CONNECTICUT

AGRICULTURAL EXPERIMENT STATION.

NEW HAVEN, CONN.

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THE COST OF PLANT FOOD IN CONNECTICUT, SPRING MONTHS OF 1897.

CONTENTS.

Notice as to Bulletins.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Station Staff.

All Bulletins earlier than No. 71 and Nos. 83, 93, 101, 102 and 118 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1887 and 1891.

By a recent legislative enactment, the Annual Report of this Station, printed at State expense, is henceforth limited to an edition of 7,000 copies.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

THE STATION AND THE FERTILIZER CONTROL.

Commercial Fertilizers are bought in this State chiefly during the months of February to June.

Samples for analysis are sent by purchasers or collected by agents of this Station, for the most part, during the same months.

The work of analysis occupies the Station chemists from March until September.

During this time are made analyses of about 500 Commercial Fertilizers, or fertilizer-materials, including every branded fertilizer legally sold within the State.

The results of the season's work—which are reported at once to those who have sent samples or letters of inquiry to the Station—may serve as a valuable guide to purchasers.

Chief among the fertilizer questions with which the Station undertakes to deal, are:—

1. What materials fit for fertilizers are in our Connecticut market, what is their composition and what the retail cash cost of the nitrogen, phosphoric acid or potash contained in them?

2. What mixed fertilizers are sold in the State, how far do the guaranteed and the actual composition of these goods agree, and are the nitrogen, phosphoric acid and potash in these mixtures readily available to crops?

3. How do the various nitrogenous fertilizers, blood, bone, fish, tankage, horn and hoof, etc., compare as regards the availability of their nitrogen?

These are questions which the farmer cannot answer for himself and are the most important points about which he needs information. If he has seasonable knowledge of them, he can himself make and apply to mixed fertilizers a schedule of valuations, which, *for his special circumstances*, will be more accurate than any which the Station may propose.

THE COMMERCIAL COST OF PLANT FOOD IN FERTILIZERS.

High priced Commercial Fertilizers in general should be used solely to supply plant food.

They are not universal remedies for all deficiencies of the soil or season and their use is only wise on land which is, in all other respects than supply of plant food, in good condition to bear paying crops.

For a fuller discussion of this matter the reader is referred to a paper, by the Director, "On the Best Economy of Concentrated Fertilizers," in the Nineteenth Report of this Station, 1895, page 162.

The valuable ingredients of Commercial Fertilizers, nitrogen, phosphoric acid and potash, cannot be bought in pure condition but exist only in combinations, which never contain more than about half their weight of the ingredients named and often a much less proportion.

Chemical analysis alone can determine how much nitrogen, phosphoric acid or potash any given material contains.

Every citizen of Connecticut can have fertilizers analyzed gratuitously, at this Station, under certain conditions which the experience of twenty years has shown to be necessary.

In case of chemicals or raw materials whose value lies in a single ingredient, having learned what and how much plant food the material contains and the cost per ton or pound, it can then be calculated what the *actual plant food* costs per pound.

For example, when nitrate of soda costs $45.00 per ton and contains 16 per cent. of nitrogen, its nitrogen costs fourteen cents per pound, for since the nitrate contains 16 per cent. (or pounds in 100) of nitrogen, a ton contains 320 pounds and costs $45.00. One pound of nitrate-nitrogen therefore costs $\frac{4500}{320} = 14$ cents.

This same form of calculation is necessary in order to compare the cost of plant food in materials which are different in kind.

For example, which is the cheaper form of available phosphoric acid, dissolved South Carolina rock at $13.00 per ton, or dissolved bone-black at $23? A sample of the former is found to contain 14.22 per cent. of "available" (soluble and reverted) phosphoric acid, or 284.4 pounds in the ton, and the latter 16.89 per cent. or 337.8 pounds in the ton.

Dividing the cost in each case by the number of pounds of available phosphoric acid, gives the cost per pound in each, viz: 4.6 cents for available phosphoric acid in dissolved S. C. rock phosphate and 6.8 cents for the same thing in dissolved bone black.

There is every reason to believe that one form is as available to plants as the other. The available phosphoric acid of dissolved bone black is therefore very considerably more expensive than that of dissolved S. C. rock as regards first cost.

Many farmers in the State have during the last three months sent to the Station, for analysis, the materials which they bought

or intended to buy, either to put on the land directly or to use in making mixed fertilizers.

On the following pages the results of these analyses are summarized so as to show what is now the commercial cost of plant food, as found in raw materials and fertilizer chemicals.

The analyses will be given in detail in the Report for 1897.

NITROGEN.

Nitrate of Soda.

The average percentage of nitrogen, in the thirteen samples examined, is 15.89, the range from 15.02 to 16.27.

The average retail cost has been $46.50 per ton, the range from $44 to $48.

The average retail cost per pound of nitrate-nitrogen has been 14.7 cents, the range from 13.7 to 15.6.

To illustrate what may be done by granges or farmers' clubs which join in purchasing "mixed car lots," may be instanced a single lot, which, bought in this way, cost the purchasers $39.70 per ton delivered, or 12.4 cents per pound for nitrogen,— 2 cents less per pound of nitrogen than the average retail price.

Sulphate of Ammonia.

This material has for some years been too expensive to use as a fertilizer, but at present rates its nitrogen costs no more than that of nitrate of soda.

Two samples, sold for $60.00 per ton, contained 20.84 and 20.88 per cent. of nitrogen, making its cost per pound 14.4 cents.

Cottonseed Meal.

This continues to be one of the most popular as well as the commercially cheapest form of quickly available nitrogen.

Sixty-one samples have been tested, which contained from 6.92 to 8.02 per cent. of nitrogen, the average being 7.41 per cent.

This is a higher average than that of any previous year. The meal also contains 3.15 per cent. of phosphoric acid and 1.90 per cent. of potash.

The average cost has been $22.00 per ton, the range from $21.50 to $23.50.

If the relatively small quantities of phosphoric acid and potash in the meal are valued at 4½ and 5 cents per pound respectively, the average retail cost of nitrogen per pound in 56 samples has been 11.6 cents, a cent less than in 1896.

The cost of nitrogen in the samples ranged from 10.4 to 12.7 cents.

Vegetation experiments indicate that the nitrogen of cotton seed meal is somewhat more available than that of blood, fish, bone or tankage, but considerably less available than that of nitrate of soda.

"Tankage Cottonseed Meal."

This inferior article, apparently unhulled cottonseed meal, is offered every year as a fertilizer, but is a very expensive source of nitrogen.

A single sample, sold for $18.00 per ton, contained

Nitrogen	4.48	per cent.
Phosphoric acid	1.88	"
Potash	1.58	"

Nitrogen therefore costs 16.4 cents per pound, nearly five cents more than in prime yellow or hulled meal.

Castor Pomace.

Two samples of pomace contained 4.02 and 4.51 *per cent.* of nitrogen respectively and cost $19.00 per ton.

Nitrogen in these samples costs 18.5 and 21.1 cents per pound respectively.

There is no good reason for using castor pomace as a fertilizer, on any crop, at this price.

Comparative Availability of Various Forms of Fertilizer-Nitrogen.

The comparative availability to the oat and maize crops of various forms of nitrogen, has been a subject of experimental study at this Station during the last three years.

The following table gives some of the results.

NITROGEN AVAILABILITY.

Pounds.		Pounds.			Pounds.			
619	nitrate of soda	containing	100	nitrogen, yielded	63.8	of nitrogen to the crops.		
480	sulphate of ammonia*	"	100	" "	52.9	"	"	"
2064	castor pomace	"	100	" "	46.8	"	"	"
1205	cottonseed meal,	"	100	" "	46.3	"	"	"
1560	linseed meal	"	100	" "	44.6	"	"	"
1037	dry fish	"	100	" "	44.1	"	"	"
739	dried blood	"	100	" "	42.9	"	"	"
652	horn and hoof	"	100	" "	41.8	"	"	"
1960	bone tankage	"	100	" "	38.2	"	"	"
1480	pulverized leather	"	100	" "	1.2	"	"	"

* Calculated from results of experiments by Wagner.

The table shows, first, how many pounds of each of the fertilizers named are required to furnish 100 lbs. of nitrogen and, second, how many pounds of crop-nitrogen are obtainable from 100 lbs. of the several kinds of fertilizer-nitrogen.

In all cases the conversion of fertilizer-nitrogen into crop-nitrogen is accompanied by a more or less considerable waste or loss. We see that scarcely two-thirds of the nitrate-nitrogen entered the crop, while of most of the other fertilizers rather less than one-half, and of pulverized leather little more than one-hundredth of their nitrogen was available.

These results agree substantially with those obtained in Germany by Wagner, in cultures of rye, wheat and carrots on plots of loamy soil.

COST OF CROP-NITROGEN.

When we reckon the cost of crop-nitrogen we find that in these tests a pound derived from nitrate cost 22 cents, a pound from cottonseed meal, 28, one from castor pomace, 38, and one from dried blood, 34 cents.

These figures express the relative agricultural values for crop-production of the several forms of nitrogen, as found by practical use in cultures of oats and indian corn during three successive years. The experiments were made necessarily on a small scale, but doubtless more accurately than is commonly practicable in field trials. The results do not necessarily apply to all other crops, but show conclusively that different forms of nitrogen have very different fertilizing and economic values.

PHOSPHORIC ACID.

Dissolved Bone Black.

The average cost of the five samples tested is $23.00 per ton. They contain 17.4 *per cent.* of "available" phosphoric acid, whose cost per pound is 6.6 cents.

Dissolved Rock Phosphate.

The average cost of dissolved rock phosphate is $15.50, and it contains 14.15 per cent. of available phosphoric acid, making the average cost per pound of the latter, 4.8 cents.

Dissolved rock phosphate bought in "mixed car lots" by associations of farmers has cost from $10.00 to $11.00 delivered, and the available phosphoric acid has cost from 3.5 cents to 4.8 cents per pound.

POTASH.

Muriate of Potash.

In large transactions muriate of potash is sold on a guaranteed percentage of muriate, usually 80 per cent., equivalent to 50.5 per cent. of potash.

The price is fixed at so much for "80 per cent. muriate," and if the invoice contains over 80 per cent. the purchaser pays for the excess at the same rate, while if it contains less, a deduction is made.

The per cent. of potash is fixed by analysis of samples drawn in Germany when shipment is made, and these analyses only are used in selling the goods. It often happens, however, that the potash salts, after transportation to this country, do not have the same percentage composition as before. The seller, however, gives only the German analyses as a statement of composition.

Naturally the small lots sold to consumers are taken, as far as may be, from lots which run near 80 per cent. muriate because retail sales have to be made "flat," i. e. the seller gets nothing more for higher grade muriate, but he has to pay more for it in Germany or when bought wholesale from importers. In nine samples of muriate the average percentage of potash was 50.96, the range from 48.89 to 52.73.

The average cost was $43.25, and the cost per pound of potash ranged from 3.9 to 4.5 cents, the average being 4.2 cents.

High Grade Sulphate of Potash.

As found in our retail market, this contains on the average 49.0 per cent. of actual potash, equivalent to 90.6 per cent. of chemically pure sulphate of potash.

The average cost is about $50.20 per ton and the cost of potash per pound ranges from 4.7 to 5.5 cents, the average being 5.1 cents.

Attention is called to the fact that the high grade sulphate is not absolutely free from chlorides, though the amount present is so small that it is not likely to produce any bad effects on either the potato or tobacco crops. The percentages of chlorine found in five samples were 0.34, 1.40, 1.40, 1.92, and 2.40.

Double Sulphate of Potash and Magnesia.

The percentage of potash found in this material has ranged this season from 23.25 to 29.68 per cent., and at $29.25 per ton for the double sulphate, the average cost per pound of potash has been 5.7 cents, the range being from 4.7 to 6 cents.

The percentages of chlorine in four samples of the double sulphate were 2.24, 1.68, 1.66, and 1.08.

Kainit.

Two samples of kainit containing 12.7 *per cent.* of potash cost $12 and $14 per ton respectively, and the potash in them cost 4.8 and 5.4 cents per pound respectively.

The values just stated may be summarized as follows:

COST OF FERTILIZER PLANT-FOOD IN CONNECTICUT, SPRING OF 1897.

	Cents per pound.		
	Average.	Max.	Min.
Nitrogen in nitrates	14.7	15.6	13.7
in sulphate of ammonia	14.4	14.4	14.4
organic, in cottonseed meal	11.6	12.7	10.4
" " " " (unhulled)	16.4	---	---
" castor pomace	19.8	21.1	18.5
Phosphoric acid, soluble and reverted, in dissolved bone black	6.6	6.7	6.3
Phosphoric acid, soluble and reverted, in dissolved rock phosphate	4.8	5.2	4.4
Potash, as muriate	4.2	4.5	3.9
as high grade sulphate	5.1	5.5	4.7
as double sulphate	5.7	6.0	4.7
as kainit	5.1	5.4	4.8

It is seen that nitrate-nitrogen can be bought for 14.7 cents per pound, quickly available organic nitrogen for 12 cents or less per pound, phosphoric acid in soluble form for 5 cents per pound and potash for 4¼ cents per pound.

It also appears that there is a mean difference of about 7 per cent. between the average and the maximum cost, a premium for care and skill in making purchase of fertilizers.

It is also shown that clubs, by making purchases of nitrate of soda and of acid phosphate in car lots or mixed car lots, have got these articles for from 15 to 27 per cent. below the average selling price.

Fish, Bone, Tankage.

Each of the materials thus far noticed contains only one of the three fertilizer ingredients in any considerable quantity.

All the other fertilizers in common use in this State contain two or more ingredients, so that we cannot directly calculate the actual cost per pound of the plant food in them.

For instance, three samples of dry ground fish recently analyzed have the following average composition and cost:

Nitrogen as ammonia	.61	per cent.
" organic	7.83	"
Phosphoric acid, soluble	.83	"
" reverted	5.69	"
" insoluble	.94	"
Cost per ton	$30.00	

In one ton there are:

12.2 pounds of ammonic nitrogen,
157.6 " " organic nitrogen,
130.4 " " available phosphoric acid,
18.8 " " insoluble phosphoric acid,

and the whole costs $30.00.

That the fertilizer ingredients cost more in fish than in sulphate of ammonia, cottonseed meal and acid phosphate is evident. The same quantities of ammonic and organic nitrogen and available phosphoric acid, which a ton of dry fish contains, could be bought in the forms named, for about $27.20.

The nitrogen of cottonseed meal is more available than that of fish, and it is also likely that the available phosphoric acid of acid phosphate is more effectual than that of fish. On the other

hand, the fish contains nitrogen and phosphates intimately mixed, which in some cases is a convenience.

Bone and tankage not only contain two elements of plant food, nitrogen and phosphoric acid, but the rapidity with which plants can take them up depends largely on their mechanical state, whether fine or coarse, hard or soft.

It is therefore quite impossible to make any very strict comparison of the commercial cost of nitrogen and phosphoric acid in bone and tankage with their cost in fertilizer chemicals such as have been previously discussed, and the comparative agricultural value of bone in different degree of fineness is not at present known.

Large quantities of bone, tankage and fish are used in this State. It is acknowledged that their action on crops is not as quick as that of the more soluble fertilizers, nitrate of soda, sulphate of ammonia, cottonseed meal and acid phosphates. Bone, fish and tankage are thought, however, to have a more "lasting" effect, to "carry the crop along" better than the others.

On the other hand, it should be borne in mind that very excellent results have been secured in fertilizing peach orchards and nurseries with nitrate and acid phosphate, together with potash salts, where a slow, "lasting" action would seem to be required, and it is also true that on hoed crops, garden truck, etc., the quicker the action of the fertilizer the sooner will it make returns for the investment.

It is believed by many good farmers that in most cases the substitution of these soluble chemicals for bone, tankage and fish will be found to pay.

Nitrate of Soda, Sulphate of Ammonia and Potash Salts require much care in their application, as, unless finely pulverized and uniformly spread, they easily injure young and tender vegetation.