for pound, about one-half that of corn silage.

Billings [2] compared the dry pulp with corn silage, and concluded that the pulp ration gave 10.2 per cent more milk than did the silage ration; but, because of the cost of the dried pulp, it was more economical to feed silage. In his trial the cows receiving the pulp ration lost in flesh.

It is believed that 5½ to possibly 6 tons of silage is substantially equivalent in feeding value to 1 ton of the dried pulp. Under present conditions it is considered not to be good economy for farmers to buy pulp to be used in place of home-grown corn silage, the farm being the place for the production of carbohydrate food stuffs.

Dried Beet Pulp vs. Corn Meal.

At this station six cows were fed on a basal ration of hay, bran and cottonseed meal. In addition three of the cows averaged 4.3 pounds of plain pulp or molasses beet pulp, while the other three were receiving a like amount of corn meal. After a lapse of five weeks the conditions were reversed. The results may be briefly stated as follows :

Milk Yields (Pounds.)

Character of Ration.	Total Milk.	Daily per Cow	Total Fat.	Butter Equivalent.
Corn meal, ...	3,941.3	18.8	215.3	251.1
Plain pulp, ...	4,017.1	19.1	216.5	252.3
Corn meal, ...	4,184.0	19.9	233.4	272.3
Molasses pulp, . . .	4,054.0	19.3	220.6	257.3

[1] Only those living in the immediate vicinity of the factory can afford to use the wet pulp. It is worth not over $2 a ton on the farm.

[2] Bulletin No. 189, New Jersey Experiment Station.

The corn meal ration produced about 2 per cent less milk than the plain pulp ration. In the second trial the corn meal ration caused an increase of some 3 per cent of milk over the molasses pulp ration. From the above trials one may conclude that the corn meal and beet pulps as components of a ration had about the same effect.[1]

If the pulp can be purchased at slightly less per ton than the corn, it would prove economical for dairy animals.

The Feeding of Beet Pulp.

Dried beet pulp absorbs a great deal of water, and in case it is fed dry, this absorption will take place in the mouth and stomach, and is likely to cause choking, indigestion and stomach irritation. It should be first moistened with two to three times its weight of water, and the dry grain mixed with it.

Sample Daily Grain Rations Containing Dried Beet Pulp.

(a) **Dairy Cows.**

I.

3 pounds distillers' grains,
4 pounds dried pulp.

II.

1.5 pounds gluten feed,
1.5 pounds cottonseed meal,
4.0 pounds dried pulp.

III.

2 pounds gluten feed,
2 pounds flour middlings,
3 pounds dried pulp.

IV.

2 pounds wheat bran,
2 pounds cottonseed meal,
3 pounds dried pulp.

(b) **To Supplement Pasturage.**—By weight one-half of dried pulp and one-half gluten feed; or one-third dried pulp, one-third gluten feed and one-third wheat bran; or two-thirds dried pulp and one-third distillers' grains, would prove desirable combinations (feed from 3 to 7 pounds daily of the mixture, depending upon requirements).

(c) **For Fattening Stock.**—It should prove satisfactory for fattening beef animals in the proportion, by weight, of two-thirds beet pulp and one-third cottonseed meal. The material is hardly to be recommended for swine and horses.

[1] See foot note 1, bottom of page 2.

Dried Beet Pulp as Roughage.

As high as eight pounds of the dried pulp can be well moistened with water and fed to each animal as a partial source of roughage in place of corn silage, together with what hay the animal will eat clean (10 to 16 pounds daily). If thus fed, it naturally should be omitted from the grain ration.

The Place of Dried Beet Pulp in the Farm Economy.

Farmers who are in position to produce their own feed cannot afford, as a rule, to purchase starchy feedstuffs, of which dried beet pulp is a type. Such material should be produced upon the farm in the form of corn, oats and barley.

For milk production it is more desirable for the farmer to purchase materials rich in protein, such as cottonseed and linseed meals, distillers' and brewers' dried grains, gluten feed, malt sprouts, fine middlings and wheat bran. These feedstuffs are not only very helpful in milk production, but likewise supply increased amounts of nitrogen in the manure. Only when the supply of home-grown corn is exhausted or limited would it be considered economical to substitute dried beet pulp either as a portion of the grain ration or as a part of the roughage.

Milk producers who purchase all of their feed will find the dried pulp a satisfactory component of the daily ration, providing it can be secured at a relatively reasonable price.

BEET LEAVES.

Every autumn the station is in receipt of inquiries concerning the value of beet leaves for feeding purposes. In order to answer these inquiries the following information is submitted :

Composition and Digestibility.

The leaves have the following average composition : [1]

	Per Cent.
Water,	89.30
Ash,	1.80
Protein,	2.30
Fiber,	1 50
Extract matter,	4.70
Fat,	.40

From the above analysis it is evident that the leaves contain a great deal of water, and on the basis of dry matter are relatively rich in protein and ash and poor in fiber. The leaves contain from 20 to 37.7 per cent of their nitrogen in the form of amids. The ash contains a large amount of oxalic acid (3.5 per cent of the dry matter), and in the extract matter varying amounts of dextrose and laevulose have been recognized.

According to F. Lehmann,[2] sheep digest 61 per cent of the crude protein, 52 per cent of the fat and 75 per cent of the extract matter.

How to Feed the Leaves.

Beet leaves are best suited for dairy cows and for fattening cows and steers. They are less suited for young stock, swine, horses and sheep. Fed in too liberal quantities they have a decidedly laxative effect, and likewise cause indigestion. This is due to the oxalic acid and inorganic ash constituents. The same bacteria which in the paunch of the bovine produces lactic acid, act to an extent upon the oxalic acid and partially decompose it.

[1] E. Pott, Handbuch der Thier. Ernährung, etc., Zweite Auflage, II, Bd. S. 201.
[2] See E. Pott, already cited, p. 202.

It is advisable to feed not over 50 pounds daily of the green leaves to dairy cows, together with dry hay and grain. In case of cows that are near to calving one-half of this amount is preferable. It is stated that dry cows and thin steers will take larger amounts without bad effect.

German observers have found it helpful, in order to guard against the unfavorable action of the oxalic acid, to feed one ounce of precipitated chalk to every 50 pounds of leaves. It is not advisable to feed the leaves when the milk is intended for young children. Before feeding, the leaves should be made as free from soil as possible. This can in a measure be accomplished by shaking off the dirt with the aid of a fork, or by placing them in slatted drums or on sieves made of slats. It is not economical to wash them, as too much of the water-soluble nutrients is lost.

Beet leaves may be ensiled, and thus treated have been found to be less laxative in their effect. The oxalic acid is also partly decomposed. The leaves should be allowed to wilt, freed from excessive earth or sand, and then placed in pits in the earth or in ordinary wooden silos and thoroughly tramped. Excess of moisture is to be avoided. In case of necessity the leaves may be placed in small piles, and will keep very well from one to two weeks. The ensiled material contains approximately 76 per cent of water, and E. Wildt[1] has shown it to have the following percentages digestible :

	Per Cent.
Protein,	65
Fat,	60
Extract matter,	54

It is not advisable to feed to cows over 25 pounds daily of the ensilage, together with hay, straw and grain. Larger amounts frequently act unfavorably on the animal, and are likely to produce a strong taste in the milk. German authorities are inclined to prefer the ensiled to the fresh leaves, especially if the latter are at all frosted or decayed.

[1] E. Pott, already cited, p. 207.

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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

CABBAGE, CAULIFLOWER, TURNIP, RAPE, AND OTHER CRUCIFERS

WILLIAM P. BROOKS

Soils. The crops in this group thrive in quite a variety of soils, but none will do well if water be near the surface or the soil inclined to be wet. Well tilled loams in good fertility should be selected, the lighter for English turnips and Swedes or for early cabbage, and medium loams for late cabbage and cauliflower. Under irrigation success is possible on very light soils if highly manured or fertilized. With deficient drainage or over-wet soils these crops are peculiarly liable to the disease known as clubroot. They should not be grown two successive years on the same land nor come into any rotation more frequently than one year in four or five.

Lime Necessary. These crops will fail or do poorly in any soil which is sour in marked degree. If blue litmus paper in contact with the moist soil turns red an application of lime is needed. The rate of application must, of course, be varied to suit different conditions, but in general for the lighter soils which are sour the application of about one ton per acre of air-slaked lime or marl, or one and one-half tons of fine ground limestone is desirable, while for the heavier soils about fifteen hundred pounds of hydrated (water-slaked) lime is likely to be beneficial.*

Prevention of Clubroot. The disease known as clubroot (foot) or sometimes "fingers and toes," is due to the growth of a fungus in the cells of the roots. It causes the distorted root swellings, often of enormous size, familiar to most who who have grown these

* For fuller discussion of use of Lime see Bulletin No. 137 which will be sent on application.

crops. No cure or certain prevention when soil has become infected is known. Rotation of crops, no one of this group to be put upon any given field oftener than once in four years, and a rather free use of lime, will help secure immunity. After soil has been brought into condition by one good initial liming a yearly application of a mild lime at the rate of five hundred pounds per acre should be sufficient. If slag meal be used for all crops in the rotation (except potatoes if they be included), it is probable that a second liming will be unnecessary.

The Use of Manures. The crops of this family will repay liberal manuring, and barnyard or stable manures are well suited to all except turnips or Swedes for table use. For these it is best to avoid the too free use of such manures, as the roots are less smooth, stronger in flavor and more liable to be attacked by worms. For all these crops, manures from animals fed refuse from any of them should be avoided as such manures will be likely to carry disease germs. This is particularly true of hog manure or manures on which hogs run, because these animals are often fed waste vegetables, which usually means those which are diseased, and which, therefore, carry the germs of disease. Manures should, in general, be plowed in or deeply disked under.

Fertilizer Needs. All crops of this family are dependent in a very unusual degree upon a liberal supply of phosphoric acid in highly available forms. Acid phosphate, dissolved bone and basic slag meal prove highly beneficial. When manure is freely used no other fertilizer than a phosphate may be necessary. These crops are less dependent upon artificial potash supply than most, and it may be doubted whether potash in addition to manure will be called for. Some nitrate to push the plants rapidly from the start makes it easier to prevent serious injury from lice and some other insects, and is always desirable in connection with moderate applications of manure, especially for early crops.

Fertilizers for Use with Manure. In connection with a medium dressing of manure use for cabbage or cauliflower a mixture made up as follows:

Acid phosphate,	6 parts.
High grade sulfate of potash,	1 part.
Nitrate of soda,	2 parts.

This mixture will contain nitrogen 3.44, available phosphoric acid 10.66 and potash 5.55 per cent.

Apply broadcast just before plants are set and use from eight to twelve hundred pounds per acre.

For brussels sprouts, kohl-rabi and kale about the same application will be useful.

For rape use one-half to two-thirds the above amounts.

If one grows these crops on a small scale only it will often be preferable to use a ready mixed fertilizer having about the composition of the mixture of chemicals recommended. There is usually no saving in cost when chemicals must be purchased in small quantities, and of course this practice involves rather more trouble.

When Fertilizers Only Are Used. When fertilizers only are to be used for these crops it is believed that they should show about the same general composition as the mixture above recommended for use with manure; but a rather higher percentage of nitrogen will be useful except after clover, alfalfa or other legumes, or on soils in high fertility or containing a large proportion of humus, such as reclaimed muck or peat. A portion of the nitrogen in a fertilizer for this use should be derived from materials less soluble and more slowly available than nitrate of soda, such as cyanamid, tankage or bone. A part of the phosphoric acid also may be in less soluble form than acid phosphate, and it is believed an application of basic slag meal will be highly desirable. This has the double advantage of furnishing available phosphoric acid and a large amount of lime (mostly, it is true, in neutral compounds), thus reducing, as has been pointed out, the necessity for a separate application of lime in preparation for these crops. It is believed that when the slag is used it will be found best to apply it by itself on the rough furrow to be deeply worked in by disking, and if some time before putting in the crop, so much the better. The previous fall will be the best time. The useful application will probably range from 600 to 1200 pounds per acre, according to soil and crop. It will be desirable, especially with soils low in fertility, to mix sulfate of potash with the slag at the rate of 100 pounds per acre.

In connection with this preparatory application of slag meal and potash a mixture of chemicals made up in the following proportions is recommended:

Acid phosphate,	4 parts.
H. G. sulfate of potash,	1 part.
Nitrate of soda,	2 parts.
Cyanamid,	2 parts.
Tankage,	4 parts.

This mixture will have about the following chemical composition: nitrogen 6.5%, phosphoric acid 8.8% and potash 3.8%. It may be used in amounts varying from 1000 to 1600 pounds per acre.

It may be here again remarked that if only small areas are to be fertilized it will probably be most satisfactory to buy a mixed fertilizer of the desired composition.

Application of the Fertilizers

Whether fertilizer is to be used with manure or alone it will be best in most cases to apply the mixture broadcast just before setting the plants or sowing seed; though in work upon a small scale it is probable that lesser amounts of fertilizer can be made to give fairly satisfactory crops if a part at least is reserved for application in wide circles about the plants after they are set, to be worked in with the cultivator. The harrow will sufficiently work under a broadcast application of such mixtures as are recommended.

CIRCULAR No. 50. MARCH, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

RATIONS FOR DAIRY STOCK*

BY J. B. LINDSEY.

1. COMPOSITION OF CATTLE FEEDS.

All cattle feeds, whether in the form of grains and their by-products, or as hay, corn silage and straw, are composed of the following groups of substances:

Water—The several grains and their by-products contain from 7 to 12 per cent of water; hay and straw, 12 to 16 per cent; field-cured corn stover, 30 to 40 per cent; and corn silage, 76 to 80 per cent.

Ash represents the mineral ingredients, and constitutes the ashes after the feed is burned. These ashes consist of lime, potash, soda, magnesia, iron, phosphoric and sulfuric acids.

Protein is a collective name for all of the nitrogenous matter; it corresponds to the lean meat in the animal, and may be termed "vegetable meat." It has the same elementary composition as animal flesh. When fed to animals as a component of the various feed stuffs, it serves as the exclusive source of flesh as well as a source of heat or energy and fat.

Crude fiber or cellulose is the coarse or woody part of the plant. It may be called the plant's framework. It is a source of heat or energy and fat.

Non-nitrogenous extract matter represents the sugars, starch and gums. It is the principal source of heat or energy and animal fat.

Fat includes not only the various oils and fats in all grains and coarse fodders, but also waxes, resins and coloring matters. It is frequently termed *ether extract*, because it is that portion of the plant soluble in ether. It serves as a source of heat or energy and fat in the body of the animal.

Carbohydrates is a term which is generally used to include both the fiber and the non-nitrogenous extract matter.

It will thus be seen that all of the several groups of nutrients—protein, carbohydrates and fat—are sources of energy; that is, they furnish the food or fuel to maintain the life of the body. They also are convertible into fat. The protein, however (including the ash), is the only group from which the animal can make its flesh or lean meat. In order to form the bones all the groups are used.

* Originally prepared for the Massachusetts State Board of Agriculture as Circular No. 3.

2. Digestibility of Cattle Feeds.

The several groups of nutrients above described, which make up the various cattle feeds, are valuable to the animal only in so far as they can be digested and assimilated. The concentrated feeds are considerably more digestible than the coarse fodders, as a single illustration will show.

	100 Pounds Timothy Hay.			100 Pounds Gluten Feed.		
	Composition.	Per Cent Digestible.	Pounds Digestible.	Composition.	Per Cent Digestible.	Pounds Digestible.
Water, . .	15.0	—	—	8.5	—	—
Ash, . .	4.3	—	—	1.7	—	—
Protein, . .	6.3	48	3.0	26.2	85	22.3
Fiber, . .	28.4	58	16.5	7.2	76	5.5
Extract matter,	43.6	63	27.5	53.3	89	47.4
Fat, . . .	2.4	61	1.5	3.1	83	2.6
Totals, . .	100.0	—	48.5	100.0	—	77.8

In the first and fourth columns are given the composition of average samples of timothy hay and of gluten feed. In the second and fifth columns are shown the percentages of the different groups which are digestible. Thus, of the 6.3 pounds of the protein in timothy, 48 per cent are digestible, or 3 pounds; and of the 26.2 pounds of protein in 100 pounds of gluten feed, 85 per cent or 22.3 pounds, are digestible. Excluding the ash, which is not generally taken into account, it is shown that 100 pounds of timothy hay contain about 48 pounds of digestible or actual food material, and 100 pounds of gluten feed 78 pounds. It is evident, therefore, that the gluten feed is decidedly more valuable as a source of nutrition than the timothy hay.

3. Method of Measuring the Efficiency of Feeding Stuffs.

The digestibility of a feed, however, is not the true measurement of its nutritive value, for the reason that some feeds require more energy for their digestion than others. What is termed *net energy value*, expressed in the form of calories[1] or therms,[1] represents more accurately the true nutritive values of feeding stuffs.

Explanation. The entire amount of heat or energy contained in a feeding stuff is termed its *total heat* or *energy* value. All of this heat or

[1] A calorie represents the amount of heat necessary to raise 1 gram of water 1° Centigrade. It is the unit of heat measurement. A therm represents the amount of heat required to raise 1000 kilograms of water 1° Centigrade.

energy cannot be utilized by the animal for the purposes of maintaining its body in a state of temperature equilibrium, or for aiding in the production of growth and milk. The several losses may be enumerated as follows: (*a*) the undigested material, *i. e.*, the fæces; (*b*) the incompletely used material (urea, etc.) of the urine; (*c*) the work required in the processes of digestion and assimilation in preparing the nutrients so that they can be used for maintenance and for the production of growth and milk. These several sources of loss expressed as energy, deducted from the total energy, leave the real or *net energy value.*

Here follows a table showing the *relative* net energy values (relative values) of a few of the more important feeding stuffs. Instead of expressing the relative energy values in therms of energy, they are stated on the basis of 100 for the sake of direct comparison. The figures were secured by the use of the so-called Kellner method.[1] They are not perfect, but represent the results of the best method that we have available at this time. Corn meal is taken as 100 and the other feeds, both concentrated and coarse, are compared with it :

RELATIVE VALUES OF FEEDING STUFFS.

Corn meal,	100	Hay, Kentucky blue grass,	41
Apple pomace,	11	Hay, orchard grass,	38
Beet pulp (dried),[2]	69	Hay, red top,	43
Brewers' dried grains,	66	Hay, rowen,	48
Brewers' wet grains,	18	Hay, swamp or swale,	23
Buckwheat middlings,	90	Hay, tall oat grass,	36
Corn bran,	78	Hay, timothy,	36
Corn silage,	12	Hominy meal,	105
Corn stover, from field,	27	Linseed meal (old process),	94
Corn stover, very dry,	36	Malt sprouts,	66
Cottonseed meal,	95	Oats, ground,	83
Distillers' dried grains, largely from corn,	94	Rye feed,	91
Gluten feed,	91	Wheat bran,	57
Gluten meal,	99	Wheat kernels, red,	92
Hay, alfalfa or clover,[3]	42	Wheat kernels (white),	94
Hay, barnyard millet,	36	Wheat middlings (flour),	98
Hay, English (mixed grasses), fine early cut,	43	Wheat middlings (standard)	67

It should be borne in mind that the above figures express only net energy and not protein value. If protein is needed to balance the ra-

[1] For a full explanation of the components of the animal body, the composition of feeds, the different ways in which the food is used in the animal body, and the explanation for using the therm in the calculation of rations for farm animals, see Farmers' Bulletin 346, United States Department of Agriculture, prepared by H. P. Armsby.

[2] Our own experiments, comparing beet pulp with corn meal, as components of a dairy ration, have shown their feeding values to be more nearly equal.

[3] Alfalfa probably preferable, especially as source of protein.

tion, it can be purchased most economically in the high-grade protein concentrates, such as cottonseed meal, gluten feed, distillers' dried grains and the like.

4. Nutritive Ratio of Cattle Feeds.

The *numerical* relation which the digestible protein bears to the other digestible organic nutrients (fiber extract matter and fat [1]) is termed the nutritive ratio of the feed or ration. Timothy hay has. for example, 3 parts of digestible protein to 47.3 parts of other digestible nutrients, or as 1 is to 15.8. This is termed a very wide nutritive ratio. Gluten feed contains 22.3 parts of digestible protein to 58.6 parts of other digestible nutrients or as 1 is to 2.6. This may be termed a very narrow nutritive ratio or proportion. All feeds having a nutritive ratio of 1 to 5 or less may be said to have narrow ratios, those from 1 to 5 to 1 to 8 a medium ratio, and above 1 to 8 a wide ratio.

The cereals and other non-leguminous coarse fodders have medium to wide ratios, leguminous coarse fodders medium ratios, and the leguminous seeds and most concentrated by-products narrow ratios.

5. Combining Coarse and Concentrated Feeds (Balanced Rations).

Desirable rations for dairy stock should possess (*a*) palatability, (*b*) sufficient bulk, and (*c*) 1 part of protein to 5.5 to 7 parts of the other digestible organic nutrients. If the ratio is much narrower than 1 to 5.5, the ration is likely to be too stimulating for continuous feeding, and the animal is likely to become thin in flesh. If the ratio is much wider than 1 to 7, the tendency will be for the animal to put on fat rather than to give milk. In both cases the ration may be said to be *out of balance*.

For both economical and physiological reasons it is necessary that a considerable portion of the daily ration of the dairy animal should be composed of coarse fodder or roughage, because such materials are easily and cheaply produced upon the farm, and because the digestive tract of the bovine is especially suited to utilize them. Most of these home-grown coarse feeds, however, are very high in carbohydrates, low in protein, and have a relatively low digestibility. It is necessary, therefore, to supplement them to an extent with the cereal grains, which, though relatively low in protein, are very digestible; and with the concentrated by-products, which in addition to a relatively high digestibility, are quite rich in protein. A single illustration will make this clear. Many experiments have demonstrated that a 1,000-pound

[1] The fat is converted into the energy equivalent of the starch or fiber by multiplying by 2.2; thus, 3 per cent of fat would have an energy equivalent of 6.6 per cent or parts of starch.

cow, producing daily 10 quarts of milk of average quality, needs approximately the following amounts of *digestible* nutrients:

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds. .	2.25	.5	13 or 13.5	16	1 to 5.6 or 7

Now, if this animal were fed daily as much of an *extra* quality of hay as she would consume (28 to 30 pounds), she would receive:

Digestible.	Protein.	Fat.	Carbyhydrates.	Total.	Nutritive Ratio.
Pounds, .	1.3	.3	13	14.6	1 to 10.5

Such a ration is deficient both in total digestible nutrients as well as in digestible protein. If 7 pounds of the hay were replaced by an equal amount of corn meal, the hay and corn meal would furnish:

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds. .	1.4	.47	14.35	16.22	1 to 11

The corn meal being very digestible, but a one-sided or starchy feed, would sufficiently increase the total digestible nutrients, but not the protein. If 4 pounds of corn meal were replaced by 2 pounds of bran and two pounds of cottonseed meal, the several feeds would supply:

Digestible.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds. .	2.07	.60	13.20	15.87	1 to 6.6

The replacing of 7 pounds of hay with 3 pounds of corn meal rich in digestible matter and with 2 pounds each of bran and cottonseed meal especially rich in digestible protein, furnishes a ration containing less fiber and more starchy matter and protein than is contained in the hay. Such a ration contains the requisite amount of both total digestible matter and digestible protein, and may be said to be *properly balanced*.

6. Types of Balanced Rations.

Because of the high prices usually prevailing for all concentrated feeds, dairymen are frequently in doubt as to the kinds to be selected and the amount to be fed in order to secure the best returns for the money invested. Farmers selling cream to the creamery, or located where there is not a quick demand for milk, probably will not find it economical to feed over 3 to 5 pounds of purchased grain daily, and will use maximum amounts of home-grown hay and silage (1 bushel of silage and what hay the animal will eat clean). If the silage is well eared, 1½ pounds each of cottonseed meal and flour middlings, sprinkled over the silage to distribute it, will produce a fairly well-balanced ration, and prove helpful in maintaining the milk flow. If corn meal is a home product rather than silage, mix by weight ¼ bran, ½ corn and cob meal and ¼ cottonseed meal, (100 pounds bran, 200 pounds corn

and cob meal and 100 pounds cottonseed meal), and feed 5 to 6 quarts daily, or by weight ⅔ corn and cob meal and ⅓ cottonseed meal and feed 4 to 5 quarts daily, together with one feeding of cut or shredded corn stover and what hay the animal will clean up.

Producers of market milk generally find it advisable to feed somewhat more grain, and a number of combinations are suggested which will produce satisfactory balanced rations when fed with what hay the animal will eat clean (18 to 24 pounds a day), or with 1 bushel of corn silage and 10 to 16 pounds of hay.

I

100 pounds bran.
100 pounds flour middlings.
100 pounds gluten feed.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

II.

100 pounds bran.
100 pounds corn or hominy meal.[1]
100 pounds cottonseed meal.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

III.

100 pounds wheat bran.
200 pounds gluten feed.
25 pounds cottonseed meal.
Mix and feed 7 pounds (7 quarts) daily.

IV.

100 pounds wheat bran or malt sprouts.
100 pounds corn or hominy meal.
150 pounds gluten feed.
Mix and feed 7 pounds (or quarts) daily.

V.

75 pounds wheat bran.
150 pounds corn and cob meal.
100 pounds cottonseed meal.
Mix and feed 6 to 7 pounds (or quarts) daily.

VI.

100 pounds distillers' grains.
100 pounds malt sprouts.
150 pounds corn meal.
50 pounds cottonseed meal.
Mix and feed 7 pounds (7 to 8 quarts.) daily.

VII.

150 pounds distillers' grains.
150 pounds standard middlings.
100 pounds corn or hominy meal.
Mix and feed 7 pounds (or quarts) daily.

VIII.

150 pounds wheat bran,
200 pounds gluten feed.
Mix and feed 7 pounds (8 to 9 quarts.) daily.

IX.

200 pounds dried brewers' grains.
100 pounds corn meal.
50 pounds cottonseed meal.
Mix and feed 7 pounds (9 quarts) daily.

X.[2]

300 pounds bran.
100 pounds flour middlings.
100 pounds corn meal.
100 pounds ground oats.
300 pounds gluten feed.
100 pounds linseed meal.
Mix and feed as desired.

[1] Corn and cob meal, if on hand, can be used in place of corn or hominy meal.
[2] Ration designed for cows on test; rather expensive for ordinary purposes.

XI.	XII.
1.5 pounds gluten feed.	3 pounds distillers' grains.
1.5 pounds cottonseed meal.	4 pounds dried beet pulp.[1]
4.0 pounds dried beet pulp.[1]	

The cost of a pound of the several mixtures is likely to vary from 1.5 to 1.7 cents. It is believed that the above selections are more economical on the basis of their content of nutritive material than most of the sugar feeds and other proprietary mixtures.

In general it may be said that the *amount of grain* to be fed daily depends (*a*) upon the size of the cow, (*b*) daily milk yield, and (*c*) the local market value of the milk. The richer the milk, the more food is required to produce a given amount; and *vice versa*.

Six to 7 pounds of the above mixtures is a fair average amount for cows weighing 800 to 900 pounds, which are yielding 10 quarts of 4 to 5 per cent milk. For every 2 quarts of milk yielded in excess of this amount the grain ration may be increased by 1 pound.

7. Rations for Young Stock.

Young dairy stock may receive 1 peck or more of silage daily, depending upon their size, in addition to what hay, corn stover or other coarse fodder they will eat clean; or the entire roughage may consist of hay. Ten to 15 pounds of roots daily in cases where silage is not available will prove appetizing and helpful. Grass and clover rowen form a very desirable feed for growing animals. In addition to the above, it is usually advisable to feed from 1 to 3 pounds daily of a grain mixture reasonally rich in protein and ash.[2] Any of the above grain mixtures will prove satisfactory. The writer has found mixtures by weight of ½ bran, ¼ corn meal and ¼ flour middlings; or ½ bran, ¼ corn meal and ¼ ground oats quite satisfactory. A ration composed of late-cut hay and corn meal would not be desirable, it lacking both flesh and bone forming material (protein and ash).

Several months before the heifer freshens it is well, if circumstances permit, to increase the grain ration to 5 or 6 pounds per day in order to get her accustomed to grain and to encourage a large future milk flow.

The feeder will do well to bear the following in mind:

1. Late-cut hay is noticeably less nutritious than early-cut.
2. The fine grasses are more nutritious than the coarse.

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[1] Beet pulp should be moistened with two to three times it weight of water before feeding.

[2] If the roughage consists largely of grass or clover rowen, 2 pounds daily of a mixture of bran and corn meal, or even of corn meal alone, will prove satisfactory.

3. The clovers and alfalfa should be cut in early bloom. If cut in late bloom their nutritive value is noticeably lessened.

4. Concentrated feeds, aside from their palatability, should be purchased for their high digestibility or net energy value and protein content.

5. The cereals have a high net energy value; cottonseed meal, gluten feed, distillers' dried grains and flour middlings, while they are highly digestible (high net energy value) are purchased as a rule because of their protein content.

6. Wheat bran is an expensive source of nutrition, but its bulk and laxative qualities frequently commend its use to eastern feeders in amounts not exceeding 25 to 30 per cent of the entire grain ration.

7. Some proprietary grain mixtures are fairly economical; others, which contain low-grade by-products, are quite expensive, due to the fact that such feed mixtures are sold at about the same prices as the high-grade concentrates.

8. The farm is the carbohydrate factory. As a rule, it is not practicable for the farmer or dairyman to produce all of the high-grade protein feeds to supplement his home-grown carbohydrates. He should endeavor to produce as much as possible of the needed protein in the form of clover, alfalfa, peas and possibly soy beans. In some cases he will find it necessary to purchase corn and the like, but this, as a rule, is not good economy.

Circular No. 51. (Revision of No. 40.) March, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

AMHERST.

DOWNY MILDEW OF CUCUMBERS.

(Peronoplasmopara cubensis (B & C) Cl.)

By George E. Stone.

Downy mildew, which is not difficult to distinguish from other leaf fungi, is most likely to occur on greenhouse cucumbers in August and September, and has never been observed by us in greenhouses in the winter. The fungus occurs on the under side of the leaf, causing whitish or yellowish angular spots (see Fig. 1,) and these spots are more prominent on greenhouse than on field cucumbers. Ordinarily,

Fig. 1. Showing characteristic spotting of cucumber leaf by downy mildew (Peronoplasmopara)

an attack of this mildew lasts but a few weeks, and causes only an insignificant spotting of the leaf. Reproduction is by means of small spores, which retain their vitality longest in a moist atmosphere.

Downy mildew was first observed on material received from Cuba in 1868, and was later noted in Wisconsin in 1882. In 1888 it was found on cucumber leaves obtained from Japan, and in 1889 it was found in New Jersey, causing injury under glass, at which time it was also common on field cucumbers. During the same year it was reported abundant in Florida and Texas. In 1890 it appeared in Massachusetts and again in 1892, when it was found on greenhouse and field crops. In New Jersey it was common in 1891, 1892 and 1893, and in Connecticut and New York about the same time.

In 1895 it appeared in Ohio, and later caused considerable injury in that state both to greenhouse and field crops. In 1899 it was noted in England; in Brazil in 1900; in Russia, Austria-Hungary, Java and East Africa in 1902, and in Italy in 1903, showing that the disease has been quite cosmopolitan in its progress. Since its appearance in this country it has been generally distributed and quite destructive to field crops of cucumbers, although from 1892 until 1900, it was not observed in Massachusetts, to our knowledge. Since 1900, however, it has appeared annually on field crops and occasionally in greenhouses, where its appearance has caused little alarm.

It has been shown that this fungus is perennial in the south and travels north every season, apparently about the time cucurbitaceous crops mature. It usually makes its appearance in Massachusetts about the middle of August, although sometimes a little earlier; but in 1913 there was a bad infection on greenhouse cucumbers in the Boston district in May, June and July, which caused much loss, especially in unheated houses, where the air often becomes very damp. This is the first time downy mildew has been observed here earlier than August, and this attack may have some connection with the unusually warm winter of 1912—1913.

While the downy mildew is capable of doing considerable injury to greenhouse crops, it is not difficult to hold the disease in check if proper attention is paid to the moisture in the house. In no case should moisture be allowed to remain on the foliage for more than two or three hours, and even in the warm months steam should occasionally be turned on to dry out the house and change the air. All mildews and leaf blights are encouraged by moisture on the foliage, lack of light during the period of plant development, and stagnant air. In our experiments, in which we have grown cucumbers and melons under glass every month in the year, we have never had the slightest infection from mildew when the plants were syringed properly; i. e., only on bright mornings when the leaves will dry quickly. While cucumbers can be grown without syringing, the risk from red spider during the spring and summer months is necessarily great.

After the middle of September or October first there is little danger of infection, therefore it is better to start the winter crop at this time rather than in August. A slight attack of downy mildew does little or no harm, and if cucumber growers always used the same judgment as lettuce growers, an infection would seldom prove serious. It has been shown that spraying with Bordeaux mixture constitutes an effective preventive in the field, and sulfur and oil painted on the pipes in the greenhouse has proved beneficial.

This unlooked for attack of downy mildew in the early summer months makes it apparent that in the future all cucumber growers should be on the lookout for early infection.

Circular No. 52 (Revision of No. 41). March, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

THE CONTROL OF ONION SMUT.

By George E. Stone.

Onion smut has been known in Massachusetts for about forty years, Mr. Benjamin P. Ware having referred to the injury caused by this fungus in the Massachusetts State Board of Agriculture Report for 1869—70. The smut spores infect the seedlings at a very early stage, the disease taking the form of dark-colored or sooty masses, and as the onion matures the black areas of pustules may be noticed on the leaves and bulbs. Since infection takes place in early stages of the seedling, onion sets being immune, any method which will kill the spores on the seed or in the soil must be beneficial. Where onions are grown year after year on the same land the smut shows a marked tendency to increase, but even here it can be controlled by the use of proper preventive measures.

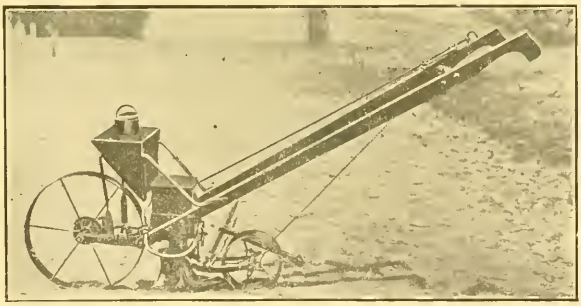

Fig. 1. Showing Planet Jr. cultivator with formalin drip.

Positive results have been obtained by applying sulfur thoroughly mixed with air-slaked lime in the drills, at the rate of 100 pounds of sulfur and 50 pounds of lime to the acre. Ground lime, drilled in

with a fertilizer drill, at the rate of 75 to 100 bushels per acre also is good. But by far the best results have been obtained from the use of formalin, which may be applied at the rate of one ounce to one gallon of water (1-128), or in even weaker solutions. Some onion growers in the Connecticut valley, where the crop is grown extensively and and with great success, occasionally use the formalin stronger than the amounts recommended, but this results in injury to the crop. 1-100 parts, which is sometimes used, is capable of killing almost anything. and in our opinion is too strong to apply to seed.

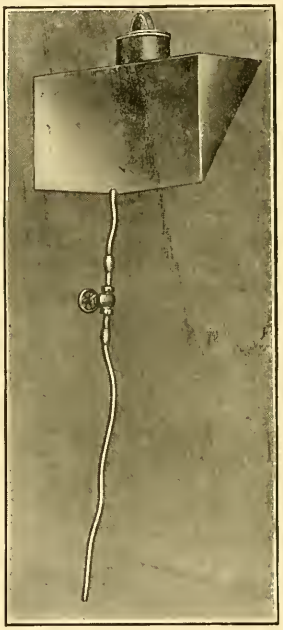

FIG. 2. Formalin tank, block tin pipe and valve. (See Fig. 1.)

By the aid of certain devices, formalin can be easily and cheaply applied when the seed is sown. Tests have shown that about 1200 feet of drill can be treated with one gallon of formalin solution. One of the first devices used for this purpose was made by the writer, and consists of a tank attachment. At the bottom is fastened a block tin tube about a quarter of an inch in diameter, to which is attached a valve to regulate the flow of formalin. This tube can be easily bent to discharge at any desired point and yet has sufficient stiffness to

hold its position. The tank, which holds one gallon, may be attached to any onion sower (see fig. 1) by means of strips of iron. Although not fastened to the iron frame, the tank stays in place and can be easily removed.

In figure 2 the tank and tube are shown detached from the sower. A special feature of the tank consists in the ease with which it can be drained, the middle of the tank being lower than the ends. A larger tank may be used if necessary, as the weight of the formalin is not enough to affect the easy handling of the machine. The flow of the formalin solution in a tank of this shape is nearly uniform, there being little difference in the amount flowing when the tank is full and when nearly empty.

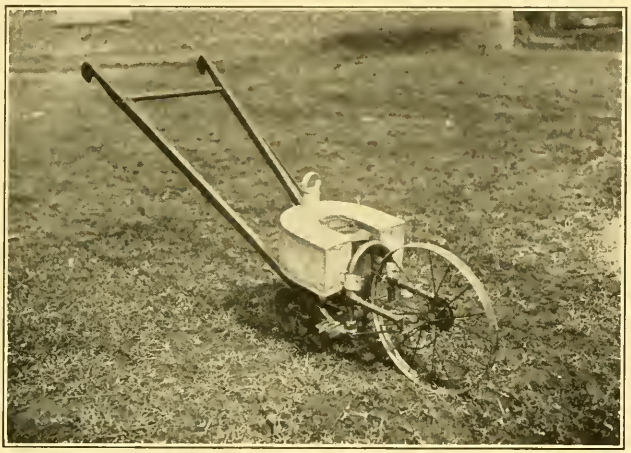

FIG. 3. Horse-shoe form of tank. A tank similar to this might be readily adapted to any two-row seed sower.

Figures 3 and 4 show more recent devices of this nature. The tanks are in both cases made of galvanized iron and have a capacity of two gallons. An improvement over the earlier apparatus consists in an iron rod attached to the valve and leading to the handles of the sower, by means of which the operator can adjust the flow at will. The horse-shoe form of tank shown in figure 3 has the largest use in the Connecticut valley.

In the treatment of onion smut only enough liquid need fall to cover the seed and moisten a little of the surrounding soil.

Very satisfactory results have been noted from the use of the for-

malin drip in this state. Some land so infested with the smut as to make it impossible to grow profitable crops of onions has produced clean crops after treatment by this method. In one case the smut was so severe that the land had to be abandoned, but it now rents for $50.00 an acre as onion land. The apparatus can be made by any

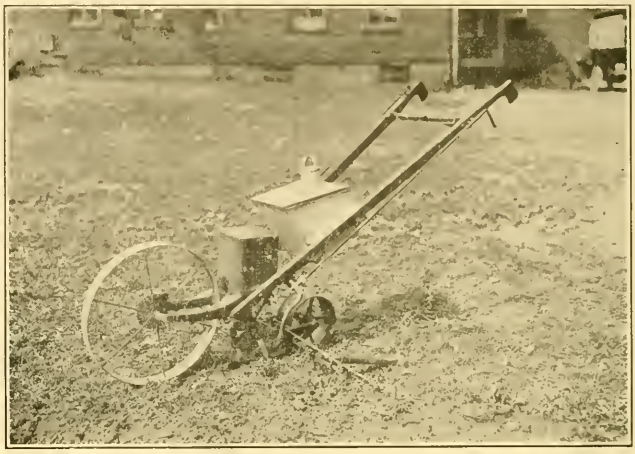

FIG. 4. Showing tank suspended between the handles of the sower.

local plumber, and on the whole the formalin treatment constitutes one of the most effective methods for the control of onion smut. It has each year resulted in saving many thousands of dollars to onion growers.

NOTE.—Formaldehyde solution, U. S. P., 40 per cent. volume can be obtained from the Perth Amboy Chemical Works, 100 William St., New York City, at the following rates :

In 400 lb. barrels,	9c	per lb.
In 250 lb. barrels,	9¼c	per lb.
In 125 lb. kegs, f. o. b. New York,	9½c	per lb.
In 60 lb. kegs,	11c	per lb.
In 1 lb. bottles, 50 to a case,	19c	per lb.

CIRCULAR No. 53 (Revision of No. 39). APRIL, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

LIME AND SULFUR SOLUTIONS.

BY G. E. STONE.

Lime and sulfur has been used for many years in various forms and for different purposes, although it is only comparatively recently that its value as a fungicide has been realized. The extensive use of this solution as a spray for the San José scale has incidentally demonstrated its great value as a fungicide. Our observations and experiments with the use of lime and sulfur when applied to trees in a dormant condition have convinced us that no preparation which has ever been used can be compared with it for efficiency in controlling different fungi. For many years lime and sulfur has been largely used as a spray for fruit trees in a dormant condition, but of late it has also been used in various modified forms as a summer spray with very encouraging results. Many trials have been made of the diluted concentrated preparations, and also of what is known as the "self-boiled lime and sulfur," but the methods are in a more or less experimental stage.*

Lime and sulfur used as a spray on trees in a dormant condition is a positive preventive of peach leaf curl and Monilia and Cladosporium infection on peach twigs. Its use holds in check the leaf spots of the apple, pear, plum, quince and other fruit trees and shrubs. We also believe that it has a material effect on cankers, black knot and other common twig diseases. So effective is this treatment for leaf spots that in many cases after only one spraying not a single spot could be found on the foliage of fruit trees during any part of the season.

Self-Boiled Lime and Sulfur Mixture.

For some purposes, especially summer spraying, self-boiled lime and sulful mixtures are useful. One of the best rules is the following:

W. M. Scott's Formula.

Flowers of sulfur or sulfur flour,	8 pounds.
Fresh stone lime,	8 pounds.
Water,	50 gallons.

* The diluted lime and sulfur has not proved equal to Bordeaux for spraying potatoes. —Geneva Agri. Exp. Station (N. Y.), bul. 347, F. C. Stewart and G. T. French.

In making this mixture the best stone lime procurable should be placed in a barrel and slaked, using precautions not to drown the lime in slaking it. W. M. Scott recommends that enough water be applied to nearly cover the lime when slaking. As soon as the lime has commenced to slake and some heat has generated, apply the sulfur through a fine sieve to break up the lumps. The mixture should be stirred and more water added gradually, bringing it to a thin paste. As soon as the lime is well slaked, more water should be added to cool the mixture.

Since there is much difference in lime as regards the development of heat, it is difficult to specify any particular time to add the water for the purpose of cooling, but it should be done before the sulfur goes into solution and forms sulfides, which are injurious to peach foliage. Under ordinary conditions, the mixture should not be allowed to remain hot over ten or fifteen minutes after slaking. With the intense heat developed from slaking and constant stirring a uniform mixture of fairly finely divided sulfur and lime is obtained with only a small trace of sulfides in solution. It should be strained before using.

Mr. Scott has used this successfully for peach brown rot and scab. In this formula he also mixed two pounds of arsenate of lead, which proved effective in helping to control the plum-weevil and other insect pests. Mr. Scott believes that the arsenate of lead is less likely to burn tender foliage when in combination with lime and sulfur than when used alone.

Concentrated Lime and Sulfur Solutions.

There are a number of these solutions on the market which are apparently similar in composition. Their specific gravity varies from 30° to 34° Baumé, and in using them it is necessary to dilute according to the strength of the solution and the nature of the foliage to which they are to be applied. The directions furnished by manufacturers for the dilution of their own product for different purposes can usually be relied upon.

Arsenate of lead at the rate of 3 pounds of paste or 1½ pounds of powder to 50 gallons of the mixture may be combined with these commercial lime and sulfur solutions as a summer spray. Extreme care should be taken to mix the two substances thoroughly as injuries have been reported from this combination of arsenate of lead with the commercial solutions, especially in the eastern part of the state. To do away entirely with the risk of injury to the foliage and fruit it would be safer to combine the arsenate of lead with the self-boiled lime and sulfur solutions as outlined in the previous section.

Home Made Lime and Sulfur Solutions.

Very few orchardists find it profitable to prepare the home-made lime and sulfur solutions now that the commercial solutions are so much more convenient to use and are virtually as efficient. Information concerning the preparation of the home-made solutions may be found in bulletins Nos. 329 and 339, of the New York (Geneva) Agricultural Experiment Station, which may be obtained from the director of that station.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST.

POULTRY MANURES, THEIR TREATMENT AND USE.

BY WILLIAM P. BROOKS

The total number of fowls kept in the state is estimated at two and one-half millions. The average night droppings of medium breeds according to determinations made in this station must amount to 40 pounds per fowl per year. On this basis the amount of poultry manure easily collectible from the fowls of the state annually is 50,000 tons. If the plant-food in a ton of average fresh poultry manure be purchased at current prices in fertilizers, the outlay would amount to nearly $7.50. Observations and experiments indicate that as poultry manure is frequently handled it suffers a loss of one-half or more of the nitrogen it contains when voided before it reaches the land. If a loss of one-half correctly represents the average, the total money value of nitrogen annually wasted from our poultry manures must amount to about $160,000. It is the aim of this circular to show how this loss may be prevented.

General character and composition of poultry manures.

Poultry manures are particularly rich in nitrogen and their general characteristics are such that they readily decompose. As a result of decomposition the manure heats and there is a rapid and large loss of moisture and of ammonia.

The composition is subject to wide variations, due to some extent to differences in feeding, but in far greater degree to methods of handling and keeping

The following tables present the results of recent analyses made in our laboratory.*

Table 1 shows the composition of the material just as it was collected and taken to the laboratory. Table 2 shows the composition of the different samples of hen manure all reckoned upon the same basis of dry matter in 100 pounds.

Samples B-1, 2 and 3 are richer than the others in nitrogen, because the fowls received more animal food. Potash varies relatively little. Phosphoric acid varies widely and must be greatly affected by the amount of bone in the animal food given to the fowls.

The comparison between the amounts of nitrogen shown in Table 2 in samples B-1, 2 and 3, and between samples G-1 and 2 is particularly instructive. *It illustrates the fact that hen manure unmixed with absorbents or chemicals suffers very rapid loss of nitrogen.* Sample B-2 differs from B-1 only in the fact that the interval between tthe removal of droppings from beneath the roosts was longer. The season of this experiment was March, and the droppings were frozen a part of the time. During warmer weather the loss must have been yet greater. G-2, though

* Credit for these analyses is due H. D. Haskins and L. S. Walker, Chemists in the fertilizer division of the station.

TABLE 1.
COMPOSITION OF POULTRY MANURES.

Hen Manure	Moisture %	Nitrogen %	Potash %	Phos. Acid. %	Lime %
C (about 2 weeks), . .	67.62	1.36	.43	1.11	1.33
P " " . .	68.58	1.07	.44	1.10	2.78
L " " . .	74.96	1.21	.43	1.22	1.71
B-1 (1 night), ...	69.76	1.91	.33	1.00	.53
B-2 (2 or 3 weeks), . .	60.61	2.30	.48	1.09	1.40
B-3 (6 or 8 weeks), . .	48.82	1.90	.63	2.07	1.93
G-1 (1 night), ...	66.69	1.58	.42	.50	1.46
G-2 (3 nights), . . .	64.06	1.13	.39	.62	1.89
Pigeon, ...	25.01	3.90	1.06	2.15	.96
Duck, ...	61.62	1.12	.49	1.44	1.12
Goose.	67.06	1.12	.51	.53	.26

TABLE 2.
COMPOSITION ON BASIS OF EQUAL DRY MATTER.

Hen Manure	Dry Matter %	Nitrogen %	Potash %	Phos. Acid. %	Lime %
C (about 2 weeks), . .	32.	1.34	.42	1.096	1.314
P " " . .	32.	1.09	.44	1.120	2.831
L " " . .	32.	1.486	.52	1.499	2.101
B-1 (1 night), ...	32.	2.021	.31	1.058	.56
B-2 (2 or 3 weeks), . .	32.	1.868	.38	.86	1.137
B-3 (stored 6 or 8 weeks),	32.	1.19	39	1.294	1.206
G-1 (1 night), ...	32.	1.517	.31	.47	1.402
G-2 (3 nights), . . .	32.	1.006	.34	.55	1.682
Average, ...	32.	1.44	.39	.99	1.53

accumulating only during three nights, seems to have lost relatively more nitrogen than B-2, perhaps because the house was much warmer than the one from which samples B came ; although this seems an insufficient explanation to account for so large a difference.

Examination of Table 1, especially comparison of the samples B-1 and B-2, shows that the fact that nitrogen has been lost is obscured by the further fact that there has been an even larger loss of water. The percentage of nitrogen in B-2 (Table 1) is larger than in B-1, but only because the former is drier. Table 2 shows that there has been a large actual loss.

Methods of Preservation. The free use of fine dry loam, or the admixture of such materials as kainit, acid phosphate, muriate of potash or land plaster, or of a combination of some of these, will effectively prevent loss of nitrogen. Loam alone must be used in quantities so large as considerably to increase cost of handling. Either kainit, muriate of potash or acid phosphate alone is effective but the mixture, especially with the first, holds the material too moist for convenient handling Plaster is of less value as an absorbent of ammonia and if largely used the mixture may form hard, dry cakes.

Dry sawdust has been successfully used with acid phosphate and kainit by the Maine Experiment Station. In bulletin 216, that Station recommends using with each 30 pounds of fresh droppings (their estimate of the yearly amount of night droppings from one hen);

10 pounds sawdust,
16 pounds acid phosphate,
8 pounds kainit.

The writer recommends:

1. Where poultry is kept upon a small scale and where fine dry earth can be readily obtained that this be sprinkled in moderate quantities on the dropping boards whenever the accumulation is removed, which should be daily. To each 100 pounds of fresh droppings add a mixture of chemicals as follows:

(*a*) Where the material will be used as top-dressing for grass lands or for lawns:

Acid phosphate, 20 pounds,
Kainit, 15 pounds.

(*b*) Where the mixture will be used for field crops such as corn or in the vegetable garden:

Acid phosphate, 50 pounds,
Kainit, 25 pounds.

In either case sprinkle the mixture in proper proportion over each lot of fresh material as it is added to the accumulating stock and mix before use.

Mixture (*a*) with 65 pounds of dry earth (estimated amount needed) will weigh 200 pounds, and provided the droppings are similar in composition to sample B-1, it should have about the following composition:

Nitrogen,	0.95 per cent.
Phosphoric acid,	2.00 per cent.
Potash,	1.14 per cent.

This estimate does not make any allowance for the small amount of plant-food found in the earth. One ton of this mixture will supply plant-food about as follows,

Nitrogen,	19 pounds,
Phosphoric acid,	40 pounds,
Potash,	23 pounds.

Mixture (*b*) with 70 pounds of earth added gives a total weight of 245 pounds. This will contain about:

Nitrogen,	0.8 per cent.
Phosphoric acid,	3.5 per cent.
Potash,	1.5 per cent.

One ton of this mixture will supply about:

Nitrogen.	16 pounds,
Phosphoric acid,	70 pounds,
Potash,	30 pounds.

2. Where poultry is kept upon a large scale obtaining and handling earth in as large quantities as are necessary will greatly increase the labor and the cost of applying the manure. Under such circumstances, therefore, the writer is inclined to indorse the Maine system. Placing this upon the same basis as the other, the proportions would be as follows:

Fresh droppings,	100 pounds,
Acid phosphate,	50 pounds,
Kainit,	25 pounds,
Dry sawdust,	30 pounds.

This proportion of sawdust is slightly lower than that recommended in the Maine bulletin. The total weight is 205 pounds, but there is in practically all cases some loss of moisture and it is sufficiently accurate for practical purposes to estimate the weight of the mixture at 200 pounds. On this basis the composition would be as follows:

Nitrogen,	0.95 per cent.
Phosphoric acid,	4.25 per cent.
Potash,	1.79 per cent.

One ton of this mixture will supply:

Nitrogen,	19 pounds,
Phosphoric acid,	85 pounds,
Potash,	36 pounds.

What not to do. Do not mix wood ashes or lime with poultry manure as both of them are strongly alkaline and will release ammonia, thus causing greater loss than would occur if nothing were mixed with the manure.

The use of poultry manure. The fact should be kept in mind when planning for the use of poultry manure that its constituents are quickly available. It should be remembered, moreover, that the material is naturally so strong that in close contact with either seeds, foliage or delicate rootlets in large quantities it will burn and injure. Such mixtures as have been recommended are usually best used by spreading either broadcast or very widely in the hill or drill. It will not be found easy to make the materials sufficiently fine for application with a fertilizer drill, but they can be successfuly applied with such a fertilizer distributor as the Greenwood or by the use of a manure spreader. The quantity of poultry manure to be applied must naturally be varied with soils and crops, but it should be remembered that such manure well preserved with such mixtures as have been suggested are much stronger and richer than ordinary manures and should be used in smaller quantities. From about 1½ to 2½ tons per acre will be the usual range in quantity.

If poultry manure is to be used for potatoes the writer would recommend substituting 8 pounds high grade sulfate of potash in place of the 25 pounds of kainit recommended in the 2d and 3d mixtures. Poultry manures if unmixed or with the chemicals in mixture No. 1 can probably be most profitably used as a top-dressing for grass because of the high percentage of nitrogen contained in them.

CIRCULAR NO. 55 (Revision of No. 37). AUGUST, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

GREEN MANURING AND COVER CROPS.

BY WILLIAM P. BROOKS.

Green manuring is the practice of cultivating a crop for soil improvement. The crop is usually, but not always, plowed in while green. A cover crop is one grown largely for soil protection, but it may at the same time serve all the purposes of a green manure crop. On the other hand, during the period of its growth a green manure crop is a cover crop.

The practice of using crops for soil protection and improvement has received much more attention in recent years than formerly, largely because its possible benefits and the conditions essential to their realization are better understood. It is not yet as general as it should be. The objects of this circular are:

1. To briefly indicate the possible benefits from the use of green manure and cover crops, and the principal reasons therefor.
2. To consider the special characteristics, value and adaptation of each of the principal crops.
3. To state the conditions under which the introduction of these crops is to be advised.

1. POSSIBLE BENEFITS

Erosion prevented. The protection of the soil against damage by wind which carries away the finer and better particles, and water which washes fields which have any considerable slope. In other words, to prevent erosion.

Plant-food saved. The conservation of soluble plant-food compounds. Plant-food compounds soluble in water tend to wash through the soil (and of course most largely on those which are of coarse and open texture) to lower levels, or they are carried away through natural or artificial drainage channels. The danger of this loss is of course greatest in seasons of abundant rainfall and it goes on most largely in fields which are bare. If the soil be kept full of hungry rootlets of a growing crop the amount of loss through this source is greatly reduced.

Weeds prevented. Green manure and cover crops may be made of much use in preventing the growth of weeds and the ripening of weed seeds, and also in some cases they may be made very helpful in exterminating certain kinds of weeds with which a field may have become infested.

Soil enriched in nitrogen.

Those green manure or cover crops which belong to the family of legumes (pod bearers) are capable, under the right conditions, of assimilating nitrogen from the air. They do this through the agency of bacteria that live in nodules on their roots. Through the cultivation of legumes it is possible, therefore, to increase the sum total of nitrogen in the soil. The vegetable matter produced by such crops as clover, peas, beans and vetches is rich in nitrogen and when it decays, this element, in the form of ammonia or nitrates, is gradually rendered available to a following crop.

Plant-food made availible.

The availibility of the mineral food constituents of the soil is increased. The increase is due:

1. To the action of the living roots which exercise a solvent action on the mineral particles of the soil.
2. To the increased biological activity (bacteria and other micro-organisms) favored by shade and the increased proportion of organic matter in the soil.
3. By the solvent action of carbonic acid and other organic acids produced in the decay of the added vegetable matter.

Humus increased.

Improved physical condition due to the admixture of vegetable matter and the gradual increase in the amount of humus. This means better capacity to retain and to conduct moisture.

Subsoil mellowed.

In the case of the deep rooted green manure or cover crops the subsoil is to a considerable extent opened and mellowed so that following crops root more deeply. To some extent, also, such crops transfer material gathered by their deep roots in the subsoil toward the surface.

2. PRINCIPAL CROPS

Desirable characteristics.

Among characteristics which especially fit a crop for cover or green manure are the following: ability to thrive broadcast; rapid growth; deep and vigorous root system; freedom from injury by frosts. If the crop, besides possessing the characteristics named, is a legume it will prove most valuable because in one respect it surpasses all others, viz., it has the ability to gather nitrogen from the air which none of the others possesses.

Non-Legumes

None of the crops of this class have the capacity to gather nitrogen from the air.

Winter rye.

Suited to light soils, one of the most useful of the green manure crops outside of the legumes, grows late in the autumn and begins growth very early in the spring, especially valuable for preventing waste of nitrates during the fall, winter and spring rains, and because it affords cover

and protection in winter, preventing both damage from wind and washing; produces a large amount of vegetable matter sufficiently early in the season to be plowed under and followed by a crop to be harvested. Seed broadcast, 2 to 3 bushels per acre.

Buckwheat. Suited to light soils, characterized by extremely rapid growth in warm weather, killed by frosts, valuable especially in preventing growth or subduing weeds and producing a large amount of vegetable matter within a short period of time. Seed broadcast, 1 bushel per acre.

White mustard. Suited to the lighter soils, characterized by rapid growth and hardiness, valuable for nitrogen conservation, will make a good growth before cold weather if put in after early potatoes or sown in corn at the time of the last cultivation. Seed 5 to 6 pounds per acre if sown in corn; one-half that quantity alone broadcast.

Rape. Suited to medium soil. There are two classes—Spring, represented by Dwarf Essex, and Winter. The latter is not hardy in most parts of Massachusetts. Where it can be grown, especially valuable, it starts into growth extremely early in spring and furnishes a large amount of vegetable matter in season to plow under for most crops. Dwarf Essex rape may be sown after harvesting an early crop, being very hardy, continues to grow until late in the autumn, especially valuable for nitrogen conservation. Seed broadcast 3 to 5 pounds per acre.

Legumes

All the crops included in this class have the capacity to gather nitrogen from the air. They will do this, however, to an important extent only when the following conditions are met:

1. The soil must be neutral or alkaline.
2. It must be stocked with bacteria of the right kind or they must be supplied. In the case of legumes which have commonly been grown in the locality the appropriate bacteria are usually abundant. When a legume new to the locality is to be grown the bacteria should be supplied either in the form of a culture or by the use of loam from a field where they are abundant. Cultures are now commercially prepared and if of good quality are generally to be preferred to soil.*
3. It must not contain a large amount of nitrogen in the form of available compounds. If it does the legume will take most of its nitrogen from the soil and will not draw upon the air to any considerable extent.

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*Cultures may be obtained of the "Department of Microbiology," Mass. Agricultural College, Amherst. A charge of 25 cents is made which covers cost and postage on sufficient for one bushel of seed.

The soy bean. Suited to the better loams, is not hardy and is not well suited for prevention of erosion or conserving nitrogen, will furnish a large amount of vegetable matter within a comparatively short period of summer weather, does best if planted in drills. About ½ bushel of seed per acre.

The cow pea. Suited to light and medium loams, endures drought and hot weather exceedingly well, not hardy, but will furnish a large amount of vegetable matter in a relatively short period of summer weather, does best in drills and requires about ½ bushel of seed per acre.

3. CONDITIONS WHEN GREEN MANURING IS ADVISABLE

The statement of possible benefits of green manuring quite clearly indicates by inference the conditions under which the introduction of a green manure crop is advisable, but at the same time it includes references to so many and so important advantages that the reader may be in danger of over-estimating its value. There is no question that it can produce the beneficial effects referred to but there are conditions under which these effects would be secured at too great cost. Under the following conditions there can be no question that green manuring will be profitable:

1. When the green manure crop can be produced without the sacrifice of a crop to be harvested, or during a period when the field would otherwise be unoccupied, when it will help prevent loss of nitrates, erosion and infestation by weeds.
2. Green manuring will be especially important on soils made up largely of sand or clay and naturally deficient in humus.
3. Green manuring, especially with legumes, will be unusually beneficial on soils naturally deficient in available nitrogen compounds.
4. It is especially beneficial in orchards: preventing erosion, furnishing organic matter and keeping down weeds.
5. The introduction of a green manure crop in cases where a crop to be harvested must be sacrificed will self-evidently be in place only on the cheaper lands.

When not advisable. On the other hand where a farm is stocked to its capacity, green manuring will seldom or never be advisable. Many of the green manure crops have large food value. It will be found more profitable to feed clover to the animals of the farm than to turn it in in most cases, and where the excrements are carefully saved and returned to to the land practically all the effects of green manuring will be realized.

4. The legume must be allowed to attain nearly full development if the gain in nitrogen is to be large, since during the early stages of its growth the nitrogen which it requires comes in large measure from the soil.

Vetches. There are two classes of cultivated vetches—spring and winter. The winter vetches are much more valuable than those belonging to the other class. The hairy or sand vetch is the most valuable variety. It is suited to medium loams, found especially valuable in orchards, useful both in preventing erosion and in gathering and conserving nitrogen and should usually be sown with winter rye. Broadcast 1 bushel of seed per acre.

Field peas. Suited to medium or fairly heavy loams, quite hardy and useful for nitrogen gathering, should be grown with a grain crop. Broadcast $1\frac{1}{2}$ to 2 bushels of seed per acre.

Crimson clover. Best suited to medium loams, may be cultivated either as a winter annual or annual, not quite hardy enough to make it reliable as a winter annual in most parts of Massachusetts, though it occasionally goes through the winter. Where it does this, it is one of the most valuable cover and green manure crops. Sown in August it makes a thick mat of leaves, serves to conserve nitrogen and prevent erosion, starts its growth very early the following spring and can be turned under in season to be followed by a crop which is to be harvested; where hardy particularly valuable in orchards. Seed broadcast about 15 to 20 pounds per acre.

Common and mammoth red clovers. Suited to a wide variety of soils, but do best in medium loams; if sown the latter part of July or early in August make sufficient growth in autum to prevent erosion and conserve nitrogen, start into growth fairly early the following spring but will not mature in season to be followed by such crops as corn and potatoes. These clovers are very deep rooted, may often be very profitably used for combined forage and green manure, much used in orchards. Seed broadcast 8 to 10 pounds per acre.

Sweet clover. Distinct from the true clovers, like them in many respects but not nearly as valuable for forage, suited to a wide variety of soils if drainage is perfect, particularly deep rooted, sown in July will prevent erosion and conserve nitrogen, starts into growth extremely early the following spring and will furnish a large bulk of vegetable matter which may be turned under in season to be followed by crops to be planted about the same time with corn. There are two varieties, white and yellow; the white is the more valuable for green manuring. Seed broadcast about 20 pounds per acre.

The soy bean. Suited to the better loams, is not hardy and is not well suited for prevention of erosion or conserving nitrogen, will furnish a large amount of vegetable matter within a comparatively short period of summer weather, does best if planted in drills. About ½ bushel of seed per acre.

The cow pea. Suited to light and medium loams, endures drought and hot weather exceedingly well, not hardy, but will furnish a large amount of vegetable matter in a relatively short period of summer weather, does best in drills and requires about ½ bushel of seed per acre.

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and protection in winter, preventing both damage from wind and washing; produces a large amount of vegetable matter sufficiently early in the season to be plowed under and followed by a crop to be harvested. Seed broadcast, 2 to 3 bushels per acre.

Buckwheat. Suited to light soils, characterized by extremely rapid growth in warm weather, killed by frosts, valuable especially in preventing growth or subduing weeds and producing a large amount of vegetable matter within a short period of time. Seed broadcast, 1 bushel per acre.

White mustard. Suited to the lighter soils, characterized by rapid growth and hardiness, valuable for nitrogen conservation, will make a good growth before cold weather if put in after early potatoes or sown in corn at the time of the last cultivation. Seed 5 to 6 pounds per acre if sown in corn; one-half that quantity alone broadcast.

Rape. Suited to medium soil. There are two classes—Spring, represented by Dwarf Essex, and Winter. The latter is not hardy in most parts of Massachusetts. Where it can be grown, especially valuable, it starts into growth extremely early in spring and furnishes a large amount of vegetable matter in season to plow under for most crops. Dwarf Essex rape may be sown after harvesting an early crop, being very hardy, continues to grow until late in the autumn, especially valuable for nitrogen conservation. Seed broadcast 3 to 5 pounds per acre.

Legumes

All the crops included in this class have the capacity to gather nitrogen from the air. They will do this, however, to an important extent only when the following conditions are met:

1. The soil must be neutral or alkaline.
2. It must be stocked with bacteria of the right kind or they must be supplied. In the case of legumes which have commonly been grown in the locality the appropriate bacteria are usually abundant. When a legume new to the locality is to be grown the bacteria should be supplied either in the form of a culture or by the use of loam from a field where they are abundant. Cultures are now commercially prepared and if of good quality are generally to be preferred to soil.*
3. It must not contain a large amount of nitrogen in the form of available compounds. If it does the legume will take most of its nitrogen from the soil and will not draw upon the air to any considerable extent.

*Cultures may be obtained of the "Department of Microbiology," Mass. Agricultural College, Amherst. A charge of 25 cents is made which covers cost and postage on sufficient for one bushel of seed.

4. TREATMENT OF THE GREEN MANURE CROP

It is a common practice to turn under crops grown as green manures as soon as their growth is completed, but even in the case of those which are killed by autumn frosts, if protection from wind and washing is especially needed, it may be preferable to leave the crop on the surface until the following spring. It is not believed there will be any great loss in manurial value if this practice be followed because the crop on the surface in winter weather will not decay to a sufficient extent to render its constituents soluble. In deciding upon the time for working a green manure crop into the soil it should be remembered that this should be done a few weeks at least before the seed of the following crop is to be sown. The presence of a large amount of undecayed vegetable material a few inches below the surface is unfavorable to the germination and early growth of a following crop. Time should be allowed for the vegetable matter to settle and in part decay and for the capillary connection between the portion of the soil turned over and the undisturbed soil below to have become re-established. In a majority of instances it seems better to turn a green manure crop under rather than to leave it on the surface. A plow turning a large furrow slice is best suited to the work and a disk coulter is desirable. If the crop is tall, a chain fastened to the middle of the evener long enough so that the end will drag in the furrow about opposite the mould-board may be used with advantage. A chain so used divides the standing crop and bends it forward just ahead of the plow so that it is covered much better than would be possible without it. In some cases the chain is looped in such a way as to accomplish the same result. In the case of a crop killed by winter frosts but allowed to remain upon the surface until spring, it is best to go over the field with a disk harrow, cutting up the stems and working the material somewhat into the soil before attempting to plow.

5. SHOULD GREEN MANURE CROPS BE FERTILIZED

While a moderate degree of benefit may follow the introduction of green manure crops without the application of any fertilizer, its full benefits will not be realized on soils which are much exhausted without the application of materials that furnish, at least, moderate quantities of the mineral elements of plant food, for which purpose basic slag meal and a potash salt applied broadcast, after plowing, and deeply worked in, will prove among the most useful.

Further, it will not be possible to greatly enrich the soil in nitrogen from the air through the growth of legumes unless lime be first applied in the case of all soils which are acid, because the nodular bacteria cannot multiply to any great extent, nor actively assimilate nitrogen in soils which are sour.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST.

WM. P. BROOKS, Director

E. D. WAID, Acting Director of Extension Service

CAMPAIGN TO ELIMINATE BACILLARY WHITE DIARRHOEA

1. White Diarrhoea is common in this State and is the occasion of great loss.

2. The disease is transmitted by the hen laying the egg.

3. Hens harboring the bacillus can be detected by a laboratory test of the blood.

4. If such hens (reactors) are eliminated from breeding flocks losses of chicks from Bacillary White Diarrhoea with proper sanitation can be practically entirely avoided. This fact has been demonstrated by tests made both in the Massachusetts and the Connecticut Experiment Stations.

5. The facts above stated must make it apparent that a campaign for the elimination of this disease is desirable and practicable. Breeders have simply to cease using eggs from reacting hens for hatching and the disease will soon dissappear.

6. The Extension Service and the Experiment Station of the Massachusetts Agricultural College, working co-operatively, are prepared to begin testing the breeding hens of owners applying for the test under the following general conditions :

(a). The collection of the blood samples will be carried out by the Extension Service.

(b). The agglutination test of the blood samples will be made in the Veterinary Department of the Experiment Station and from that Department reports on the results with such directions as may be necessary will go to the flock owners.

(c). As the work of the Veterinary Department will be largely routine and not experimental in its nature a charge will be made by the Station to cover a part of the cost. This for the present will be five cents for each hen tested.

7. Those desiring to have their flocks tested on this basis should address their applications : Poultry Department, Agricultural College, Amherst.

8. Those who have already applied for the test, whether verbally or in writing, as well as others should now make application as directed under "7."

9. So far as conditions permit applications will be accepted in the order of priority: but locality, as will be readily understood, must be considered since at present only one man can be employed in taking blood samples. It may not be possible to satisfy all applications, as the forces and facilities available for the work are limited.

CIRCULAR NO. 57 (Revision of No. 28) SEPTEMBER, 1915

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Department of Chemistry

RULES RELATIVE TO TESTING DAIRY COWS

General Requirements

The Massachusetts Agricultural Experiment Station, working in conjunction with the various pure bred cattle associations, will conduct, when possible, official tests of pure bred cows, on the following conditions :

1. Two weeks' notice of a desired test must be given the Station.
2. Charges for testing will be as follows :

(a) The charge for a single day's test, *when made in a sequence with others of a similar character*, will be $5.00. Additional days for the same party will be at the rate of $2.75 per day. These prices do not include the tester's time while en route.

(b) The charge for a "seven-day" test will be $25.00. An allowance of nine consecutive days will be made, which shall include the tester's time en route. Additional days beyond the nine day limit will be charged for at the rate of $2.75 a day.

(c) The charge for a "thirty-day" test will be $80.00, and 32 consecutive days will be allowed, which shall include the tester's time en route. Additional days beyond the 32 day limit will be at the rate of $2.50 a day.

(d) When the cost of supervisor's time and traveling expenses is in excess of the preceding rates the actual cost of the test will be charged. Such a charge, however, will not include office supervision, breakage or items other than the supervisor's time and traveling expenses.

(e) All bills for this work must be paid within ten days of date rendered. Breeders failing to comply with this requirement shall lose the privilege of having their cows tested under Experiment Station supervision.

(f) The owner of the stock must, at his expense, care for the supervisor during the test, and when necessary, convey him to and from the railroad station or car line.

3. The owner of each herd desiring tests must provide a satisfactory Babcock machine, the necessary acid and hot water, *and a suitable box or cupboard fitted with a hasp for a padlock, in which the supervisor may keep his samples.*

4. In case of long tests, supervisors will be changed every thirty days, if deemed advisable.

5. All reports of tests must be brought or sent to the Experiment Station by the supervisors. Such reports, after being verified, endorsed and copied, will be forwarded to the proper club. The station, however, reserves the right of using the data, if deemed advisable.

Duties of the Supervisor

1. The supervisor shall not be held responsible for the identity of any cow tested, but shall accept the statement of the owner or his representative as to her name and registration number. The supervisor, however, shall state whether the cow answers her registered description, if the same has been furnished him.

2. The supervisor shall see the cow milked dry at the regular milking prior to beginning the test,* shall verify the fact with his own hands and note the time of the same. The last milking must occur at the same hour, one or more days later according to the length of the test.

3. The number of cows to which an inspector is limited daily shall be dependent upon the amount of work required and the facilities at hand. He shall not exceed five cows when milked four times daily nor ten when milked two or three times daily, without special permission from the station. Where inferior facilities for testing are furnished the number of cows allowed daily may be reduced. The authority for such action rests, however, with the Experiment Station official in charge and not with the supervisor. The supervisor shall allow only one of the cows entered to be milked at a time and shall personally oversee the entire milking.

4. A cow must be milked out at a single sitting. In no case will it be allowable to go back and strip her a second time.

5. The supervisor shall verify the weight of the pail before each cow is milked. As soon as a cow is milked the supervisor shall take charge of the pail and its contents and keep it under his control until he shall have weighed the milk and taken the sample for the Babcock

*In case of Ayrshire and Jersey breeds it is not necessary to see the cow milked dry before beginning test.

test. He must thoroughly mix the milk previous to taking the necessary sample and must retain the sample under absolute control until tested.

6. Disturbing conditions such as sickness, being in heat, change of milker, etc., must always be entered on the report.

7. When required, as indicated on the blanks furnished, the supervisor must also record the date of the cow's birth, when last calf was dropped, when the cow was served, when test was begun, statement of kind and amount of feed, both grain and roughage, method of feeding, also the use of condiments, condition powders, or drugs of any kind.

8. In the case of yearly tests the supervisor shall at the beginning of the test record in duplicate on blanks furnished him for the purpose a full description of the animal entered for test.

9. Any tampering with a cow under test or with the samples by the owner or an employee, by refusal to comply with the rules must be reported at once to the station by telephone. Lack of proper apparatus or facilities for doing satisfactory work should also be reported.

10. All the butter fat tests and weights of milk secured by a supervisor shall be recorded by him in a suitable record book or upon special blanks furnished for that purpose, which he shall retain constantly in his possession until called for by the Experiment Station official in charge of the work.

11. The supervisor shall adhere to the foregoing rules in every particular as well as to the rules of the various breeders' associations under which he may be working.

Special Rules

The owners of pure bred animals under test are advised to thoroughly familiarize themselves with the rules under which their respective associations are working. Our supervisors are instructed to refer all questions in regard to rules to the proper pure bred cattle associations. The information in this circular is simply intended to supplement the rules of the various associations and in no way to conflict with them. The supervisor is not at liberty to decide as to which stipulations contained herein are essential and which are not and any apparent variation between the instructions in this circular and those of the pure bred cattle associations should be referred at once to the Experiment Station.

Yield of Milk and Butter Fat Required for Advanced Registry.

	7 Days		365 Days	
	Milk lbs.	Fat lbs.	Milk lbs.	Fat lbs.
AYRSHIRE				
2 years old at commencement of test,	....	....	6,000	214.3
3 " " " "	....	....	6,500	236.0
4 " " " "	....	....	7,500	279.0
5 " " " "	...	....	8,500	322.0
Daily increase required,	..	....	274.	0.12
GUERNSEY				
2 years old at commencement of test,	....	....	....	250.5
3 " " " "	....	....	....	287.0
4 " " " "	....	....	....	323.5
5 " " " "	....	...	....	360.0
Daily increase required,	....	....	....	0.1
HOLSTEIN FRIESIAN				
2 years old at calving,	....	7.2	....	250.5*
3 " " "	....	8.8	....	287.0*
4 " " "	....	10.4	....	323.5*
5 " " "	....	12.0	....	360.0*
Daily increase required,	....	.00439	....	0.1
JERSEY				
2 years old at commencement of test,	....	....**	....	250.5
3 " " " "	....	....	....	287.0
4 " " " "	....	....	....	323.5
5 " " " "	....	....	...	360.0
Daily increase required,	....	...	....	0.1

Confirmed Butter Tests: 14 pounds of actual butter testing at least 80 per cent. fat for 7 days, for 90 days or less an average of 2 pounds a day, for 265 days 500 lbs.

Secretaries of Breeders' Associations

Ayrshire Breeders' Association; C. M. Winslow, Brandon, Vt.

American Guernsey Cattle Club; W. H. Caldwell, Peterboro, N. H.

†Holstein-Friesian Association of America; F. L. Houghton, Brattleboro, Vt.

American Jersey Cattle Club; R. M. Gow, 324 West 23d Street, New York, N. Y.

Communications pertaining to advanced registry work addressed to the Massachusetts Experiment Station should be sent in care of the undersigned.

PHILIP H. SMITH,
Massachusetts Agricultural Experiment Station,
Amherst, Mass.

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*Competition restricted to cows having been admitted to Advanced Register on 7 day test.

**For special requirements of seven, fourteen and thirty day tests consult Jersey Rules.

†Communications in regard to advanced registry should be addressed to Malcolm H. Gardner, Superintendent of Advanced Registry, Delavan, Wis.

CIRCULAR No. 58 (Revision of No. 47). NOVEMBER, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST.

The Feeding Value of Apple Pomace.

BY J. B. LINDSEY.

There is often considerable discussion in the agricultural press and among farmers concerning the value of apple pomace as a food for dairy and beef cattle. With a view to getting some positive data, this station instituted a number of experiments, the results of which are here briefly stated.

(*a*) *Composition of Apple Pomace* (*Per Cent.*)

	Water.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
Sample I, ...	81.40	.73	.94	3.00	13.03	.90
Sample II, ...	80.20	.60	1.01	3.19	13.73	1.27
Corn silage for comparison	80.00	1.10	1.70	5.40	11.10	.70

It will be seen from the above figures that apple pomace is a carbohydrate feed similar to corn silage, It contains about the same amount of water, rather less protein and fiber, and a larger proportion of extract matter. Whether the extract or starchy matter in the pomace is as valuable, pound for pound, as that contained in the corn, has not been thoroughly demonstrated.

(*b*) *Digestibility of Apple Pomace.*

The value of a feed cannot always be measured by its composition. A food is valuable as a source of nutrition only in so far as its various constituents can be digested and assimilated. This station has made two different experiments to ascertain the digestibility of the pomace, and the detailed results are to be found in the seventeenth report of this station. The summary follows:

Digestibility of the Pomace (Per Cent.)

	Number of Single Trials.	Dry Matter.	Ash.	Protein	Fiber.	Extract Matter	Fat.
Apple pomace (first experiment), . .	3	72.5	54.7	—	61.6	84.5	47.2
Apple pomace (second experiment), .	3	70.6	42.8	—	67.3	84.3	43.4
Average, . .	6	71.5	48.7	—	64.4	84.4	45.3
Dent corn silage (for comparison). .	17	64.0	—	52.0	62.0	69.0	85.0
Flint corn silage (small varieties), . .	11	75.0	—	65.0	77.0	79.0	82.0

The above figures mean that 71.5 per cent of the total dry matter, 64.4 per cent. of the total fiber, etc., contained in the pomace are digested. The total dry matter in apple pomace is shown to be about as digestible as in the best grades of silage. The protein content of the pomace is small—about 1 per cent—and it has not been possible, by present methods, to ascertain its digestibility. *Judging from the composition and digestibility of the pomace, one would feel justified in assuming that, pound for pound, it should approach in feeding value an average quality of corn silage.*

(*c*) *Experiments with Dairy Animals.*

While this station has not carried out any exhaustive comparative tests with pomace and other coarse feeds, it has fed the pomace a number of seasons to dairy animals. The material was drawn fresh from the mill, and placed in a large pile under cover. A noticeable quantity of juice gradually drained from it, but it kept in good condition for two months. The animals received from 15 to 30 lbs. daily, ate it readily, and the results were quite satisfactory. In one case two cows were fed alternately, four weeks at a time, on grain and hay, and on grain, hay and pomace; 25 pounds of pomace were compared with 5 pounds of hay. During the pomace period the animals produced 1,153 pounds of milk, and gained 24 pounds in live weight; during the hay period 1,138 pounds of milk and lost 6 pounds in weight. On this basis 5 pounds of pomace were more than equivalent to 1 pound of hay. Judging from this feeding test, and from the composition and digestibility of the pomace, it seems probable that every 4 to 5 pounds, when fed in what is termed a "balanced ration," would be equal in feeding value to 1 pound of good cow hay.

The Vermont Experiment Station has fed apple pomace for four years, using in all 20 cows for the several trials. The pomace was shoveled into the silo, leveled off and kept in good condition without further care. In some cases it was placed on top of the corn silage after the latter had settled. The quantity fed varied from 10 to 35 pounds daily, with no unfavorable effects. As a result of the several experiments, the Vermont station concludes that the pomace is equivalent in feeding value to an equal weight of average corn silage,* and that it is without injurious effect on the flavor of milk and butter.

(*d*) *How to Feed the Pomace.*

Farmers are cautioned not to feed too large quantities at first, but to begin with 10 pounds daily, and to gradually increase the quantity to 30 pounds, taking a week or more in which to do it. In this way danger of a sudden milk shrinkage or of the animals getting "off feed," as is sometimes reported, may be avoided. Judging from all the data available, it is believed that farmers living in the vicinity of cider mills will find it good economy to utilize the pomace as a food for their dairy stock, dry cows, steers and sheep.

As roughage for mature cows or steers, 30 pounds pomace may be fed, or 15 pounds pomace and 15 pounds of corn silage, together with what hay the animal will eat, which will usually be from 10 to 16 pounds daily In addition, 5 to 10 pounds of a grain mixture will be necessary for dairy cows, the amount depending upon the size of the animal and her milk yield.

Some desirable grain mixtures for dairy animals to be fed with roughage:

I

100 pounds bran,
100 pounds flour middlings,
100 pounds gluten feed.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

II.

100 pounds bran,
100 pounds corn or hominy meal,[1]
100 pounds cottonseed meal.
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

III.

100 pounds wheat bran,
200 pounds gluten feed,
35 pounds cottonseed meal.
Mix and feed 7 pounds (7 quarts) daily.

IV.

100 pounds wheat bran or malt sprouts,
100 pounds corn or hominy meal,
150 pounds gluten feed.
Mix and feed 7 pounds (or quarts) daily.

* There is doubt in the mind of the writer whether pomace would prove equal to well-preserved and well-eared corn silage. It certainly would approach it in feeding value and ought to be fully utilized.

[1] Corn and cob meal, if on hand, can be used in place of corn or hominy meal.

V.

75 pounds wheat bran,
150 pounds corn and cob meal,
100 pounds cottonseed meal.
Mix and feed 6 to 7 pounds (7 quarts) daily.

VI.

100 pounds distillers' grains,
100 pounds malt sprouts,
150 pounds corn meal,
50 pounds cottonseed meal.
Mix and feed 7 pounds (7 to 8 quarts) daily.

VII.

150 pounds distillers' grains,
150 pounds standard middlings,
100 pounds corn or hominy meal.
Mix and feed 7 pounds (or quarts) daily.

VIII.

150 pounds wheat bran,
200 pounds gluten feed.
Mix and feed 7 pounds (8 to 9 quarts) daily.

IX.

200 pounds dried brewers' grains,
100 pounds corn meal,
50 pounds cottonseed meal.
Mix and feed 7 pounds (9 quarts) daily.

X.[2]

300 pounds bran,
100 pounds flour middlings,
100 pounds corn meal,
100 pounds ground oats,
300 pounds gluten feed,
100 pounds linseed meal.
Mix and feed as desired.

XI.

1.5 pounds gluten feed,
1.5 pounds cottonseed meal,
4.0 pounds dried beet pulp.[3]

XII.

3 pounds distillers' grains,
4 pounds dried beet pulp.[3]

The cost of a pound of the several mixtures is likely to vary from 1.4 to 1.6 cents. It is believed that the above selections are more economical on the basis of their content of nutritive material than most of the sugar feeds and other proprietary mixtures.

In general, it may be said that the *amount of grain* to be fed daily depends (a) upon the size of the cow, (b) daily milk yield, and (c) the local market value of the milk. The richer the milk, the more food is required to produce a given amount, and *vice versa*.

Six to seven pounds of the above mixtures is a fair average amount for cows weighing 800 to 900 pounds, which are yielding 10 quarts of 4 to 5 per cent milk. For every two quarts of milk yielded in excess of this amount the grain ration may be increased by one pound.

[2] Ration designed for cows on test; rather expensive for ordinary purposes.

[3] Beet pulp should be moistened with two or three times its weight of water before feeding.

CIRCULAR NO. 59. DECEMBER, 1915.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION
AMHERST.

THE USE OF FERTILIZERS IN 1916.

WILLIAM P. BROOKS

The directors of the Agricultural Experiment Stations in the New England States, New York and New Jersey have recently held a meeting for the discussion of the present situation as affecting the use of fertilizers. At this meeting it was decided to make certain fairly definite suggestions, each director to present the subject with due regard to special local conditions. The following suggestions embody the substance of the points agreed upon except that in a few instances special reference is made to conclusions based chiefly upon results obtained in this Experiment Station and not, perhaps, generally supported.

The person planning his use of fertilizers for next season confronts a peculiarly difficult situation. Neither potash salts nor basic slag meal which have been coming to us from Europe can be imported and neither can be purchased except for prices practically prohibitive. Nitrate of soda has advanced sharply in price on account of its extensive use in the manufacture of explosives and the excessively high ocean freight rates due to the scarcity of shipping and the blocking of the Panama Canal. Acid phosphate is also much higher than in recent years on account of the heavy demand for sulfuric acid, essential in its manufacture, in the production of munitions of war. Most other materials have advanced in sympathy and all mixed fertilizers are necessarily higher and contain little or no potash.

Under these conditions it becomes especially important to adopt such general measures as will reduce so far as possible the necessity for purchased fertilizers.

MEASURES FOR LESSENING THE NEED FOR FERTILIZERS

Among such measures some of the more important may be mentioned and briefly discussed.

1. Selection of the Soil

No good farmer is satisfied to follow a system which means that his soils are growing poorer, but during the ensuing season fertilizer potash will be practically unobtainable while other materials will be high. In order, therefore, to reduce the necessary expenditure for fertilizer so far as possible and at the same time not to run undue risk of crop failure, it will manifestly be good policy to grow hoed crops chiefly on the better soils. In deciding which are the better, we must consider both natural characteristics and previous treatment. The heavier soils are in general stronger than the lighter. It is especially important to remember that they contain more total and usually also more available potash. The soils rich in organic matter stand least in need of manure or fertilizer nitrogen. The soils that have recently been well manured or fertilized will carry crops through a period of temporary fertilizer shortage better than those less liberally treated. Freshly broken up grasslands, especially if clover has constituted a considerable proportion of the herbage, and recently reclaimed soils will, other things being equal, furnish more available food to a hoed crop than fields long under cultivation.

2. Increasing the Availability of Soil Constituents

Most soils contain large enough quantities of the important plant food elements for good crops for many years, but as a rule only a small proportion of these elements is in available forms. This is especially true of potash which is locked up in enormous quantities in most of our soils and subsoils.

There are two distinct lines of treatment which may help bring inert soil constituents into available forms, namely tillage and the use of indirect fertilizers.

Tillage. Thorough tillage should be mentioned first. It is within the reach of all. Deeper plowing and more careful harrowing, more perfect pulverization of the soil for the production of a better seed-bed, and better care of the crop while growing mean that the plant's needs will be more largely met by the soil itself, for all these measures favor changes which render naturally inactive soil constituents more available, and the amount of such constituents in most soils is relatively large.

Indirect Fertilizers. There are a number of materials, some of them not in themselves usually important as direct sources of plant food and others which are of value as direct sources of plant food, which exercise an indirect effect upon the soil favorable to an increase in the availability of some of its constituents. Among the more important of these may be mentioned lime in its different forms, land plaster, common salt, soda ash, nitrate of soda and acid phosphate. Under existing conditions it is a matter of the greatest importance that we consider to what extent the use of these materials may bring inert soil constituents within the reach of the plant.

(a) Lime

Lime is without doubt one of the most important of the indirect fertilizers. It sweetens sour soils, promotes decay of organic matter, hastens the availability of the plant food such matter contains, and increases the activity of beneficial soil organisms; it improves the physical condition of heavy soils, and it is usually asserted that it helps make the naturally inert potash of the soil more available. To what extent it will do this seems, however, to be a question, and the experiments in this station indicate that in the lighter and medium soils at least lime does not by any means take the place of potash application.

(b) Land Plaster

Authorities have usually claimed that land plaster as well as lime increases the availability of soil potash, but experiments in this station indicate that its activity in that direction is not materially greater than that of lime. The use of plaster cannot render application of potash unnecessary.

(c) Common Salt

It is claimed in some quarters for this material also that it will increase the availability of the soil potash. It is probably worth trying for that purpose. This station has no direct evidence bearing upon this question. It is pointed out, however, that the chlorine which is a constituent of common salt will undoubtedly increase the loss of lime from the soil, and the writer believes that it may also exert an unfavorable influence upon the quality of potatoes and perhaps render plants more susceptible to frost injury and winterkilling.

(d) Soda Ash

Soda ash may help sweeten a sour soil and may possibly somewhat decrease the necessity for the addition of potash, but the supply is small and the price high.

(e) Nitrate of Soda

Nitrate of soda, as is well understood, is one of the most valuable nitrogen fertilizers. Some authorities assert that where this material is used as a source of nitrogen the use of potash as a fertilizer is rendered either entirely or in part unnecessary. The authority for this statement is so good that it does not seem possible to doubt that nitrate of soda is useful in the direction indicated, but that the employment of this material will render potash fertilization unnecessary is not supported by the experimental work of this station.

(f) Acid Phosphate

Good authorities assert that acid phosphate favors the activity of beneficial soil organisms, that it indirectly favors the assimilation of atmospheric nitrogen, and that as a result of its use the availability of soil potash is increased. The latter effect is supposed to be due to the calcium sulfate (land plaster) which acid phosphate contains. Experimental work at this station shows clearly that on our medium soils the effect of acid phosphate upon potash availability is by no means great.

In conclusion upon this topic, it is urged that while it is not believed that the use of the materials under consideration can be made to entirely take the place of potash fertilization, it is nevertheless worthy of consideration. The cheaper of these materials should undoubtedly be more freely used than under ordinary conditions.

3. More Careful Conservation and Utilization of All Home Resources.

Animal Manures. These, of course, should be carefully saved and used at all times. They should be so handled as to prevent undue heating in loose piles for this means loss of ammonia. Especially at this time when potash from other sources cannot be obtained at reasonable cost, all loss of urine should be prevented, for this contains about four-fifths of the total potash of the excrements as well as a large amount of nitrogen. Exposure to rains in piles or small heaps means the washing out of soluble constituents—chiefly nitrogen and potash. The use of acid phosphate scattered over the manure at the rate of about a pound per day for each horse or cow may sometimes be advisable as a means of preventing loss of ammonia.

Attention is called to the fact that the earth beneath leaky stable floors absorbs and retains most of the potash from the urine which passes through, and if the stable has been long used, this earth may be richly worth removal. The same may be true of the surface earth of open yards or pens in which manure has accumulated for some time. It may be worth while to remove a few inches, or at least to scrape them much closer than usual. The same may be true of the earth below manure heaps and composts.

Well-saved manure carries per ton about the following amounts of the chief plant-food constituents:

Nitrogen	10 pounds
Phosphoric acid	7 "
Potash	10 "

The weight of a cord varies from about two to three tons. An ordinary two-horse cartload of cow manure weighs about a ton. Since manure must apparently in most cases be the chief source of potash for next season, it is apparent that when possible some manure should be applied to all land which is to be planted to hoed crops unless it is known that the soil is already well supplied with that element. Moderate manuring and some

fertilizer for all should be the rule rather than heavy manuring without fertilizer for some and exclusively fertilizer for others.*

Refuse Organic Materials. All refuse vegetable matter has a manurial value and many kinds are particularly rich in potash. A ton of dry corn stover, at the present prices for potash salts, contains nearly ten dollars' worth of that element. Tobacco stems are still richer, while the stems and tops of all crops and weeds of many kinds are also rich in that element. Under existing conditions it will pay unusually well to gather and utilize all materials of this class, weeds carrying ripe seeds perhaps excepted. Such weeds may be burned and their ashes utilized. Many of them can be used as bedding in stables and pens where animals are kept. If, as in the case of corn stover, they have a food value, the potash they contain may be practically all recovered in the animal excrements, provided the urine is carefully saved. Vegetable materials not fitted for use as bedding or the feed of live stock may be plowed or otherwise worked into the soil, or may be first made into compost.

Wood Ashes. These will be unusually valuable this year. They will help sweeten sour soils as they contain a large proportion of carbonate of lime and other alkalies, and they supply potash. Save all that are made upon the farm or in the house and buy wherever possible at a reasonable price. House to house purchase in one's own neighborhood may be advisable in localities where wood is much used as fuel. Remember that leaching removes most of the potash of ashes. Local lime and brick kilns should not be forgotten. Ashes from these are lower in potash than house ashes, but are well worth looking for.

Green Manuring. Green manuring may to some extent reduce the necessity for the application of fertilizers. It is sometimes valuable in preventing erosion; it may reduce the loss of soluble plant food by leaching; it may increase the availability of soil constituents by direct action of the feeding roots and by the fermentation of the crop when incorporated with the soil; and if a legume is selected, it may increase the stock of soil nitrogen by acquisition from the air. It is now too late to undertake green manuring for hoed crops of next year, but its advantages should be kept in mind.

Kelp and Seaweed. These are particularly valuable as sources of nitrogen and potash, and under existing conditions those living near the seaboard can well afford to incur a heavier expense in collecting and applying these materials than in years when fertilizers can be more cheaply obtained.

FERTILIZER SOURCES OF PLANT FOOD

1. Nitrogen

Nitrate of soda is the most immediately available source of nitrogen and is especially important for crops whose early growth is chiefly at low temperatures and on soils deficient in potash, since the soda it contains will somewhat reduce the amount of potash taken by the plant.

On soils not deficient in lime sulfate of ammonia is a good source of nitrogen, although its action is not quite so immediate as that of nitrate.

Cyanamid, at present prices one of the cheapest quick-acting nitrogen fertilizers, is also a good source of that element. Because it contains lime it may be especially adapted for use on acid soils; but for the same reason it is likely to cause loss of ammonia if mixed with sulfate of ammonia or organic

*Farmers' Bulletin 192 on "Barn Yard Manures" can be obtained of the United States Department of Agriculture, Washington, D. C.

materials such as blood or tankage, and if mixed with acid phosphate it may decrease the solubility of the phosphoric acid. It does not appear to be best to use it in mixtures in excess of about 200 pounds to the ton, and if applied in fairly liberal quantities by itself, it should if possible be incorporated with the soil a few days before the seed is planted.

Vegetable sources of nitrogen such as cottonseed meal and castor pomace are exceptionally high in price, but it is well to remember that besides nitrogen they furnish some potash and phosphoric acid.

Blood and tankage are good sources of nitrogen.

For a single application to long-season crops, a combination made up of about one-third each of nitrate of soda, either cyanamid or sulfate of ammonia, and either cottonseed meal or tankage is likely to be satisfactory.

2. Phosphoric Acid

The use of fine ground rock phosphate is not recommended for general application and certainly not for quick returns, and there appears to be no conclusive evidence that mixing it with manure as is sometimes advised increases its availability.

The phosphoric acid of bone and tankage is much more available than that of rock phosphates, but acid phosphate is the most quickly available source of phosphoric acid and must be chiefly depended upon as a source of that element for general crops. The high price at which it is now held suggest the advisability of unusual care in its use. It should not be forgotten, however, that a fairly liberal use of a fertilizer supplying soluble phosphoric acid seems to promote early root development, rapid growth of the crop and relatively early and perfect ripening. Because of its effect upon early root development it may have an important influence on the extent to which the plant is able to draw upon the soil itself for food.

3. Potash

It should be remembered that no complete substitute for potash is known. Fine ground feldspar as a source of potash cannot be recommended as the potash which it contains is not available and, so far as known, there is at present no practicable method, economically speaking, of rendering potash from this source accessible to the crop.

Wood ashes in most localities seem likely to be the only material that can be purchased to supply potash, but the percentage of that element in these, on account of the unusual demand, is likely to run low, and they should be purchased only on guarantee.

4. Mixed Fertilizers

The mixed fertilizers offered in the market this year, according to the announcements of a number of the more prominent manufacturers, will include brands showing the following variations in plant food:

Ammonia	from 1	to	6	per cent
equivalent to				
Nitrogen	" .8	"	4.95	"
Available phosphoric acid	" 8	"	10	"
Potash	" 0	"	1	"

SUGGESTIONS FOR DIFFERENT CROPS

1. Top-dressing Grasslands

Where market hay relatively free from clover is desired, an application furnishing nitrogen alone is probably advisable this year, since potash can-

not be obtained and phosphoric acid is unusually high in price. One to two hundred pounds of nitrate of soda or of cyanamid, or of a mixture of equal quantities of the two, or a similar mixture of nitrate of soda and sulfate of ammonia, or about one hundred to one hundred and fifty pounds of sulfate of ammonia alone, seem likely to prove as satisfactory as anything.

For mowings where clover is desired, or for clover and alfalfa, among different materials which can be obtained ashes will prove best suited, and if pure wood ashes are not obtainable, those from lime or brick kilns may prove the next best material.

2. Corn

Experiment stations have long taught that the farm manures under ordinary conditions should be largely used for the corn crop. Ten tons of good manure will carry:

100 pounds of nitrogen,
66 " " phosphoric acid,
100 " " potash.

With this it will usually be advisable to use a very little quick-acting nitrogen and some acid phosphate or, if preferred, about 300 to 500 pounds of a mixed fertilizer containing about:

2.5 per cent nitrogen and
10 " phosphoric acid.

3. Potatoes, Root Crops and Vegetables

If available, it is advisable to use manure on account of its potash content, and about six to eight tons well worked into the soil may be recommended. With this should be used about 500 to 600 pounds of a mixed fertilizer containing:

2.5 per cent nitrogen and
8–10 " phosphoric acid.

If no manure is available, it is recommended to apply wood ashes broadcast for all these crops, except potatoes on soils which are neutral or alkaline. It is believed that wood ashes may be safely used for potatoes up to about 1000 pounds per acre on the majority of our soils which are decidedly acid if put on broadcast and worked into the soil a little in advance of planting. In connection with ashes, from 1000 to 2000 pounds of a mixed fertilizer containing about:

4.1 per cent nitrogen and
8–10 " phosphoric acid,

can be recommended; or in place of it a mixture of chemicals supplying similar amounts of plant food.

4. Spring-sown Cereals or Top-dressing Winter Cereals

Except on the richer soils, the use of from 300 to 500 pounds of mixed fertilizer containing

4.1– 5 per cent nitrogen and
8 –10 " phosphoric acid,

is likely to give a profitable increase of crop, or in place of such mixed fertilizer, a combination of chemicals, including a considerable proportion of nitrate of soda for nitrogen, which will supply similar amounts of plant food.

5. Orchards

It is doubtful whether fertilizer can profitably be used to any great extent on orchards this year unless it be for those standing in grass. If the

orchard can be well tilled and a system of growing cover crops is followed, many soils produce satisfactory growth and fruitfulness without fertilizer. The use of 75 to 100 pounds per acre of nitrate of soda for peaches on the lighter and poorer soils may constitute an exception.

THE PURCHASE OF FERTILIZERS

1. Secure quotations and guarantees from several responsible parties and buy for cash if possible.

2. Remember value is fixed by food content, not by weight, and make sure you get the maximum for money spent.

3. At current prices very cautious use of fertilizers must be the rule, but a relatively liberal expenditure is a necessity for crops of high money value per acre and those requiring heavy outlay for labor. For these, even at present prices for potash, it may be good policy to purchase something to supply that element in all cases where experience indicates it to be important.

SUMMARY

1. The fertilizer situation in 1916 is peculiarly difficult because:—

a. Potash salts cannot be purchased at a price which farmers can afford to pay.

b. Nitrate of soda and acid phosphate are exceptionally high because of the war, the scarcity and high price of coastwise freights, and the blocking of the Panama Canal.

c. Most other materials have advanced in price in sympathy.

2. The farmer under these conditions should adopt all possible means for lessening the need for commercial fertilizers. Among such measures are the following:—

a. Putting all hoed crops upon the better soils.

b. Adopting all possible means of increasing the availability of inert plant food found in the soil, including:—

(a) Better and deeper tillage, and drainage where needed.

(b) Use of indirect fertilizers such as lime, land plaster and common salt which may help make soil potash available. It should be remembered that nitrate of soda and acid phosphate besides serving as direct fertilizers may also help render soil constituents available.

3. Unusual care in saving and applying farm manures.

a. Prevent escape of urine which means loss of potash, heating which means loss of ammonia, and leaching which means loss of all soluble constituents.

b. Apply some manure to all cultivated land.

4. Organic refuse.

a. Carefully save all refuse vegetable materials. These are chiefly valuable for the potash they contain.

b. If fitted for such use, employ such material as bedding; otherwise, incorporate directly with the soil.

5. Wood ashes.

These, if of good quality, will be unusually valuable for the potash they carry. Gather from all possible sources and purchase wherever available at reasonable prices.

6. Green Manuring.

Should the war continue another year, this would be especially worth consideration.

7. Kelp and seaweed will be worth more than usual on account of the potash and nitrogen they carry.

8. Fertilizer sources of plant food.

a. Nitrogen.—Nitrate of soda is the most quickly available source of nitrogen and may also help reduce the necessity for potash. Sulfate of ammonia and cyanamid are good sources of nitrogen, the latter the cheapest; while organic materials such as tankage and cottonseed, though high, may be necessary in connection with those already named.

b. Phosphoric acid.—Acid phosphate whether by itself or in mixed fertilizers is the most quickly available and generally best adapted to the needs of our agriculture, since basic slag meal cannot be obtained. Fine ground rock phosphates cannot be advised, but the phosphoric acid in fine ground bone and tankage is valuable though much slower in action than that in acid phosphate.

c. Potash.—It should be remembered that there are no thoroughly satisfactory potash substitutes. Fine ground feldspar cannot be recommended. Wood ashes of different kinds are at present the only important available source of potash, although the vegetable ammoniates such as cottonseed meal and castor pomace contain a moderate amount of that element.

d. Mixed fertilizers both with and without potash will be offered, but the maximum of that element will probably be 1 per cent. It is not thought that these goods in the quantity in which they can generally be employed will furnish sufficient potash to be of much value to the crop, while it will necessarily add materially to the cost of the fertilizer. The mixed fertilizers on the market are most of them practically ammoniated superphosphates, supplying nitrogen and phosphoric acid in varying proportions and combinations.

9. Suggestions for different crops.

a. For grasslands where clover is not particularly desired, for this year, materials furnishing nitrogen chiefly or exclusively; nitrate of soda, sulfate of ammonia and cyanamid being among the best. A combination of the first and third has sometimes given exceptionally good results. Quantity of this mixture or any of the single materials, 100 to 200 pounds per acre. If phosphoric acid also is deemed necessary, a highly nitrogenized commercial brand may be desirable.

b. Top-dressing clover and alfalfa.—Wood ashes if obtainable are probably best under the peculiar conditions now existing.

c. Corn.—Use manure and 300 to 500 pounds of a fertilizer carrying 2½ to 3 per cent of nitrogen and about 10 per cent available phosphoric acid.

d. Potatoes, root crops and vegetables.—Use some manure if available and in connection with it 500 to 600 pounds of a mixed fertilizer containing about 2½ per cent nitrogen and 8 per cent phosphoric acid. If ma nure is not available and the soil is strongly acid, broadcast 800 to 1000 pounds of wood ashes and use 1000 to 2000 pounds of mixed fertilizer containing about 4 to 4½ per cent nitrogen and 8 to 10 per cent phosphoric acid, or a mixture of chemicals which will furnish equivalent plant food.

e. Oats, barley and spring top-dressing winter grain.—Except on soils made rich by heavy applications to previous crops, 300 to 400 pounds per acre of mixed fertilizer containing about 4 to 5 per cent nitrogen and 8 to 10 per cent phosphoric acid, or a mixture of chemicals made up chiefly of nitrate of soda and acid phosphate, supplying about 100 pounds of the former to 200 of the latter.

f. Orchards.—Chief dependence this year should be placed upon tilage where practicable. A little nitrate of soda may be useful on the poorer soils and where orchards stand in grass.

Bulletin 162 on Phosphates in Massachusetts Agriculture, Circulars on Green Manuring, on the use of Lime and on the Selection of Fertilizers for our leading crops will be sent on application. Address, Experiment Station, Amherst, Mass.

CIRCULAR NO. 60 FEBRUARY, 1916

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST.

Suggestions for the Use of Fertilizers for Tobacco and Onions for 1916.

H. D. HASKINS.

The unusually large number of requests from local farmers for suggestions and advice in relation to the use of fertilizers for tobacco and onions has warranted the publication of this circular.

It is evident that the tobacco and onion growers are confronted by unusual conditions. The extremely wet season of last summer must have modified soil conditions by the elimination of much of the soluble nitrogen and potash, as well as numerous other soluble plant food residues which the soil contained. The washing out of these saline substances, which had accumulated during the past several years due to the lack of a normal rainfall, is likely to benefit materially large areas of tobacco land, altho in all probability it will be necessary to supply available nitrogen somewhat more liberally than during the past few years. Potash is not as readily leached out of the soil as nitrogen, yet from analyses made of tobacco soils collected late in the fall of 1915 it would seem that considerable soluble potash had been lost. It is felt, however, that old tobacco soils are sufficiently well stocked with potash to grow good crops for a few seasons without any additional potash application.

The fertilizer manufacturers have decided upon a maximum of 2 per cent potash in mixed fertilizers; the majority of the brands, however, are guaranteed to contain only 1 per cent for which $5.00 a unit is charged; many of the companies are not offering potash in any of their mixed goods.

Fertilizers for Tobacco.

In fertilizing for tobacco the usual practice has been, up to the time of the scarcity of potash in this country, to use each year about 3,000 pounds per acre of a formula testing 4.50 per cent nitrogen, 3 per cent available phosphoric acid and 5.50 per cent potash, this amount

having been used by some of the best growers—with 5 cords of manure every other year. In recommending a fertilizer formula for any crop it is realized that it is impossible to compound one that will answer equally well for all conditions, as each farm and sometimes each field is an individual problem. It is felt, however, that a formula may be recommended that will answer in many cases, changes and substitutions to be made to fit individual conditions.

The following recommendations are made with the understanding that the tobacco stalks from healthy tobacco (plants suffering from calico and other diseases being rejected) be cut into short lengths, returned to the land acre for acre and thoroughly disked in previous to plowing.

Formula No. 1.

To be used with 10 tons of manure per acre.

200 pounds ammonium sulfate, or a like amount of calcium cyanamid,
1700 " cottonseed meal (6.50 per cent nitrogen),
500 " acid phosphate (16 per cent grade).

This formula will test about 6.6 per cent nitrogen, 5 per cent available phosphoric acid and 1 per cent potash.

Formula No. 2.

To be used per acre without manure.

200 pounds ammonium sulfate, or a like amount of calcium cyanamid,
2000 " cottonseed meal (6.50 per cent nitrogen),
300 " fish or concentrated tankage,
600 " acid phosphate (16 per cent grade).

This formula will test about 6.9 per cent nitrogen, 6 per cent available phosphoric acid and 1 per cent potash.

In the above formulas 300 to 400 pounds of castor pomace may be substituted for a like amount of cottonseed meal if desired. Precipitated bone may be used in place of acid phosphate in amounts to furnish about the same phosphoric acid. Either of the two formulas are recommended for old tobacco land. On new land formula No. 2 may be used with a medium application (8 to 10 tons) of manure per acre.

Lime for Tobacco.

The results of many chemical tests on tobacco soils during the past year, taken according to directions from this laboratory, have indicated

that *altogether too much lime has been used for tobacco in the past.* Similar conclusions may be drawn from an experiment which was conducted on a tobacco farm in Sunderland, Mass., where the various lime products were tested to show their effect upon the growth and quality of tobacco. It is believed that lime should be used sparingly on old tobacco land, and when used it should be for the purpose of controlling the quality of the crop. Probably new land should receive a medium application of agricultural lime, in order to produce the proper quality of leaf.

Fertilizers for Onions.

Formula No. 1.

To be used on old onion land; soil rather heavy; amount given sufficient for 1 acre.

250 pounds nitrate of soda,
200 " ammonium sulfate,
300 " 9 per cent tankage,
1250 " 16 per cent acid phosphate.

This mixture would analyze about 5.2 per cent nitrogen and 11 per cent available phosphoric acid. In addition to the above it is recommended that when the onions get to be 3 or 4 inches high a mixture of 125 pounds of nitrate of soda and 200 pounds of fine ground fish or tankage be used as a top-dressing per acre. This should be scuffled or cultivated in.

Formula No. 2.

To be used on medium or lighter soils; amount given sufficient for 1 acre.

200 pounds nitrate of soda,
150 " ammonium sulfate or a like amount of calcium cyanamid,
500 " concentrated tankage or fish,
1150 " 16 per cent acid phosphate.

This formula would test about 5.2 per cent nitrogen and 10.5 per cent available phosphoric acid.

In addition to this it may be necessary to use a top-dressing as recommended in the previous formula. If it is felt that the soil is deficient in potash, even tho the soil may be heavy in character, 1000 to 1500 pounds of wood ashes may be used per acre, in which case lime need not be used.

Lime for Onions.

It is felt that lime can be used on onions a good deal more freely than on tobacco, and if a soil is inclined to be of an acid character it certainly should receive a liberal lime application. The hydrated or slaked lime usually will be found best on the heavy types of soil, while on the lighter soils the more mild forms, such as marl, precipitated lime or finely ground limestone will prove more suitable. Certain ground limestones are now offered in very fine mechanical condition, and in this fine state their activity is very much improved.

General Suggestions.

It may be felt by many that in the fertilizer formulas given in this circular a pretty liberal amount of nitrogen and phosphoric acid has been recommended. The formulas, of course, can be varied to suit individual conditions, and the amount used per acre may be reduced if it is felt that the soil is already in a very high state of fertility. It is felt, however, that it is necessary in growing both tobacco and onions that the crop have a sufficient amount of available plant food to make a rapid, constant growth.

It is needless to say that whenever the grower feels so inclined mixed commercial fertilizers may be used in place of the formulas given and in amounts to furnish about the same proportion of plant food. In fact it is felt that during the present season it is possible in many instances to buy plant food as cheaply in the form of mixed goods (on a cash basis) as in raw materials and chemicals, the latter being offered at unusually high prices.

CIRCULAR No. 61. (Revision of No. 43) FEBRUARY, 1916.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

CUTWORMS.

BY H. T. FERNALD, PH. D.

The general term "Cutworms" refers to the caterpillars of the Noctuids or owlet moths, but all Noctuid caterpillars are not necessarily cutworms. There are two classes of cutworms, those which feed on weeds, vegetables, and flowers, which are the ones here treated, and those which feed on the leaves and buds of trees, which are not usually abundant enough in Massachusetts to cause serious injury.

The cutworms attack almost any succulent and juicy plant, such as grass, clover, corn and wheat, garden vegetables and flowering plants.

LIFE HISTORY. The moths lay their eggs, 200-500 in number, in masses of rank vegetable growth, usually on the stalk, though sometimes on the leaves. This occurs about the last of August or the first of September and about the last of September or the first of October the young caterpillars begin to feed on the plant upon which the eggs were laid. After they have grown to about three-fourths of an inch in length, they go into a dormant state for the winter in the ground and remain there until spring. They then come to the surface and eat whatever plant food they may find until full grown, this being generally between the last of June and the last of July. The following features are possessed by nearly all the species and by these they may be recognized. They are from 1 1-4 to nearly 2 inches in length; have sixteen feet, the three anterior pairs being sharp, the five posterior pairs blunt and stout and armed with minute hooks for clasping; they have the appearance of being stout with an inclination to taper at both ends and they are usually dull-colored, greasy-looking, dingy-brown, gray or greenish, with some light and dark longitudinal lines and sometimes with oblique dashes. The head is large, shiny and usually of a red or reddish brown color. The first ring or collar bears a darker colored, shiny, horny plate as also does the last segment of the body.

When full grown the caterpillars cease feeding and work their way into the soil for a depth of four to six inches, and there form an oval cell by rolling and twisting about until it is smooth and compact and then change to brown, conical pupae.

Usually in July and August, the moths emerge from these pupae and fly at night feeding upon the nectar of flowers and other sweet exudations from trees or plants.

The life history of this insect is completed about the last of August when the eggs are laid for the new generation.

HABITS. The presence of cutworms becomes noticeable in a field as soon as the plants are set out or when the seeds have begun to sprout. Plants all through the field will have fallen or will have disappeared. If examined they will be found to have been cut off at the surface or a little below the surface of the ground by the cutworms and this injury continues until the worms are full grown.

ENEMIES. Because of their large size and hairless bodies these insects are an easy pray to many enemies. The robin is especially effective as it destroys more than any other bird. Poultry, especially chickens, destroy many of them and if trained to follow the plow they will do effective work. The beetle larvae known as the cutworm lion and the cutworm dragon, as well as the toad, help much to keep this insect pest in check.

REMEDIES. There are two kinds of remedies to be applied to this insect; preventive and destructive. Of the former *clean culture* is the most important. As the moths usually deposit their eggs in rank growth, it is advisable where the land is not seeded down to keep it clean and not let it grow up to weeds. Fall plowing will in many cases prove quite beneficial, provided it is done early.

If on preparing a field for planting any crop liable to attack, cutworms are noticed as abundant, complete the preparation of the field, then spray some clover heavily with Paris green, and then cut the clover and scatter it here and there over the field. The cutworms coming up after food will feed on this and be poisoned.

After a crop is in a different treatment is necessary. In such cases prepare a bran mash made of fifty pounds of bran or middlings, one pound of Paris green, two quarts of molasses to sweeten, and water to make a dough or mash. Place a little of this at the base of each plant in the latter part of the afternoon, and keep fowls away. The cutworms coming up to feed at night will find in this mash a food they prefer, because of its sweetness, to the plant stem and will feed on it instead. In this way nearly all of these pests will be destroyed and it is not often necessary to repeat this treatment.

A recently discovered and very effective modification of this last method of control is as follows. Take 20 lbs. of coarse flaked bran, 1 lb. of Paris green, 2 quarts of molasses, and 6 oranges or lemons. Stir the molasses into a gallon of water; add the juice of the fruits and their rinds finely chopped; stir in the Paris green and bran, adding enough more water to make into a dough dry enough so it can be spread broadcast by hand, and spread the whole over the field at or after sunset. The success of this method is largely dependent upon getting the fruit flavor and some of the Paris green on each flake of the bran, making these flakes both attractive and poisonous to the cutworms; therefore mix thoroughly. The amount given above should be enough to cover from 3 to 5 acres.

In gardens considerable protection may be obtained by sinking a stiff paper cylinder into the ground around the stem of each plant.

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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST.

Beet Residues for Farm Stock.

BY J. B. LINDSEY.

1. DRIED BEET PULP.

Dried beet pulp represents the residue in the manufacture of sugar from sugar beets. It is first run through presses to reduce its water content as much as possible, and then put into kilns where it is thoroughly dried by direct heat. It is coarse and of a gray color.

Molasses beet pulp is the pressed plain pulp mixed with the residuum beet molasses and dried. It is said that another method of making molasses pulp consists in mixing a definite amount of molasses with the dried plain pulp.

Composition of Beet Pulp.

	Plain Pulp.	Molasses Pulp.	Corn Meal for Comparison.
Water,	9.08	8.48	11.00
Ash,	3.02	6.93	1.30
Protein,	8.90	11.16	9.80
Fiber,	18.76	10.16	2.00
Extract matter,	59.59	62.76	72.00
Fat,	.65	.51	3.90
Total,	100.00	100.00	100.00

It will be noted that the plain pulp contains about 9 per cent of water, a relatively large amount of fiber, and practically no fat. In chemical composition it differs from corn meal in having much

more fiber, less extract matter and much less fat. The percentage of sugar present is small, the larger part of the extract matter being in the form of the hemi-celluloses. The molasses pulp contains considerably more ash, due to the large amount of mineral matter in the molasses. The fiber content is noticeably less than that of the plain pulp, due to the replacing of the pulp by the molasses, which is without fiber. They are, however, carbohydrate feeds of the same chemical type of composition as corn.

Pounds of Digestible Matter in a Ton.

	Protein.	Fiber.	Extract Matter.	Fat.	Totals.
Plain pulp,	92.56	311.42	1,005.79	—	1,409.77
Molasses pulp,	140.62	162.56	1,129.68	—	1,432.86
Corn meal for comparison,	132.00	—	1,322.00	70.00	1,524.00

The above figures show that a ton of the corn meal with substantially 11 per cent of water contains about 8 per cent more digestible organic nutrients than a ton of the plain beet pulp having 9 per cent of water. One would not expect, therefore, to note a marked difference in the effect of these several feeds when used as a component of grain rations intended for milk production.[1]

Beet Pulp as a Substitute for Corn Silage.

Wing[2] compared the wet pulp with corn silage, feeding 50 to 100 pounds daily, together with 8 pounds of grain and 6 to 12 pounds of hay, and concluded that the dry matter in the pulp was of equal value, pound for pound, with the dry matter found

[1] Calculations on the basis of net energy values show the plain pulp to have 30 per cent less energy than the corn meal. This is due to the inferior quality of the nutrients in the pulp, and, according to Kellner, to the extra energy required for its mastication. Kellner states that the dried pulp has about the same energy value as bran, but noticeably less than the cereals and oil cakes. Probably the larger the amount of dried pulp fed, the greater would be the difference in its feeding effect as compared with corn meal.

[2] Bulletin No. 183, Cornell Experiment Station.

in the silage. The milk-producing value of wet beet pulp,[1] as it comes from the factory, according to Wing, is, pound for pound, about one-half that of corn silage.

Billings[2] compared the dried pulp with corn silage, and concluded that the pulp ration gave 10.2 per cent more milk than did the silage ration; but, because of the cost of the dried pulp, it was more economical to feed silage. In his trial the cows receiving the pulp ration lost in flesh.

It is believed that 5½ to possibly 6 tons of silage is substantially equivalent in feeding value to 1 ton of the dried pulp. Under present conditions it is considered not to be good economy for farmers to buy pulp to be used in place of home-grown corn silage, the farm being the place for the production of carbohydrate food stuffs.

Dried Beet Pulp vs. Corn Meal.

At this station six cows were fed on a basal ration of hay, bran and cottonseed meal. In addition three of the cows averaged 4.3 pounds of plain pulp or molasses beet pulp, while the other three were receiving a like amount of corn meal. After a lapse of five weeks the conditions were reversed. The results may be briefly stated as follows:

Milk Yields (Pounds.)

Character of Ration.	Total Milk.	Daily perCow.	Total Fat.	Butter Equivalent.
Corn meal, ...	3,941.3	18.8	215 3	251.1
Plain pulp, ...	4,017.1	19.1	216.5	252.3
Corn meal, ...	4,184.0	19.9	233.4	272.3
Molasses pulp, . . .	4,054.0	19.3	220.6	257.3

[1] Only those living in the immediate vicinity of the factory can afford to use the wet pulp. It is worth not over $2 a ton on the farm.

[2] Bulletin No. 189, New Jersey Experiment Station.

The corn meal ration produced about 2 per cent less milk than the plain pulp ration. In the second trial the corn meal ration caused an increase of some 3 per cent of milk over the molasses pulp ration. From the above trials one may conclude that the corn meal and beet pulps as components of a ration had about the same effect.[1]

If the pulp can be purchased at slightly less per ton than the corn, it would prove economical for dairy animals.

The Feeding of Beet Pulp.

Dried beet pulp absorbs a great deal of water, and in case it is fed dry, this absorption will take place in the mouth and stomach, and is likely to cause choking, indigestion and stomach irritation. It should be first moistened with two to three times its weight of water, and the dry grain mixed with it.

Sample Daily Grain Rations Containing Dried Beet Pulp.
(*a*) *Dairy Cows.*

I.

3 pounds distillers' grains,
4 pounds dried pulp.

II.

1.5 pounds gluten feed,
1.5 pounds cottonseed meal,
4.0 pounds dried pulp.

III.

2 pounds gluten feed,
2 pounds flour middlings,
3 pounds dried pulp.

IV.

2 pounds wheat bran,
2 pounds cottonseed meal,
3 pounds dried pulp.

(*b*) *To Supplement Pasturage.*—By weight one-half of dried pulp and one-half gluten feed ; or one-third dried pulp, one-third gluten feed and one-third wheat bran ; or two-thirds dried pulp and one-third distillers' grains, would prove desirable combinations (feed from 3 to 7 pounds daily of the mixture, depending upon requirements).

[1] See foot note 1, bottom of page 2.

(*c*) *For Fattening Stock.*—It should prove satisfactory for fattening beef animals in the proportion, by weight, of one-third beet pulp, one-third corn meal and one-third cottonseed meal. The material is hardly to be recommended for swine and horses.

Dried Beet Pulp as Roughage.

As high as eight pounds of the dried pulp can be well moistened with water and fed to each animal as a partial source of roughage in place of corn silage, together with what hay the animal will eat clean (10 to 16 pounds daily). If thus fed, it naturally should be omitted from the grain ration.

The Place of Dried Beet Pulp in the Farm Economy.

Farmers who are in position to produce their own feed cannot afford, as a rule, to purchase starchy feedstuffs, of which dried beet pulp is a type. Such material should be produced upon the farm in the form of corn, oats and barley.

For milk production it is more desirable for the farmer to purchase materials rich in protein, such as cottonseed and linseed meals, distillers' and brewers' dried grains, gluten feed, malt sprouts, fine middlings and wheat bran. These feedstuffs are not only very helpful in milk production, but likewise supply increased amounts of nitrogen in the manure. Only when the supply of home-grown corn is exhausted or limited would it be considered economical to substitute dried beet pulp either as a portion of the grain ration or as a part of the roughage.

Milk producers who purchase all of their feed will find the dried pulp a satisfactory component of the daily ration, provided it can be secured at a relatively reasonable price.

2. BEET LEAVES.

Every autumn the station is in receipt of inquiries concerning the value of beet leaves for feeding purposes. In order to answer these inquiries the following information is submitted :

Composition and Digestibility.

The leaves have the following average composition :[1]

	Per Cent.
Water,	89.30
Ash,	1.80
Protein,	2.30
Fiber,	1.50
Extract matter,	4.70
Fat,	.40

From the above analysis it is evident that the leaves contain a great deal of water, and on the basis of dry matter are relatively rich in protein and ash, and poor in fiber. The leaves contain from 20 to 37.7 per cent of their nitrogen in the form of amids. The ash contains a large amount of oxalic acid (3.5 per cent of the dry matter), and in the extract matter varying amounts of dextrose and lævulose have been recognized.

According to F. Lehmann,[2] sheep digest 61 per cent of the crude protein, 52 per cent of the fat and 75 per cent of the extract matter.

How to Feed the Leaves.

Beet leaves are best suited for dairy cows and for fattening cows and steers. They are less suited for young stock, swine, horses and sheep. Fed in too liberal quantities they have a decidedly laxative effect, and likewise cause indigestion. This is due to the oxalic acid and inorganic ash constituents. The same bacteria, which in the paunch of the bovine produce lactic acid, act to an extent upon the oxalic acid and partially decompose it. It is advisable to feed not over 50 pounds daily of the green leaves to dairy cows, together with dry hay and grain. In case of cows that are near to calving, one-half of this amount is preferable. It is stated that dry cows and thin steers will take larger amounts without bad effect.

[1] E. Pott, Handbuch der Thier, Ernährung, etc., Zweite Auflage, II. Bd. S. 201.

[2] See E. Pott, already cited, p. 202.

German observers have found it helpful, in order to guard against the unfavorable action of the oxalic acid, to feed one ounce of precipitated chalk to every 50 pounds of leaves. It is not advisable to feed the leaves when the milk is intended for young children. Before feeding, the leaves should be made as free from soil as possible. This can in a measure be accomplished by shaking off the dirt with the aid of a fork, or by placing them in slatted drums or on sieves made of slats. It is not economical to wash them, as too much of the water-soluble nutrients is lost.

Beet leaves may be ensiled, and thus treated have been found to be less laxative in their effect. The oxalic acid is also partly decomposed. The leaves should be allowed to wilt, freed from excessive earth or sand, and then placed in pits in the earth or in ordinary wooden silos and thoroughly tramped. Excess of moisture is to be avoided. In case of necessity the leaves may be placed in small piles, and will keep very well from one to two weeks. The ensiled material contains approximately 76 per cent of water, and E. Wildt[1] has shown it to have the following percentages digestible :

	Per Cent.
Protein, ...	65
Fat, ...	60
Extract matter, . . .	54

It is not advisable to feed to cows over 25 pounds daily of the ensilage, together with hay, straw and grain. Larger amounts frequently act unfavorably on the animal, and are likely to produce a strong taste in the milk. German authorities are inclined to prefer the ensiled to the fresh leaves, especially if the latter are at all frosted or decayed.

[1] E. Pott, already cited, p. 207.

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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST

BALANCED RATIONS FOR DAIRY STOCK

By J. B. LINDSEY

1. *Composition of Cattle Feeds.*

All cattle feeds, whether in the form of grains and their by-products, or as hay, corn silage and straw, are composed of the following groups of substances:

Water—The several grains and their by-products contain from 7 to 12 per cent of water; hay and straw, 12 to 16 per cent; field-cured corn stover, 30 to 40 per cent; and corn silage, 76 to 80 per cent.

Ash represents the mineral ingredients, and constitutes the ashes after the feed is burned. These ashes consist of lime, potash, soda, magnesia, iron, phosphoric and sulfuric acids.

Protein is a collective name for all of the nitrogenous matter; it corresponds to the lean meat in the animal, and may be termed "vegetable meat." It has the same elementary composition as animal flesh. When fed to animals as a component of the various feedstuffs, it serves as the exclusive source of flesh as well as a source of heat or energy and fat.

Crude fiber or cellulose is the coarse or woody part of the plant. It may be called the plant's framework. It is a source of heat or energy and fat.

Non-nitrogenous extract matter represents the sugars, starch and gums. It is the principal source of heat or energy and animal fat.

Fat includes not only the various oils and fats in all grains and coarse fodders, but also waxes, resins and coloring matters. It is frequently termed *ether extract*, because it is that portion of the plant soluble in ether. It serves as a source of heat or energy and fat in the body of the animal.

Carbohydrates is a term which is generally used to include both the fiber and the non-nitrogenous extract matter.

It will thus be seen that all of the several groups of nutrients—protein, carbohydrates and fat—are sources of energy; that is,

they furnish the food or fuel to maintain the life of the body. They also are convertible into body fat. The protein, however, (including the ash), is the only group from which the animal can make its flesh or lean meat. In order to form the bones all the groups are used.

2. *Digestibility of Cattle Feeds.*

The several groups of nutrients above described, which make up the various cattle feeds, are valuable to the animal only in so far as they can be digested and assimilated. The concentrated feeds are considerably more digestible than the coarse fodders, as a single illustration will show.

	100 Pounds Timothy Hay.			100 Pounds Gluten Feed.		
	Composition	Per Cent Digestible	Pounds Digestible	Composition	Per Cent Digestible	Pounds Digestible
Water	15.0	—	—	8.5	—	—
Ash	4.3	—	—	1.7	—	—
Protein	6.3	48	3.0	26.2	85	22.3
Fiber	28.4	58	16.5	7.2	76	5.5
Extract Matter	43.6	63	27.5	53.3	89	47.4
Fat	2.4	61	1.5	3.1	83	2.6
Total	100.0	—	48.5	100.0	—	77.8

In the first and fourth columns is given the composition of average samples of timothy hay and of gluten feed. In the second and fifth columns are shown the percentages of the different groups which are digestible. Thus, of the 6.3 pounds of protein in timothy, 48 per cent are digestible, or 3 pounds; and of the 26.2 pounds of protein in 100 pounds of gluten feed, 85 per cent, or 22.3 pounds, are digestible. Excluding the ash, which is not generally taken into account, it is shown that 100 pounds of timothy hay contain about 48 pounds of digestible or actual food material, and 100 pounds of gluten feed, 78 pounds. It is evident, therefore, that the gluten feed is decidedly more valuable as a source of nutrition than the timothy hay.

3. *Method of Measuring the Efficiency of Feeding Stuffs.*

The digestibility of a feed, however, is not the true measurement of its nutritive value, for the reason that some feeds contain more metabolizable or available energy than others. What is termed *net energy value*, expressed in the form of Calories[1] or therms,[1]

[1] A large Calorie represents the amount of heat necessary to raise 1 kilogram of water 1° Centigrade. It is the unit of heat measurement. A therm represents the amount of heat required to raise 1,000 kilograms of water 1° Centigrade.

represents more accurately the true nutritive values of feeding stuffs.

Explanation. The entire amount of heat or energy contained in a feeding stuff is termed its *total heat* or *energy* value. All of this heat or energy cannot be utilized by the animal for the purposes of maintaining its body in a state of temperature equilibrium, or for aiding in the production of growth and milk. The several losses may be enumerated as follows: (*a*) the undigested material, *i. e.*, the faeces; (*b*) the incompletely used material (urea, etc.) of the urine; (*c*) the work required in the processes of digestion and assimilation in preparing the nutrients so that they can be used for maintenance and for the production of growth and milk. These several sources of loss expressed as energy, deducted from the total energy, leave the real or *net energy value.*

Here follows a table showing the *relative* net energy values (relative values) of a few of the more important feeding stuffs. Instead of expressing the relative energy values in therms of energy, they are stated on the basis of 100 for the sake of direct comparison. The figures were secured by the use of the so-called Kellner method[1]. They are not perfect, but represent the results of the best method that we have available at this time. Corn meal is taken as 100 and the other feeds, both concentrated and coarse, are compared with it.

Relative Values of Feeding Stuffs.

Corn meal	100	Hay, Kentucky blue grass	41
Apple pomace	11	Hay, orchard grass	38
Beans (soy)	107	Hay, red top	43
Beet pulp (dried)[2]	69	Hay, rowen	48
Brewers' dried grains	66	Hay, swamp or swale	23
Brewers' wet grains	18	Hay, tall oat grass	36
Buckwheat middlings	90	Hay, timothy	36
Corn bran	78	Hominy meal	105
Corn silage	12	Linseed meal (old process)	94
Corn stover, from field	27	Malt sprouts	66
Corn stover, very dry	36	Molasses	70
Cottonseed meal	95	Oats, ground	83
Distillers' dried grains, largely from corn	94	Rye feed	91
Gluten feed	91	Straw (oat)	20
Gluten meal	99	Straw (rye or wheat)	13
Hay, alfalfa or clover[3]	42	Wheat bran	57
Hay, barnyard millet	36	Wheat kernels, red	92
Hay, English (mixed grasses), fine early cut	43	Wheat kernels, white	94
		Wheat middlings (flour)	98
		Wheat middlings (standard)	67

[1] For a full explanation of the components of the animal body, the composition of feeds, the different ways in which the food is used in the animal body, and the explanation for using the therm in the calculation of rations for farm animals, see Farmers' Bulletin 346, United States Department of Agriculture, prepared by H. P. Armsby.

[2] Our own experiments, comparing beet pulp with corn meal as components of a dairy ration, have shown their feeding values to be more nearly equal.

[3] Alfalfa probably preferable, especially as source of protein.

It should be borne in mind that the above figures express only net energy and not protein value. If protein is needed to balance the ration, it can be purchased most economically in the high-grade protein concentrates, such as cottonseed meal, gluten feed, distillers' dried grains and the like.

4. *Nutritive Ratio of Cattle Feeds.*

The *numerical* relation which the digestible protein bears to the other digestible organic nutrients (fiber, extract matter and fat[1]) is termed the nutritive ratio of the feed or ration. One hundred pounds of timothy hay has, for example, 3 parts of digestible protein to 47.3 parts of other digestible nutrients, or as 1 is to 15.8. This is termed a very wide nutritive ratio. One hundred pounds of gluten feed contains 22.3 parts of digestible protein to 58.6 parts of other digestible nutrients, or as 1 is to 2.6. This may be termed a very narrow nutritive ratio or proportion. All feeds having a nutritive ratio of 1 to 5 or less may be said to have narrow ratios, those from 1 to 5 to 1 to 8 a medium ratio, and above 1 to 8 a wide ratio.

The cereals and other non-leguminous coarse fodders have medium to wide ratios, and the leguminous coarse fodders, medium ratios and the leguminous seeds and most concentrated by-products narrow ratios.

5. *Combining Coarse and Concentrated Feeds (Balanced Rations).*

Desirable rations for dairy stock should possess (*a*) palatability, (*b*) sufficient bulk, and (*c*) 1 part of protein to 5.5 to 7 parts of the other digestible organic nutrients. If the ratio is much narrower than 1 to 5.5, the ration is likely to be too stimulating for continuous feeding, and the animal is likely to become thin in flesh. If the ratio is much wider than 1 to 7, the tendency will be for the animal to put on fat rather than to give milk. In both cases the ration may be said to be *out of balance.*

For both economical and physiological reasons it is necessary that a considerable portion of the daily ration of the dairy animal should be composed of coarse fodder or roughage, because such materials are easily and cheaply produced on the farm, and because the digestive tract of the bovine is especially suited to utilize them. Most of these home-grown coarse feeds, however, are very high in carbohydrates, low in protein, and have a relatively low digestibility. It is necessary, therefore, to supplement them to an extent with the cereal grains, which, though relatively low in protein, are very digestible; and with the concentrated by-products which, in addition to a relatively high digestibility, are quite rich in protein. A single illustration will make this

[1] The fat is converted into the energy equivalent of the starch or fiber by multiplying by 2.2; thus, 3 per cent of fat would have an energy equivalent of 6.6 per cent or parts of starch.

clear. Many experiments have demonstrated that a 1,000-pound cow, producing daily 10 quarts of milk of average quality, needs approximately the following amounts of *digestible* nutrients:

	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds,	2.25	.5	13 or 13.5	16	1 to 6.4

Now if this animal were fed daily as much of an *extra* quality of hay as she would consume (28 to 30) pounds, she would receive:

	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds,	1.3	.3	13	14.6	1 to 10.5

Such a ration is deficient both in total digestible nutrients as well as in digestible protein. If 7 pounds of the hay were replaced by an equal amount of corn meal, the hay and corn meal would furnish:

	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds,	1.4	.47	14.35	16.22	1 to 11

The corn meal being very digestible, but a one-sided or starchy feed, would increase sufficiently the total digestible nutrients, but not the protein. If 4 pounds of corn meal were replaced by 2 pounds of bran and 2 pounds of cottonseed meal, the several feeds would supply:

	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Pounds,	2.07	.60	13.20	15.87	1 to 6.4

The replacing of 7 pounds of hay with 3 pounds of corn meal rich in digestible matter and with 2 pounds each of bran and cottonseed meal especially rich in digestible protein, furnishes a ration containing less fiber and more starchy matter and protein than is contained in the hay. Such a ration contains the requisite amount of both total digestible matter and digestible protein, and may be said to be *properly balanced*.[1]

6. *Types of Balanced Rations.*

Because of the high prices usually prevailing for all concentrated feeds, dairymen are frequently in doubt as to the kinds to be selected and the amount to be fed in order to secure the best returns for the money invested. Farmers selling cream to the creamery, or located where there is not a quick demand for milk, probably will not find it economical to feed over 3 to 5 pounds of purchased grain daily, and will use maximum amounts of home-grown hay and silage (1 bushel of silage and what hay the animal will eat clean). If the silage is well eared, 1½ pounds each of cottonseed meal and flour middlings, sprinkled over the silage to distribute it, will produce a fairly well-balanced ration, and prove helpful in maintaining the milk flow. If corn meal is a

[1] Instead of expressing the nutrients needed by different animals in the forms of protein, fat and carbohydrates, it is believed we shall soon be using the terms protein and therms of net energy. Thus, a cow of 1,000 pounds producing 20 pounds of milk daily, will require 2 pounds of protein and 12 therms of energy. A circular on this subject may be published before long.

home product rather than silage, mix by weight 1-4 bran, 1-2 corn and cob meal and 1-4 cottonseed meal, (100 pounds bran, 200 pounds corn and cob meal and 100 pounds cottonseed meal), and feed 5 to 6 quarts daily; or by weight 2-3 corn and cob meal and 1-3 cottonseed meal and feed 4 to 5 quarts daily, together with one feeding of cut or shredded corn stover and what hay the animal will clean up.

Producers of market milk generally find it advisable to feed somewhat more grain, and a number of combinations are suggested which will produce satisfactory balanced rations when fed with what hay the animal will eat clean (18 to 24 pounds a day), or with 1 bushel of corn silage and 10 to 16 pounds of hay.

I.

100 pounds bran,
100 pounds flour middlings,
100 pounds gluten feed,
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

II.

100 pounds bran,
100 pounds corn or hominy meal,[1]
100 pounds cottonseed meal,
Mix and feed 6 to 8 pounds (7 to 9 quarts) daily.

III.

100 pounds wheat bran,
200 pounds gluten feed,
100 pounds corn or hominy meal,
Mix and feed 7 pounds (7 quarts) daily.

IV.

100 pounds wheat bran or malt sprouts,
100 pounds corn or hominy meal,
200 pounds gluten feed,
Mix and feed 7 pounds (or quarts) daily.

V.

75 pounds wheat bran,
150 pounds corn and cob meal,
100 pounds cottonseed meal,
Mix and feed 6 to 7 pounds (or quarts) daily.

VI.

100 pounds distillers' grains,
100 pounds malt sprouts,
150 pounds corn meal,
50 pounds cottonseed meal,
Mix and feed 7 pounds (7 to 8 quarts) daily.

VII.

150 pounds distillers' grains,
150 pounds standard middlings,
100 pounds corn or hominy meal,
Mix and feed 7 pounds (or quarts) daily.

VIII.

150 pounds wheat bran,
200 pounds gluten feed,
Mix and feed 7 pounds (8 to 9 quarts) daily.

IX.

200 pounds dried brewers' grains,
100 pounds corn meal,
50 pounds cottonseed meal,
Mix and feed 7 pounds (9 quarts) daily.

X.[2]

300 pounds bran,
100 pounds flour middlings,
100 pounds corn meal,
100 pounds ground oats,
300 pounds gluten feed,
100 pounds linseed meal,
Mix and feed as desired.

XI.

1.5 pounds gluten feed,
1.5 pounds cottonseed meal,
4.0 pounds dried beet pulp.[3]

XII.

3 pounds distillers' grains,
4 pounds dried beet pulp.

[1] Corn and cob meal, if on hand, can be used in place of corn and hominy meal.
[2] Ration designed for cows on test; rather expensive for ordinary purposes.
[3] Beet pulp should be moistened with two to three times its weight of water before feeding.

The cost of a pound of the several mixtures is likely to vary from 1.5 to 1.7 cents. It is believed that the above selections are more economical on the basis of their content of nutritive material than many of the sugar feeds and other proprietary mixtures.

In general it may be said that the *amount of grain* to be fed daily depends upon: (*a*) the size of the cow, (*b*) the daily milk yield, and (*c*) the local market value of the milk. The richer the milk, the more food is required to produce a given amount, and *vice versa*.

Six to seven pounds of the above mixtures is a fair average amount for cows weighing 800 to 900 pounds, which are yielding 10 quarts of 4 to 5 per cent milk. For every 2 quarts of milk yielded in excess of this amount the grain ration may be increased by 1 pound.

7. *Rations for Young Stock.*

Young dairy stock may receive 1 peck or more of silage daily, depending upon their size, in addition to what hay, corn stover or other coarse fodder they will eat clean; or the entire roughage may consist of hay. Ten to 15 pounds of roots daily in cases where silage is not available will prove appetizing and helpful. Grass and clover rowen form a very desirable feed for growing animals. In addition to the above, it is usually advisable to feed from 1 to 3 pounds daily of a grain mixture reasonably rich in protein and ash.[1] Any of the above grain mixtures will prove satisfactory. The writer has found mixtures by weight of 1-2 bran, 1-4 corn meal and 1-4 flour middlings; or 1-2 bran, 1-4 corn meal and 1-4 ground oats quite satisfactory. A ration composed of late-cut hay and corn meal would not be desirable, it lacking both flesh and bone forming material (protein and ash).

Several months before the heifer freshens it is well, if circumstances permit, to increase the grain ration to 5 or 6 pounds per day in order to get her accustomed to grain and to encourage a large future milk flow.

The feeder will do well to bear the following in mind:

1. Late-cut hay is noticeably less nutritious than early-cut.

2. Fine grasses are more nutritious than the coarse.

3. The clovers and alfalfa should be cut in early bloom. If cut in late bloom their nutritive value is noticeably lessened.

[1] If the roughage consists largely of grass or clover rowen, 2 pounds daily of a mixture of bran and corn meal, or even of corn meal alone, will prove satisfactory.

4. Concentrated feeds, aside from their palatability, should be purchased for their high digestibility or net energy value and protein content.

5. The cereals have a high net energy value; cottonseed meal, gluten feed, distillers' dried grains and flour middlings, while they are highly digestible (high net energy value), are purchased as a rule because of their protein content.

6. Wheat bran is an expensive source of nutrition, but its bulk and laxative qualities frequently commend its use to eastern feeders in amounts not exceeding 25 to 30 per cent of the entire grain ration.

7. Some proprietary grain mixtures are fairly economical; others, which contain low-grade by-products, are quite expensive, due to the fact that such feed mixtures are sold at about the same prices as the high-grade concentrates.

8. The farm is the carbohydrate factory. As a rule, it is not practicable for the farmer or dairyman to produce all of the high-grade protein feeds to supplement his home-grown carbohydrates. He should endeavor to produce as much as possible of the needed protein in the form of clover, alfalfa, peas and possibly soy beans. In some cases he will find it necessary to purchase corn and the like, but this is not advised whenever it can be grown upon the farm.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION
AMHERST

CO-OPERATIVE SOIL STUDIES BY THE AGRICULTURAL EXPERIMENT STATION AND THE EXTENSION SERVICE OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

F. W. Morse

The attitude of the Agricultural Experiment Station toward the examination of miscellaneous soil samples is fully defined in Circular No. 45. There are certain conditions, however, that would make a soil analysis by chemical and mechanical methods, very advantageous.

This circular is supplementary to Circular No. 45 and describes a plan by which county agents of the Extension Service can co-operate with the Agricultural Experiment Station in making soil examinations more serviceable.

It is especially desirable to compare the texture and composition of soils of known value for special crops with those of soils believed to have similar possibilities, because the varied surface of our state requires specialization in crops to utilize the land to its capacity.

The analyses of samples taken from small areas of an acre or less, are of little, if any, practical value to the community unless the fields are known to be typical of larger areas.

In order to compare and correlate the properties of unknown soils with known types, it will be necessary to have all samples taken by a uniform method, and accompanied by notes describing important field conditions.

Method of Sampling.

Use a soil auger for taking samples in all cases where the texture will permit. If the soil should be too dry to adhere to the auger, moisten the soil around the auger before withdrawing it. Make numerous borings in representative spots in the area under examina-

tion, and mix them together into a composite sample. No fixed depth can be prescribed for the borings, but the actual depths employed should always be stated in the notes accompanying the sample. The surface soil should be sampled to the depth employed in plowing or to the line of demarcation between soil and subsoil. Twelve inches actual depth in the subsoil is a convenient standard when the subsoil is sampled.

About one quart of the composite sample will be sufficient for the examinations in the laboratory, and the sample should be sent to the Agricultural Experiment Station in a receptacle which the Experiment Station will provide on request.

The necessary information by which soils may be compared and correlated is outlined in the following schedule, which is essentially like that given in "Soils, Their Properties and Management," by Lyon, Fippin & Buckman.

Outline of Factors Useful in Soil Classification.

Agencies of Formation	Weathering Water { Stream, Lake, Ocean } Wind Glaciation Gravity Plant and Animal Life
Materials of Formation	Crystalline Rocks { Acidic, Basic } Shales and Sandstones Limestone and Marl Organic Matter
Specific Properties	Color Natural Drainage Subsoil and Underlying Material Organic Matter and Humus Plant Food Carbonate of Lime
Texture	Sizes of Soil Particles

The agencies and materials concerned in the soil formation will be ascertained at the Experiment Station.

The portion of the outlined information desired from county agents is as follows:

A. Notes descriptive of the soil in place, which include:

Depth of soil,
Color of soil,
Depth of subsoil,
Color of subsoil,
Material underlying the subsoil,
Natural surface and drainage of area,
Characteristic vegetation of area.

B. Description of locality, which will enable the Experiment Station to locate it on the topographical maps of the State. The United States Geological Survey has published a complete series of topographical maps of the State on a scale of one mile to the inch and county agents will find these maps serviceable in all their field work. There are from four to twelve sheets required for each county, costing five cents per sheet, and they may be obtained of the Director of the United States Geological Survey, Washington, D. C.

By means of the topographical maps and the different publications on the geological characteristics of different portions of the State, it is expected that most of the geological information can be secured for any locality.

The laboratory investigations will include as many of the following determinations as may be deemed necessary:

Organic matter and humus,
Plant food,
Carbonate of lime,
Sizes of soil particles.

It is not planned to make this a soil survey of the State nor a substitute for a soil survey; but to make our future soil examinations after a uniform procedure, by which the results can be co-ordinated and relations between one locality and another brought out, if any exist.

CIRCULAR NO. 65. (Revision of No. 56.) SEPTEMBER, 1916.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

AMHERST

WM. P. BROOKS, Director

CAMPAIGN TO ELIMINATE BACILLARY WHITE DIARRHOEA

1. Bacillary White Diarrhoea of hens and chickens is common in this State and the occassion of great loss.

2. The disease is transmitted by the hen laying the egg.

3. Hens harboring the bacillus can be detected by a laboratory test of the blood.

4. If such hens (reactors) are eliminated from breeding flocks losses of chicks from Bacillary White Diarrhoea, with proper sanitation, can be practically entirely avoided. This fact has been demonstrated by tests made both in the Massachusetts and the Connecticut Experiment Stations.

5. The facts above stated must make it apparent that a campaign for the elimination of this disease is desirable and practicable. Breeders have simply to cease using eggs from reacting hens for hatching and the disease will soon disappear.

6. The Experiment Station of the Massachusetts Agricultural College, is prepared to test the breeding hens of owners applying for the test under the following general conditions:

(a.) The collection of the blood samples and the agglutination test will be made by the Veterinary Department of the Experiment Station and from that Department reports on the results, with such directions as may be necessary, will go to the flock owners.

(b.) As the work of the Veterinary Department will be largely routine and not experimental in its nature a charge will be made by the Station to cover a part of the cost. This, for the present, will be *five cents* for each hen tested.

7. Those desiring to have their flocks tested on this basis should address their applications : **Veterinary Department,** Experiment Station, Amherst, Mass.

8. So far as conditions permit applications will be accepted in the order of priority: but locality, as will be readily understood, must be considered since at present only one man can be employed in taking blood samples. It may not be possible to satisfy all applications, as the forces and facilities available for the work are limited.

CIRCULAR NO. ~~65~~ 66. AUGUST, 1916

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

VETERINARY DEPARTMENT

AMHERST

POULTRY FARM DISINFECTION.

JAMES B. PAIGE

To free infected premises from bacillary white diarrhea it is important to destroy the germs which cause the disease. With this in mind it has seemed advisable to print a short paper giving briefly some simple methods of disinfection which are effective in destroying disease-causing organisms. The few methods cited below have been selected from a number recommended by the Maine Agricultural Experiment Station, the United States Department of Agriculture, and this department.

PRELIMINARY STEPS.

Clean all houses, roosts, nests, incubators, brooders, etc., thoroughly. In case of houses remove all litter. sweep dust from walls and ceilings, and scrape all manure from floors, roosts and nests. The litter and manure should be taken to a spot where fowls cannot reach it and should be burned or spread on the land at the earliest convenience. Next wash the house thoroughly with water from a hose until all parts seem clean, and let the house dry a day or more. It is then ready to be disinfected.

TO DISINFECT ROOMS WHICH MAY BE MADE AIR TIGHT EASILY—such as feed rooms, brooder houses and incubator cellars.

For this purpose **formaldehyde gas** is effective. In using this method the following articles will be necessary : 1 large piece sheet iron, 1 large pan, such as a dishpan, deep enough to prevent mixture of formalin and potassium permanganate from boiling over, 1 kettle for boiling water, commercial formalin and crystals of potassium permanganate. The formalin and permanganate may be purchased at a drug store. In buying allow 3 pints of form-

alin and 23 ounces of potassium permanganate for every 1000 cubic feet of space to be disinfected.

For disinfecting with formaldehyde gas the temperature should be at least 50° Fahrenheit, preferably above. Remove birds from the house and close tightly all windows and yard openings, sealing cracks with strips of paper or cotton. Open all closets, cupboards, drawers or bins which are to be disinfected. Weigh out the required amounts of formalin and potassium permanganate in separate dishes. Scatter the permanganate crystals in the deep dishpan and place pan on the large piece of sheet iron on the floor of the room to be disinfected. Since much heat is evolved in the reaction of the formalin and permanganate all combustible materials should be removed from the vicinity of the pan. Place a kettle of boiling water in the room to give a moist atmosphere. Pour the formalin quickly over the potassium permanganate crystals in the pan, leave the room at once, and shut and seal the door tightly. Allow the house to remain closed 6-12 hours, allowing 12 hours whenever it is desired to disinfect materials into which the gas must penetrate (fabrics or hay.) At the end of 6-12 hours open the house and air thoroughly.

TO DISINFECT HOUSES, ROOSTS, NESTS, INCUBATORS, BROODERS, ETC., WITH LIQUID DISINFECTANTS.

Formaldehyde. As an affective disinfectant a solution of formalin and water may be employed. Add 1-2 pint of commercial formalin to each gallon of water used, and with a pressure spray pump or a brush apply the mixture to the areas to be disinfected. Because of the irritating vapor all doors and windows should be open. The worker should protect his hands by wearing oiled leather or rubber gloves. Apply the disinfectant twice, allowing houses, roosts, etc., to dry between applications.

Compound Cresol Solution. A highly recommended coal-tar disinfectant is found in compound cresol solution, a mixture of cresol and linseed-oil-potash soap, Such a mixture is necessary as cresol alone does not mix with water readily This compound may be purchased under the name of liquor cresolis compositus, U. S. P., or it may be made according to the following directions taken from "Diseases of Poultry," by Pearl, Surface and Curtis.

"Commercial cresol" can be obtained from a druggist. Do not allow this cresol to come in contact with the skin as it is corrosive.

If by accident it does so, wash the spot thoroughly with water. "Measure out 3 1-5 quarts (6 1-2 pints) raw linseed oil in a 4 or 5 gallon crock; then weigh out in a dish 1 pound 6 ounces commercial lye or "Babbit's Potash." Dissolve this lye in as little water as will completely dissolve it. Start with 1-2 pint water and if this will not dissolve all the lye, add more water slowly. Let this stand for at least 3 hours until the lye is completely dissolved and the solution is cold; then add the *cold* lye solution very slowly to the linseed oil, stirring constantly. Not less than 5 minutes should be taken for adding this solution of lye to the oil. After the lye is added continue the stirring until the mixture is in the condition and has the texture of a smooth homogeneous liquid soap. This ought to take not more than half an hour. While the soap is in a liquid state and before it has had a chance to harden add, with constant stirring, 8 1-2 quarts of commercial cresol." The resulting dark brown fluid will mix with water and yeild a clear solution. It should be kept covered and away from live stock.

For disinfecting purposes this cresol compound should be added to water, adding 4 to 5 ounces to each gallon of water. The mixture should be applied liberally to houses, roosts, nests, brooders, incubators, etc.,with a spray pump or scrub brush. After letting the disinfectant dry, spray houses, roosts, etc., a second time and let them dry in the sun. Brooders and incubators should be disinfected before using them for each new hatch. Houses should be treated in this way at least once or twice each year.

In addition to formalin and compound cresol solution there are many other liquid disinfectants in the market. The directions for the use of these are usually given on the containers in which the preparations are sold.

APPLICATION OF WHITEWASH AND DISINFECTANT.

As an aid to cleanliness it is desirable to whitewash houses often. For such a purpose, after the disinfectant has been applied, lime wash, to each gallon of which 4 ounces of chlorid of lime has been added, may be used. By following the directions given below (From the United States Department of Agriculture, Bulletin 480) it will be possible to apply whitewash and disinfectant at the same time.

"Slake 7 1-2 pounds of lime, using hot water if necessary to start the action. Mix to a creamy consistency with water. Stir in 15 (about 1 pint) fluid ounces of cresol (commercially known as liquid carbolic acid) at least 95% pure, and make up to 5 gallons by adding water. In case compound solution of cresol (liquor cresolis compositus) is used, add 30 fluid ounces (about 2 pints) instead of 15 as in the case of cresol (liquid carbolic.) Stir thoroughly. If to be applied through a spray nozzle, strain through a wire sieve. Stir frequently when applying and keep covered when not in use. In case a large surface is to be disinfected it will be advisable to prepare a liberal amount of the disinfecting solution before beginning the application. Such solutions, however, should not be permitted to remain in receptacles which are accessible to animals." In case of small areas the wash may be applied with a brush but in most cases a strong spray pump is desirable as it applies the solution rapidly and with sufficient force to drive the wash into all crevices. When the spraying is completed open the house to admit sunlight and air.

TO DISINFECT LITTER FOR USE IN BROODERS.

To disinfect litter for use in brooders spread cut hay or shavings on the floor, spray with cresol solution until litter is thoroughly wet, and spread it in the sun until dry.

TO DISINFECT FEED TROUGHS AND DRINKING FOUNTAINS.

All feed troughs and drinking fountains should be cleaned frequently, scalded three or four time with boiling water, and allowed to dry in the sun. In addition potassium permanganate may be used in the drinking water as an antiseptic. For this purpose add as much permanganate as can be held on the surface of a dime to each gallon of water used for drinking and stir the water well before pouring it into the drinking fountains.

TO DISINFECT YARDS.

To free poultry yards from infection, the ground should be plowed, spaded, or harrowed and dressed with lime. Whenever possible it is advisable to have a vegetable or grass crop raised on the infected area before using it again for fowls.

SPECIAL CIRCULAR January, 1919

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Department of Plant and Animal Chemistry.

THE VALUE OF APATITE AND BARIUM SULFIDE (Barium-Phosphate)

By H. D. Haskins

This material is not a chemical combination of barium and phosphorus as perhaps the name would indicate, but is a mechanical mixture of an insoluble or three lime phosphate, similar to Canadian apatite, with about 7 per cent of barium sulfide. Apatite in its natural state is recognized as the most insoluble of the natural phosphates.

Among the claims of the manufacturers of the so-called Barium-Phosphate are the following:

1. That its phosphoric acid is available as a source of plant food.
2. That it will favor early maturity of crop.
3. That it furnishes sulfur in a form readily accessible to the growing plant.
4. That it sweetens the soil by the alkaline salt barium sulfide.

With reference to these claims, the present state of our knowledge leads us to say:

1. Our experiments indicate that an insoluble phosphate similar to apatite, mixed with about 7 per cent of barium sulfide (Barium-Phosphate) when used in pots without manure, but in one instance with a green cover crop, gave up little if any phosphoric acid to the crop grown.*

2. Barium-Phosphate used with and without manure in a field experiment conducted in 1918, did not favor the early maturing of the corn crop over that grown on adjoining plots without the use of the Barium-Phosphate.

3. It is conceivable that the barium sulfide which is mixed with the apatite may eventually furnish some soluble sulfur compounds. It is hardly conceivable that the average soil which received annual manure and fertilizer applications would be found deficient in available sulfur compounds, as manure contains much soluble sulfates, and most mixed fertilizers contain an abundance of sulfur in the form of calcium sulfate, or gypsum, resulting from a union of the calcium oxide with sulfuric acid, with which the raw phosphate is treated in making the acid phosphate.

4. Provided the Barium-Phosphate does have a sweetening effect on the soil, it must be relatively small as only about 7 per cent of the product is claimed to be barium sulfide. This would mean that in a 1,000 pound application, which is the average amount recommended by the company,

only 70 pounds of barium sulfide would be applied per acre. Laboratory experiments show that the Barium-Phosphate has about 1-20 the neutralizing effect of commercial hydrated or slaked lime, and about 1-15 that of fine ground limestone. In other words, a soil that would require one ton, or 2,000 pounds of calcium hydrate to reduce soil acidity, would require 2,720 pounds of calcium carbonate, and 40,000 pounds, or 20 tons, of Barium-Phosphate to produce the same effect; or stated in another way, 136 pounds of ground limestone costing about 40 cents would be as effective a neutralizer as a ton of Barium-Phosphate.

CONCLUSIONS.

From the results of experiments thus far conducted at this Station, we have failed to observe any effect from the use of Barium-Phosphate that would warrant us in recommending its use in place of the soluble phosphates.

The manufacturers claim that to get the best results with this material, it should be used in connection with stable manure or with green crops plowed under, assuming that the bacteria in the manure will render available the insoluble phosphates. This point we have not as yet proved, and it is our purpose to conduct further experiments in order if possible to solve the problem.

*One exception was noted in one pot in the experiment conducted in 1916 with Dwarf Essex Rape.