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OF THE

## UNIVERSITY OF TENNESSEE,

STATE AGRICULTURAL AND MECHANICAL COLLEGE.

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## NOTES ON FERTILIZERS AND FERTILIZING MATERIALS.

KNOXVILLE, TENNESSEE,
U. S. A.

# THE AGRICULTURAL EXPERIMENT STATION

## OF THE UNIVERSITY OF TENNESSEE.



The Station has good facilities for analyzing and testing fertilizers, cattle foods, milk and dairy products; seeds, with reference to their purity or germinating power; for identifying grasses and weeds and studying forage plants; for investigating the diseases of fruits and fruit trees, grains and other useful plants; for making reports on injurious insects, and the best means of combatting them.

The Bulletins and Reports will be sent, free of charge, to all farmers.

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EXPERIMENT STATION,

KNOXVILLE, TENN.

☞The Experiment Station building, containing its offices, laboratories and museum, and the plant-house, and horticultural department are located on the University grounds, fifteen minutes walk from the Custom House in Knoxville. The Experiment Farm stables, milk labroatory, etc., are located one mile west of the University on the Kingston pike. The farmers are especially invited to visit the buildings and experimental grounds.

# CHEMICAL DIVISION.

## NOTES ON FERTILIZERS AND FERTILIZING MATERIALS.

By W. E. Stone.

The purpose of this Bulletin is to discuss the nature and value of some of the fertilizing materials, such as commercial fertilizers, agricultural chemicals, waste materials, marls, etc., which are available to the farmer of the State. In order to make this discussion of practical value a variety of such materials has been procured from various sources, and their constituents determined by chemical analysis. With one or two exceptions all the materials mentioned are actually for sale or can be procured within the State. The list does not include all such materials to be found in the State, but it is thought that the different classes are sufficiently well represented to give a general idea of their comparative values.

The following pages aim to present therefore, a fair representation of the fertilizing materials at the disposal of Tennessee farmers, and, by pointing out the characteristic and valuable features of each, to place in the hands of reading and thinking farmers a basis for the more intelligent purchase and use of fertilizers. The facts presented are not new but are based on recognized and accepted principles of good farming and fertilization, and are offered here in connection with the analyses of different fertilizers with the intention that each shall illustrate and emphasize the other.

Some of the commercial fertilizers have been forwarded to the Station by the Commissioner of Agriculture under the provisions of the State law; some have been sent in by inquiring farmers or secured from local dealers, while others have been obtained direct from the manufacturers and dealers in such materials.

It will be proper, before considering the different fertilizers in detail, to once more call attention to some of the foundation principles governing the general use and value of fertilizing materials.

The name fertilizer is by no means limited in its meaning to materials or artificial mixtures prepared and sold under that name. It means any substance, which, by its addition to the soil is intended to cause a better growth of plants. Such materials may have a great variety of form and may act in a variety of ways,

but their value and effect upon plants (i. e. the crop) always depend upon the nature of their constituents. Fertilizers to be effective must supply to the soil, and hence to the growing crop such materials as are required by the demands of the latter and are lacking in the soil. A fertilizer is after all only a supplement to the resources of the soil—a deposit to replace the drafts made by the production and removal of crops. To attempt to produce crops on insufficient food is poor economy. To supply materials to the soil which are already there in abundance is a waste. The intelligent use of fertilizers, therefore, requires knowledge on two points:

1. With regard to the needs of the crop to be produced and the ability of the soil to supply these needs.

2. With regard to the composition of fertilizers used and their ability to supplement the deficiencies of the soil.

Information on the first subject can only be obtained by long and careful observations by the farmer himself upon his own fields. With regard to fertilizers however, a chemical analysis determines what their constituents may be, their comparative values, and, in a geueral way, their efficiency in the soil.

Fertilization is therefore the process of maintaining in the soil the necessary supplies of plant food. In a state of nature in which plants die and decay on the spot where they have grown and matured, all the materials which they have drawn from the soil are returned. There is no loss but rather a gain, hence artificial fertilization is unnecessary. But the system of cropping as practiced by man removes from the soil each season a large amount of valuable material, which, according to the laws of supply and demand must be returned.

The chemical analysis of plants shows that all, without exception, contain the following fourteen elementary substances: Carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, iron, alumina, lime, magnesia, soda, potash and silica. These substances, or elements, are therefore regarded as essential to plant growth, i. e., no plant can grow and mature normally without a supply of the same. It is not however, necessary to return to the soil the exact amount of these materials withdrawn in the crop. The great bulk of the plant (95 per cent. or more) is made up of carbon, hydrogen and oxygen, which it obtains from the air and soil without farther care or provision on the part of man. The *ash materials*—that part remaining when a plant is burned and consisting of iron, alumina, lime, magnesia, soda, potash, silica and most of the chlorine, sulphur and phosphorus, are derived from the soil, as is also the nitrogen, in all save exceptional cases. Of these elements some are naturally more abundant than

others. For instance there is no lack of those supplied by the air, and the soil contains an abundance of nearly all the ash materials. In general, the elements in which the soil is deficient are *nitrogen*, *phosphoric acid* and *potash*, hence these are the first to be exhausted by the production and removal of crops.

These are the materials therefore, which we aim to supply to the soil in fertilizers—*nitrogen*, *phosphoric acid* and *potash*.

The ideal fertilizer is the plant itself, returned to the soil and allowed to decay there. On this account the plowing under of green crops is so beneficial. For this reason virgin soils on which plants have grown and decayed year after year are so fertile. Next to this comes the dung of animals feeding on plants — herbivorous animals—and composts prepared from vegetable matter. Then follow the great variety of materials like commercial fertilizers, ashes, plaster, marls, waste products, agricultural chemicals, etc., which may supply only one or two of the elements necessary to plant growth and are, therefore, to be regarded more as of *special* than *general* value.

The form in which these elements are offered as fertilizers, is somewhat variable, but they always occur in combination with other elements: For instance, nitrogen is sold in the form of ammonia, saltpetre, and as organic nitrogen in substances like dried meat and blood, cotton-seed meal, etc. Potash is sold as potash salts, (muriate of sulfate) cotton-seed ashes, wood ashes, etc. Phosphoric acid comes in the form of bones, the mineral or rock phosphates, etc.

These materials are sold in the markets at regular prices like other commodities and hence it is possible to calculate the average value of a pound of nitrogen or potash or phosphoric acid in all the different forms in which it is obtained. Knowing the *market* values of these materials it is easy to compute the corresponding value of any fertilizer after its composition has been ascertained. But the values thus obtained must not be understood as being *actual*; they do not represent what any particular fertilizer is worth to a crop; that is quite another matter. They do represent what the *materials* contained in that fertilizer can be bought for, at average prices, in the great market centres. These values do *not* represent prices at which the maker of the fertilizer should sell the same, because they take no account of his expenses or profits, matters in which no outside party has the right to interfere. *They do aim to offer a means by which the farmer may compare the values of different fertilizers with each other.* They enable one to say with all justice, *if* a certain fertilizer is worth $40 per ton, then a certain other one is worth $45 per ton, and so a guide is furnished to economical and intelligent purchase. This schedule of *trade*

*values* of fertilizing materials is made up each year by representatives of prominent experiment stations. That given here is for the year 1888, that for 1889, having not yet appeared. While no longer strictly applicable, it will serve the purpose desired, viz., a basis for comparison.

*SCHEDULE OF TRADE VALUES OF FERTILIZING MATERIALS AS ADOPTED BY EXPERIMENT STATIONS FOR 1888.

*Copied from Bulletin XLIX of the New Jersey Experiment Station.

| | | |
|---|---|---|
| Nitrogen in Ammonia Salts, | 17½ cts | per lb. |
| " " Nitrates, | 16 " | " |
| Organic Nitrogen in dried and fine ground fish, meat, blood, castor pomace and cotton-seed meal, | 16½ " | " |
| Organic Nitrogen in fine ground bone and tankage, | 16½ " | " |
| " " " fine-medium bone and tankage, | 13 " | " |
| " " " medium bone and tankage | 10½ " | " |
| " " " coarser bone and tankage, | 8½ " | " |
| " " " horn shavings, hair and coarse fish scrap, | 8 " | " |
| Phosphoric Acid, soluble in water, | 8 " | " |
| " " soluble in ammonium citrate, | 8 " | " |
| " " in dry ground fish, fine bone and tankage, | 7 " | " |
| " " in fine-medium bone and tankage, | 6 " | " |
| " " in medium bone and tankage, | 5 " | " |
| " " in coarser bone and tankage, | 4 " | " |
| " " in fine ground rock phosphate, | 2 " | " |
| Potash as High Grade Sulphate, and forms free from Muriates (or Chlorides), | 5½ " | " |
| Potash as Kainite, | 4½ " | " |
| " as Muriate, | 4½ " | " |

The analyses made and discussed in the following pages include:

16 Commercial fertilizers.
2 Samples of bone meal.
2 Samples of cotton-seed meal.
3 Samples of cotton-hull ashes.
2 Samples of marl.
1 Sample of phosphate meal.
1 Sample of plaster.
5 Samples of agricultural chemicals.
1 Sample of cattle dung.
1 Sample of bat dung.
1 Sample of tannery waste.
1 Sample of tankage.

## COMMERCIAL FERTILIZERS.

The term "commercial fertilizer" is commonly applied to artificial preparations or mixtures of fertilizing materials sold under trade names such as "phosphates," "guano," etc., which are thus distinguished from the simple materials such as bone meal, cotton seed meal, potash salts, etc., which are sold under their ordinary names. This distinction is not a strict one, but it holds true in most cases and may be used here for the sake of a simple classification.

Almost without exception commercial fertilizers contain phosphoric acid: if in addition to this they contain nitrogen and potash they are called "complete fertilizers" because they supply the

three elements of plant food which are commonly lacking in the soil. Some contain only phosphoric acid and nitrogen, and others only phosphoric acid and potash.

Commercial fertilizers are made by the artificial mixture of certain substances known to contain these elements. For instance, the phosphoric acid is supplied in ground bones, the mineral phosphates, fish refuse, etc., and nitrogen is furnished in cotton seed meal, bones, tankage, saltpeter, etc., while potash is obtained from ashes, kainit, potash salts, etc. In some communities it has become a practice among farmers, of late years, to compound their own fertilizers by purchasing the ingredients and mixing them at the farm. Under certain conditions this plan will prove economical and profitable.

Naturally the quality of the materials used will affect the value of the fertilizer. For instance the nitrogen in saltpeter, dried blood and cotton-seed meal is considered to be twice as valuable as that in coarse bones and tankage because it is more soluble and available to the plant. The phosphoric acid which is soluble in water is four times as valuable as that contained in the fine ground phosphatic rocks, because in the latter it is practically insoluble. On this account the chemical analysis endeavors to state so far as possible the forms and availability of the elements present.

A word may be said here in explanation of the terms used in stating the results of analyses. The amounts of the different elements found are stated in *percentages*, or, what is the same, the pounds of the given element found in every one hundred pounds of the fertilizer as sold and used.

*Moisture* indicates the amount of water which the material contains. The quantity varies from one to twenty per cent, but some is always present, and since it is paid for at the same price per pound as the other materials, it is important to know what part it forms of the whole.

*Phosphoric acid* is stated in three forms:—"Soluble" is that which can be dissolved in pure water. "Reverted" is that which is insoluble in pure water but is soluble in a weak chemical (ammonium citrate). "Insoluble" is that which is insoluble except in strong acids. The sum of the "soluble" and "reverted" acid makes up the "available" acid, as it is often stated on bags and packages, i. e., the acid which is actually available to the plant.

*Potash* is stated as "potassium oxide." It does not exist in this form in the fertilizer, but usually as a carbonate, muriate or sulfate. It is stated in this way in order that a common comparison between different fertilizers may more easily be made.

*Nitrogen* is usually stated as such in analyses. Ammonia is a compound of nitrogen and the statement "actual" and "potential"

ammonia usually given by the manufacturers of fertilizers means that the nitrogen present is there as "actual" ammonia or is capable of combining to form the given amount of (potential) ammonia. 14 parts of nitrogen make in this way 17 parts of ammonia. In the following analysis the nitrogen is computed as "potential" ammonia.

*I. Complete Fertilizers furnishing Phosphoric Acid, Nitrogen and Potash.*

2. "I. X. L. Ammoniated Bone Superphosphate." Geo. W. Miles, Agt., Milford, Conn.

3. "Planters Soluble Guano." Made by Adair Bros. & Co., Atlanta, Ga.

4. "Furman's Ammoniated Soluble Bone." Made by Adair Bros. & Co., Atlanta, Ga.

8. "Ammoniated Bone." Made by the Baldwin Fertilizer Co., Savannah, Ga.

| | 2 | 3 | 4 | 8 |
|---|---|---|---|---|
| | (Percentages or pounds in 100 lbs of Fertilizers.) | | | |
| Moisture | 7.01 | 10.49 | 11.52 | 16.39 |
| Soluble Phosphoric acid | 7.05 | 7.97 | 7.41 | 10.13 |
| Reverted " " | 1.98 | 2.30 | 2.76 | 1.35 |
| Insoluble " " | 1.29 | 1.83 | 1.85 | 0.00 |
| Total " " | 11.32 | 12.10 | 12.02 | 11.48 |
| Potential Ammonia | 2.30 | 2.50 | 1.76 | 1.34 |
| Potassium oxide | 1.26 | 1.02 | 1.59 | 0.98 |
| Trade value per ton of 2000 lbs. | $22.65 | $24.98 | $23.39 | $22.99 |

11. Fertilizer made by the Jackson Oil Mills, Jackson, Tenn.

M. 9. "Eddystone Soluble Guano," sent on by H. C. Jones, Piney, Tenn.

M. 11. "Tennessee Guano," made by the National Fertilizer Co., Nashville, Tenn.

| | 11 | M. 9. | M. 11 |
|---|---|---|---|
| Moisture | 6.45 | 16.61 | 11.77 |
| Soluble Phosphoric acid | 4.91 | 9.08 | 9.08 |
| Reverted " " | 2.43 | 2.54 | 2.81 |
| Insoluble " " | 2.32 | 2.11 | 2.87 |
| Total " " | 9.66 | 13.73 | 14.76 |
| Potential Ammonia | 3.48 | 0.37 | 1.96 |
| Potassium oxide | 2.93 | 0.93 | 1.15 |
| Trade value per ton of 2000 lbs | $25.07 | $20.86 | $25.94 |

M. 9. was sent on unaccompanied by guarantee or selling price. It contained a large amount of moisture and very low amounts of nitrogen and potash and cannot be recognized as a fertilizer of high grade.

14. "Furmans High Grade Guano," made by Adair Bros. & Co., Atlanta, Ga.

*a.* Sample received from Inspector E. G. Currey, Nashville, Tenn.

*b.* Sample received from E. W. Gillespie, Beaver Ridge, Tenn.

15. "Buffalo Bone Guano," made by Adair Bros. & Co., Atlanta, Ga.

*a.* Sample received from Inspector E. G. Currey, Nashville, Tenn.

*b.* Sample received from E. W. Gillespie, Beaver Ridge, Tenn.

| | 14 | | 15 | |
|---|---|---|---|---|
| | *a.* | *b.* | *a.* | *b.* |
| Moisture | 12.96 | 9.83 | 10.75 | 12.12 |
| Soluble Phosphoric acid | 8.00 | 7.87 | 7.36 | 7.62 |
| Reverted " " | 1.34 | 1.36 | 1.89 | 1.02 |
| Insoluble " " | 2.30 | 3.29 | 3.01 | 1.33 |
| Total " " | 11.64 | 12.52 | 12.26 | 9.97 |
| Potential Ammonia | 2.61 | 3.09 | 2.70 | 3.40 |
| Potassium oxide | 2.27 | 2.70 | 1.56 | 1.70 |
| Trade value per ton of 2000 lbs | $25.23 | $27.20 | $24.96 | $25.29 |

A comparison of these nine complete fertilizers shows how they naturally fall into one class containing 1 to 3 per cent. of potash, 1½ to 3½ per cent. of potential ammonia and 9 to 12 per cent. of phosphoric acid. A fertilizer corresponding with these in general composition and value may be easily compounded by any farmer who has the facilites for weighing and mixing the materials. A few formulæ or recipes are given showing the proportion in which the ingredients are to be used to give different qualities of composition.

1.

1000 lbs. of acid phosphate containing 14 per cent. available phosphoric acid.
700 lbs. of cotton seed meal.
300 " " cotton hull ashes.

2000 " containing approximately 3½ per cent. available phosphoric acid, 3½ per cent. of potassium oxide and 2 per cent. of nitrogen.

2.

1000 lbs of acid phosphate with 14 per cent. available phosphoric acid.
800 " " cotton seed meal.
200 " " " hull ashes.

2000 " containing approximately 8 and 3-10 per cent. phosphoric acid, 2½ per cent. of potassium oxide and 2½ per cent. of nitrogen. The nitrogen has been increased at the expense of the potash.

3.

500 lbs. fine ground bone.
500 " acid phosphate with 14 per cent. available phosphoric acid.
800 " cotton seed meal.
200 " " hull ashes.

2000 " containing approximately 9½ per cent. of phosphoric acid

2½ per ct. of potassium oxide and 3 and 3-10 per ct. of nitrogen. The phosphoric acid has been increased here, but a portion of it is in a form not readily available. The phosphoric acid of ground bone is regarded, however, as the most desirable form for permanent grass lands where a continued action is desired.

4.

800 lbs. acid phosphate with 14 per cent. available phosphoric acid.
400 " fine ground bone.
600 " cotton seed meal.
100 " " hull ashes.
100 " muriate of potash.

2000 lbs. containing 10½ per cent. of phosphoric acid, 3¾ per cent. potassium oxide and 2½ per cent. of nitrogen.

5.

800 lbs acid phosphate with 14 per cent available phosphoric acid.
400 " fine ground bone.
700 " cotton seed meal.
100 " muriate of potash.

2000 lbs containing 10 per cent phosphoric acid, 2¾ per cent of potassium oxide and 2¾ per cent of nitrogen.

*II. Fertilizers furnishing only Phosphoric Acid and Nitrogen.*

6. "Adair's Ammoniated Dissolved Bone," made by Adair Bros. & Co., Atlanta, Ga.

7. "Homestead Guano," made by Michigan Carbon Works, Detroit, Mich.

| | 6 | 7 |
|---|---|---|
| Moisture | 10.97 | 10.13 |
| Soluble Phosphoric acid | 8.92 | 7.77 |
| Reverted " " | 1.10 | 1.07 |
| Insoluble " " | 0.15 | 0.54 |
| Total " " | 10.17 | 9.38 |
| Potential ammonia | 2.90 | 2.10 |
| Total value per ton of 2000 lbs | $23.96 | $20.07 |

Besides these artificial mixtures, the various grades of ground bone offered for sale furnish nitrogen and phosphoric acid also. The value of ground bone depends upon its fineness, since this influences its decomposition and availability in the soil. The process of steaming and boiling to which bones are subjected for the extraction of the glue and fat, also removes more or less of the nitrogenous matter; the same has been completely destroyed in bone ash. Hence of the various forms of bone offered for sale the nitrogen of raw bones is most valuable, that of steamed bones next, while bone black, bone ash, etc., contain none at all.

Following are some analyses of bone meal:

1. "Raw Bone." Sample sent by Inspector E. G. Currey.

10. "Pure Bone Meal." From Memphis Fertilizer Co., Memphis, Tenn.

M. 17. "Bone Meal." From National Fertilizer Co., Nashville, Tenn.

| | 1 | 10 | M. 17 |
|---|---|---|---|
| Moisture | 6.17 | 8.04 | 7.67 |
| Total Phosphoric acid | 19.45 | 23.35 | 24.47 |
| Potential ammonia | 3.86 | 2.57 | 3.15 |
| Total value per ton of 2000 lbs | $33.83 | $35.05 | $37.94 |

The phosphoric acid of bones is insoluble in water and is therefore not so readily available as the soluble acid of artificially-made fertilizers. Bone has the property, however, of undergoing slow decomposition in the soil by which its acid is gradually made soluble, hence it is highly prized as a fertilizer which will continue to do good in the soil for a series of years.

For home mixing of fertilizers of the above class, containing only phosphoric acid and nitrogen, acid phosphate or ground bones, may be used with cotton seed meal, as follows:

1.

1200 lbs acid phosphate with 14 per cent available phosphoric acid.
800 " cotton seed meal.

2000 lbs containing approximately 2½ per cent of nitrogen and 9 per cent of phosphoric acid.

2.

1000 lbs of acid phosphate, as above.
200 " fine ground bone.
800 " cotton seed meal.

2000 lbs containing approximately 2¾ per cent nitrogen and 9½ per cent phosphoric acid.

3.

1200 lbs cotton seed meal.
800 " fine ground bone.

2000 lbs containing approximately 9 per cent of phosphoric acid 3½ per cent of nitrogen.

*III. Fertilizer furnishing Phosphoric Acid and Potash.*

9. "Bone and Potash," made by Baldwin Fertilizer Co., Savannah, Ga.

| | 9 |
|---|---|
| Moisture | 18.96 |
| Soluble Phosphoric acid | 10.86 |
| Reverted " " | 0.87 |
| Insoluble " " | 1.74 |
| Total " " | 13.47 |
| Potassium oxide | 3.51 |
| Trade value per ton of 2000 lbs | $22.95 |

This class of fertilizers is incomplete on account of the absence of nitrogen. A mixture of equal value would be made by combining 1650 lbs of acid phosphate, with 14 per cent of available phosphoric acid, with 350 lbs of cotton-hull ashes.

*IV. Fertilizers furnishing Phosphoric Acid only.*

This class of fertilizers is usually sold under the names of "acid phosphates," "super-phosphates," etc. They are composed of bone or rock phosphate, usually the latter, in which the phosphoric acid has been converted from an insoluble to a soluble form by treatment with sulphuric acid. Such fertilizers are of value simply for the soluble or available phosphoric acid which they contain. It must be borne in mind however that this "soluble" acid is subject to reversion, i. e., a changing back to an insoluble condition, especially in goods which have been prepared for a long time.

5. "Furman's Acid Phosphate." Made by Adair Bros. & Co., Atlanta, Ga.

12. "Acid Phosphate." Made by Baldwin Fertilizer Co., Savannah, Ga.

13. "X. L. C. R. Acid Phosphate." Geo. W. Miles, Agt. Milford, Conn.

| | 5. | 12. | 13. |
|---|---|---|---|
| Moisture | 12.39 | 14.58 | 2.93 |
| Soluble Phosphoric acid | 10.49 | 11.85 | 12.09 |
| Reverted " " | 3.12 | 2.36 | 2.40 |
| Insoluble " " | 2.32 | 1.60 | 1.87 |
| Total " " | 15.93 | 15.81 | 16.36 |
| Trade value per ton of 2000 lbs | $22.31 | $23.37 | $22.93 |

FERTILIZERS CONSISTING OF WASTE MATERIALS, BYE-PRODUCTS, ETC.

True economy in every industry includes a careful saving of wastes—waste force, and waste materials. Unfortunately this principle is not sufficiently recognized among farmers, and especially with regard to fertilizing materials. It is not good economy to buy commercial fertilizers at $25 to $40 per ton and allow the manure piles of the farm to lie exposed to the leaching effect of every rain storm. The waste materials to be found in cities and large towns incident to certain lines of manufacturing are too valuable to be ignored. The refuse from tanneries, soap works, slaughter houses, garbage, sewage, the manure from city stables, waste from oil mills, etc., all have a value. Nothing will serve to illustrate this point more fully than the cotton industry and its bye-products. This is of especial interest to the southern states and particularly to the cotton belt of West Tennessee. Not

many years ago the value of the cotton seed was almost unknown. It was regarded as a waste product in the production of cotton, which was almost worthless. The discovery that it contained a valuable oil changed the aspect of affairs at once. Numerous factories sprang up, and the cotton seed oil industry has assumed a magnitude considered worthy of the attention of monopolies. The waste cotton seed thus obtained a value, but there still remained a waste product, two in fact, after the extraction of the oil—the hulls and the ground and extracted cotton seed meal. Gradually the value of these materials has also become recognized. The meal serves both as a cattle food and fertilizer, and the ashes of the hulls as a rich source of potash. To-day the cotton seed meal and ashes are recognized as among the most valuable domestic fertilizing materials which we have. Following are analyses of both these products made from samples supplied within the State.

COTTON SEED MEAL.

M. 10. Cotton seed meal collected from J. W. Gaut, Knoxville, Tenn.

M. 16. Cotton seed meal collected from National Fertilizer Co., Nashville, Tenn.

The third column gives the average composition of cotton seed meal—being the average of several analyses made elsewhere:

| | M. 10. | M. 16. | Average. |
|---|---|---|---|
| Moisture | 7.08 | 8.05 | 6.80 |
| Phosphoric acid | 2.53 | 3.03 | 1.45 |
| Magnesium oxide | 1.12 | 1.25 | 0.99 |
| Calcium oxide | 0.36 | 0.32 | 0.39 |
| Potassium oxide | 1.78 | 1.97 | 0.89 |
| Potential ammonia | 8.69 | 8.78 | 7.41 |
| Trade value per ton of 2000 lbs | $28.87 | $30.09 | $23.15 |

The samples analysed were of more than average value. It is noteworthy that they contained as much potash as many of the complete fertilizers, and three to four times as much nitrogen.

COTTON-HULL ASHES.

M. 7. "White" ashes, from Jackson Oil Mills, Jackson, Tenn.
M. 8. "Gray" " " " " " "
M. 15. Ashes from National Fertilizer Co., Nashville, Tenn.

The fourth column gives the average of many analyses:

| | M. 7. | M. 8 | M. 15 | Average |
|---|---|---|---|---|
| Moisture | 0.25 | 2.52 | 2,17 | 7.33 |
| Insoluble matter, (sand, charcoal, etc.) | 43.30 | 17.69 | 14.72 | 11.79 |
| Phosphoric acid | 2.37 | 8.55 | 8.76 | 7.52 |
| Calcium oxide | 3.46 | 9.92 | 9.92 | 10.00 |
| Magnesium oxide | 7.32 | 15.56 | 10.97 | 9.50 |
| Potassium oxide | 29.52 | 29.32 | 26.92 | 20.95 |
| Trade value per ton of 2000 lbs | $32.36 | $37.87 | $37.43 | $29.97 |

It will be seen that the amount of phosphoric acid present in these ashes nearly equals that in some of the commercial fertilizers already mentioned, but the characteristic feature is the very high percentage of potash, and herein rests their great value.

These ashes are sent to the northern States in large quantities, where farmers have been quick to recognize their value and where they have become to a considerable extent a substitute for Canadian wood ashes. As the result of rather limited inquiry they have not been found on sale in this State. A manufacturing firm in West Tennessee, which produces them in large quantities, writes: "They are little, if any, used in the neighborhood of the mills where they are produced, but the market for this product is found in the New England States, where they find a ready sale at good figures."

Let us now consider the meaning of this production of the cotton crop and disposal of its waste products. A ton of cotton seed meal as we have seen has, at a low estimate, a trade value of $23.15; a ton of cotton hull ashes, a corresponding value of $29.97. The materials representing these sums are drawn directly from the soil; they represent so many dollars taken from it. These facts mean a decreased ability of the soil to produce a crop next season. They mean a weakening of the soil resources by just so many dollars. Now, of course no cotton grower fails to realize that he must replace these materials sooner or later; even the rich alluvial river bottoms will not always grow cotton without some reinforcement. The point to be learned from a study of the facts is, that Tennessee farmers cannot afford to let a pound of these materials go over their borders. Why send this nitrogen, this phosphoric acid and this potash away to the north and then purchase the same articles in fertilizers, the costly materials for which have been imported from the coasts or perhaps from beyond the seas? The bad economy of such a system is too apparent to need discussion. It is only necessary to emphasize the fact that within our own borders, almost within our cotton fields are cheap supplies of the most valuable fertilizing materials, which have been taken from the soils and in no way are so easily replaceable as by the return of these waste products to the fields from which they came.

## FERTILIZERS CONTAINING LIME.

Lime is the chief constituent of all marls, plaster, quicklime and crushed limestone. In plaster it exists as a sulphate, in the other materials as a carbonate or oxide.

The following analysis of plaster is from a sample from the de-

posits at Saltville, Va., and collected of J. W. Gaut, Knoxville, Tenn.

| | |
|---|---|
| Moisture, | 6.87 |
| Insoluble matter, | 23.18 |
| Calcium oxide, (Lime) | 21.95 |
| Sulfuric acid, ($SO_3$) | 30.22 |
| Equivalent to | 51.37 per cent sulfate of lime. |

Complaint was made that plaster from this deposit was no longer so effective as in former years; that it gave poorer results and was altogether unsatisfactory.

This sample is somewhat under the average plaster in the amount of sulphate of lime it contains, good qualities ranging from 60 to 70 per cent. of the constituent. It is, however, considerably above the gypseous shales in composition. Concerning its inefficient action reference will be made later.

The term "marl" is given to certain deposits containing considerable quantities of carbonate of lime mixed with clay or sand. The fertilizing value of such materials depends upon the amount of carbonate of lime which they contain, although some also contain small quantities of phosphoric acid and potash.

M. 3. Is marl from West Tennessee, sent on by W. M. Williams, of Cairo, Ill.

M. 4. Is not a true marl, but a tufa-like calcareous material sent by L. B. Bewley, Springvale, Tenn.; nearly white in color, easily crumbled in the fingers and containing occasional fossil shells.

| | M. 3. | M. 4. |
|---|---|---|
| Moisture, | 3.41 | 0.20 |
| Insoluble matter, | 56.79 | 2.18 |
| Calcium oxide, | 15.72 | 48.97 |
| Carbonic acid, | 14.37 | 43.19 |
| Equivalent to Calcium Carbonate | 29.87 | 87.44 |
| Sesqui-oxide of iron and alumina, | 4.20 | —— |
| Phosphoric acid, | 0.43 | —— |

At this point, a word with regard to the action of lime as a fertilizer may be in place. As already stated, ordinary soils are rarely lacking in sufficient lime to supply all the demands of the plant; this is especially true of limestone regions like that of East Tennessee. Lime applied to such soils has no *direct* action as a fertilizer. Its real action is of two sorts:

1. Burned lime when added to the soil decomposes vegetable matter already there and sets free plant food which was not previously available to the plant. We see the same effect when lime is used for cleaning hides, disinfecting, or making composts. It destroys organic and vegetable matter by which fertilizing elements contained therein are liberated. Nitrogen is converted into ammonia and set free; other materials are brought into soluble form and

may be washed out of the soil. If lime is added to a soil rich in organic matter, such as vegetable mold or stable manure, it tends to convert them into available plant food. In this respect the action is beneficial in so far as the plant is supplied with an abundance of food. But this supply is made at the expense of other materials than the lime; it acts only indirectly. If large quantities are applied the result may be that a large excess of plant food will be decomposed, particularly the vegetable matter—the present crop benefits richly, but before another season the surplus of food may have been washed away and the following crop will be more poorly supplied than if the lime had not been applied. The ultimate effect of applying lime to the soil is, therefore, exhaustion of other food materials. It directly supplies nothing to the plant which is not already in the soil, and its entire benefit is at the expense of other materials. If used at all therefore, it should be in connection with liberal additions of actual fertilizing substances.

2. Sulphate of lime or plaster is more favorably regarded than other forms. It seems to act beneficially upon clover, peas, lucern and all plants of that class. It is however, only slowly soluble in the soil and its value must be slight, particularly in limestone regions.

The complaints noted above were doubtless caused, not by the quality of the plaster used, but owing to the fact that East Tennessee soils contain already a surplus of lime.

Plaster serves a most excellent purpose as an absorbent, since it possesses the property of combining with ammonia, produced by the decomposition of nitrogenous matter, the heating of manure, etc., forming compounds in which the ammonia is no longer subject to evaporation and loss. It is of value therefore for sprinkling upon manure piles and mixing with compost heaps.

In soils containing silicates of potash, plaster may act upon the same with the effect of bringing the potash into a soluble form. The value of plaster for this purpose is certainly not to be underated.

### PHOSPHATE MEAL—THOMAS SLAG—PEINE-THOMAS SCORIA.

These names are given to a waste material or slag, resulting from the application of a comparatively new process for the removal of phosphorus from iron, in the manufacture of steel. As imported from Europe it is a fine, dark brown meal. The phosphoric acid is present in combination with lime, and while only traces are soluble in water, and none of it is commonly regarded as "available," yet its condition and composition is such that it has been found to be to a considerable degree soluble in soil water, par-

ticularly if it contains considerable carbonic acid. Its actual value as a source of plant food has been but little studied in this country. Some comparative investigations made in foreign Experiment Stations indicate that the "Thomas Slag" is a more valuable material than the ordinary mineral phosphates.

A sample received here for analysis contained:

| | |
|---|---|
| Moisture, | 0.73 per cent. |
| Total Phosphoric acid, | 20.47 " |

6.04 per cent. phosphoric acid were soluble in ammonium citrate, treated in the usual way, but strictly speaking it is doubtful if this may be regarded as "reverted" acid, owing to the peculiar basic nature of the "slag." In any case the material deserves a closer examination.

### TANKAGE.

The refuse materials from slaughter houses, including bones, blood, fleshy matter, etc., is dried, ground fine, and sold under the name of "tankage." Such a mixture forms, naturally, a valuable fertilizing material. The bones furnish phosphoric acid and the blood and meat nitrogen or potential ammonia. The only sample received here, thus far, contained:

| | |
|---|---|
| Moisture, | 6.84 per cent. |
| Phosphoric acid, | 4.63 " |
| Potential ammonia, | 5.32 " |

The quality of this is inferior, such materials usually containing about ten per cent. phosphoric acid and 7 to 8 per cent. ammonia. This, it will be seen by comparison, is rather inferior in value to cotton seed meal.

### AGRICULTURAL CHEMICALS.

Several samples of so-called agricultural chemicals have been procured from manufacturers within the State, including muriate of potash, kainit, nitrate of soda, or saltpeter and sulfate of ammonia. These are all concentrated materials furnishing potash or nitrogen.

Muriate of potash is mostly imported from Europe, in a crude form for use either alone or mixed with other materials as a fertilizer. The quality varies somewhat, as shown by the results of the two following analyses:

| | No. 1. | No. 2. |
|---|---|---|
| Moisture, | 0.72 per cent. | 1.24 per cent. |
| Potassium oxide | 47.52 " | 51.49 " |
| Equivalent to muriate of potash | 75.20 " | 81.53 " |

It is evident that this is one of the most concentrated forms of potash we have.

Kainit is a name given to a natural salt composed of sulfates of

potash and magnesia and chloride of magnesia obtained from the famous deposits at Stassfurt and Leopoldshall, in Germany, and largely imported by the fertilizer trade. Its chief value is based on the amount of potash which it contains, which is however much less than in the ordinary muriate of potash, as the analysis shows:

| | |
|---|---|
| Moisture, | 9.94 per cent. |
| Insoluble matter, | 5.52 " |
| Sodium oxide, | 9.90 " |
| Potassium oxide, | 10.98 " |
| Magnesium oxide, | 8.38 " |
| Calcium oxide, | 2.16 " |
| Chlorine, | 25.55 " |
| Sulfuric acid, ($SO_3$) | 19.01 " |

This sample is rather below the average quality, which usually contains from 12-16 per cent. of potash.

Nitrate of soda or saltpeter is valuable for the nitrogen it supplies. The sample examined contained:

| | |
|---|---|
| Moisture, | 1.14 per cent. |
| Nitrogen, | 13.99 " |
| Equivalent to ammonia, | 17.00 " |

Nitrogen in this compound is one of the most valuable forms for plant food, being immediately and easily soluble in the water of the soil, and may at once be absorbed and assimilated by the plant.

Sulfate of ammonia is still another form of nitrogen, being even more concentrated than the preceding compound. The sample analyzed contained:

| | |
|---|---|
| Moisture, | 1.10 per cent. |
| Actual ammonia, | 24.82 " |

These chemicals are, as a rule, too concentrated and costly for common use in general farming. They may be employed profitably in two ways: 1. In preparing a mixed fertilizer where it is desired to raise the percentage of nitrogen or potash without greatly increasing the bulk. 2. Upon special crops, as in market gardening, where it is desired to force rapid growth by means of quickly available and concentrated plant food.

### ANIMAL MANURES.

The dung of plant-eating animals forms a complete fertilizer for all forms of vegetation; less concentrated it is true, than many of the commercial or artificial manures, but possessing the advantage over most of the latter in supplying to the soil, organic matter which greatly improves its physical condition. The best system of general farming is believed to be that depending for fertilizing elements upon animal manures, properly supplemented

by special or so-called commercial fertilizers. With one exception, no analyses have been made at this Station of animal manure, but the following table gives the composition of the excrements of the four principal domestic animals, being the averages of many analyses. The figures relate to fresh dung with little or no admixture of foreign materials like straw, bedding, etc., and may be of interest as showing how these compare with other fertilizing materials:

| | Dung of | | | |
|---|---|---|---|---|
| | Horse. | Cow. | Sheep. | Swine. |
| Moisture, | 71.30 | 77.50 | 64.60 | 72.40 |
| Nitrogen, | 0.58 | 0.34 | 0.83 | 0.45 |
| Phosphoric acid, | 0.28 | 0.16 | 0.23 | 0.19 |
| Potash, | 0.53 | 0.40 | 0.67 | 0.60 |
| Calcium oxide, | 0.21 | 0.31 | 0.33 | 0.08 |
| Magnesium oxide, | 0.14 | 0.11 | 0.18 | 0.09 |
| Organic matter | 25.40 | 20.30 | 31.80 | 25.00 |

A sample of dung from cattle fed exclusively upon the waste from a cotton seed oil mill, was sent to the Station by Mr. John S. Price, of Houston, Texas. Its composition is of interest when compared with that of dung from cattle receiving ordinary rations, as showing the effect which a rich food may produce—the nitrogen and phosphoric acid having been increased to above the average:

| | |
|---|---|
| Moisture, | 77.50 |
| Nitrogen, | 0.53 |
| Phosphoric acid, | 0.22 |
| Potash, | 0.36 |

## BAT DUNG.

As a matter of local rather than general interest, the following analysis is given of a sample of bat dung collected in a cave near New Market, Jefferson county. A considerable deposit was observed in different parts of the cave, and we are informed that the material found a limited sale among the Knoxville gardeners at one time. The analysis shows its comparative value and may suggest its use in localities where such deposits occur. As collected the material was quite moist but free from foreign substances. A smell of ammonia was noticeable in the immediate neighborhood of the deposits, showing that decomposition and loss was going on.

The fresh material contained:

| | |
|---|---|
| Moisture, | 69.28 |
| Dry matter, | 30.72 |
| | 100.00 |
| Free ammonia, | 0.134 |

After drying in the air, it gave the following composition:

| | |
|---|---|
| Moisture, | 8.27 |
| Nitrogen, | 10.35 |
| Phosphoric acid. | 1.48 |
| Calcium oxide, | 0.49 |
| Magnesium oxide, | 0.32 |
| Potassium oxide, | 0.33 |

The material is unusually rich in nitrogen.

### TANNERY WASTE.

This material was composed of the fleshings from a city tannery, consisting of hair, flesh, pieces of hide, etc., mixed with quicklime. The whole mass had been allowed to decompose for nearly a year. A sample was dried by exposure in the air and then gave the following analysis:

| | |
|---|---|
| Moisture, | 3.47 |
| Potential ammonia, | 2.40 |
| Phosphoric acid, | 1.09 |

According to the schedule of prices already referred to, this material would be worth about $4.25 per ton.

### FERTILIZER INSPECTION.

According to the law of the State given in the following pages, all fertilizers sold within the State must bear plainly printed upon the bag or package a statement giving the actual chemical composition. The manufacturer guarantees that this statement represents the composition of the fertilizer to which it is attached. The sale of an article not true to this guarantee is punishable by law. As a controlling measure, the Commissioner of Agriculture inspects each brand of fertilizer offered for sale, and takes therefrom a sample which is subjected to analysis at this Station. The results of such analyses made during the last three months are given in the following table; together with the guarantees accompanying the samples. With few exceptions all the samples examined showed the guaranteed composition.

### LIST OF BRANDS ANALYZED.

No. 2. "I.X.L. Ammoniated Bone Superphosphate," Geo. W. Miles, Agt, Milford, Conn.

No. 3. "Planters Soluble Guano." Made by Adair Bros. & Co., Atlanta, Georgia.

No. 4. "Furman's Ammoniated Soluble Bone." Made by Adair Bros. & Co., Atlanta, Ga.

No. 5. "Furman's Acid Phosphate." Made by Adair Bros. & Co., Atlanta, Ga.

No. 6. "Adams' Ammoniated Dissolved Bone." Made by Adair Bros. & Co., Atlanta, Ga.

No. 7. "Homestead Guano." Made by Michigan Carbon Works, Detroit, Mich.

No. 8. "Ammoniated Bone." Made by Baldwin Fertilizer Co., Savannah, Ga.
No. 9. "Bone and Potash." Made by Baldwin Fertilizer Co., Savannah, Georgia.
No. 10. "Pure Bone Meal." Made by Memphis Fertilizer Co., Memphis, Tenn.
No. 11. Fertilizer, made by Jackson Oil Mills, Jackson, Tenn.
No. 12. "Acid Phosphate." Made by Baldwin Fertilizer Co., Savannah, Georgia.
No. 13. "X L C R Acid Phosphate." Geo. W. Miles, Agent, Milford, Conn.
No. 14. "Furman's High Grade Guano." Made by Adair Bros. & Co., Atlanta, Ga.
No. 15. "Buffalo Bone Guano" Made by Adair Bros. & Co., Atlanta, Ga.
No. 16. "Robertson County Tobacco Grower." Made by C. & F. Singer, Nashville, Tenn.
No. 17. "Bone Meal." Made by Loudenbeck Fertilizer Co., Cincinnati, Ohio.
No. 18. "Ammoniated Dissolved Bone." Made by Loudenbeck Fertilizer Co., Cincinnati, Ohio.
No. 19. "Sweepstakes Phosphate." Made by Loudenbeck Fertilizer Co., Cincinnati, Ohio.
No. 20. "Fine Raw Bone." Made by Northwestern Fertilizing Co., Chicago, Ill.
No. 21. "Challenge Corn Grower." Made by Northwestern Fertilizing Co., Chicago, Ill.
No. 22. "Ralston's Bone Meal." Made by Northwestern Fertilizing Co., Chicago, Ill.
No. 23. "Ammoniated Dissolved Bone." Made by Northwestern Fertilizing Co., Chicago, Ill.
No. 24. "Horseshoe Brand Tobacco Grower or Compound." Made by Northwestern Fertilizing Co., Chicago, Ill.
No. 25. "National Bone Dust." Made by Northwestern Fertilizing Co., Chicago, Ill.

| | Moisture. | Phosphoric Acid. | | | | | | | Potential Ammonia. | | Potash. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soluble. | Reverted. | Insoluble. | Total. | Total Guaranteed. | Available. | | Found. | Guaranteed. | Found. | Guaranteed. |
| | | | | | | | Found. | Guaranteed | | | | |
| 2. "IXL Ammoniated Super Phosphate," | 7.01 | 7.05 | 1.98 | 1.29 | 11.32 | . . . | 9.03 | 8.00 | 2.30 | 2.25 | 1.26 | 1.00 |
| 3. "Planters' Soluble Bone," | 10.49 | 7.97 | 2.30 | 1.83 | 12.10 | . . . | 10.27 | 8.00 | 2.50 | 2.00 | 1.02 | 1.00 |
| 4. "Furman's Ammoniated Soluble Bone," | 11.52 | 7.41 | 2.76 | 1.85 | 12.02 | . . . | 10.17 | 10.00 | 1.76 | 1.00 | 1.59 | 1.00 |
| 5. "Furman's Acid Phosphate," | 12.39 | 10.49 | 3.12 | 2.32 | 15.93 | . . . | 13.61 | 13.00 | . . . | . . . | . . . | . . . |
| 6. "Adams' Ammoniated Dissolved Bone," | 10.97 | 8.92 | 1.10 | 0.15 | 10.17 | . . . | 10.02 | 8.00 | 2.90 | 2.00 | . . . | . . . |
| 7. "Homestead Guano," | 10.13 | 7.77 | 1.07 | 0.54 | 9.38 | . . . | 8.84 | 8.00 | 2.10 | 2.00 | . . . | . . . |
| 8. "Ammoniated Bone," | 16.39 | 10.13 | 1.35 | 0.00 | 11.48 | . . . | 11.48 | 9.00 | 1.34 | 2.00 | 0.98 | 2.00 |
| 9. "Bone and Potash," | 18.96 | 10.86 | 0.87 | 1.74 | 13.47 | . . . | 11.73 | 12.00 | . . . | . . . | 3.07 | 4.00 |
| 10. "Pure Bone Meal," | 8.04 | . . . | . . . | . . . | 23.35 | 18.00 | . . . | . . . | 2.57 | 3.00 | . . . | . . . |
| 11. "Fertilizer prepared by Jackson Oil Mills | 6.45 | 4.91 | 2.43 | 2.32 | 9.66 | 8.00 | 7.34 | . . . | 3.48 | 2.50 | 2.93 | 2.00 |
| 12. "Acid Phosphate," | 4.58 | 11.85 | 2.36 | 1 60 | 15.81 | . . . | 14.21 | 12.00 | . . . | . . . | . . . | . . . |
| 13. "X. L. C. R. Acid Phosphate," | 2.93 | 12.09 | 2.49 | 1.87 | 16.36 | . . . | 14.49 | 12.00 | . . . | . . . | . . . | . . . |
| 14. "Furman High Grade Guano," | 12.96 | 8.00 | 1.34 | 2.30 | 11.64 | . . . | 9.34 | 10.00 | 2.61 | 2.50 | 2.27 | 1.50 |
| 15. "Buffalo Bone Guano," | 10.75 | 7.36 | 1.89 | 3.01 | 12.26 | . . . | 9.25 | 8.00 | 2.70 | 2.00 | 1.56 | 1.00 |
| 16. "Robertson County Tobacco Grower," | 7.50 | 5.50 | 1.88 | 8.64 | 16.02 | . . . | 7.38 | 8.00 | 2.18 | 3.00 | 4.14 | 3.00 |
| 17. "Bone Meal," | 7.28 | 0.93 | 8.56 | 13.69 | 23.18 | . . . | 9.49 | 10.00 | 3.43 | 2.50 | 1.33 | 3.00 |
| 18. "Ammoniated Dissolved Bone," | 8.04 | 5.04 | 1.86 | 5.01 | 11.91 | . . . | 6.90 | 12.00 | 3.33 | 3.00 | 1.66 | 3.00 |
| 19. "Sweepstake Phosphate," | 8.44 | 3.86 | 2.65 | 3.90 | 10.41 | . . . | 6.51 | 9.00 | 2.65 | 3.00 | 2.21 | 3.00 |
| 20. "Fine Raw Bone," | 9.63 | . . . | . . . | . . . | 23.13 | 23.00 | . . . | . . . | 3.51 | 3.00 | . . . | . . . |
| 21. "Challenge Corn Grower," | 16.67 | 6.42 | 1.55 | 4.12 | 12.19 | . . | 8.07 | 8.00 | 2.72 | 2.00 | 6.84 | 0.54 |
| 22. "Ralston's Bone Meal," | 12.72 | . . . | . . . | . . . | 20.75 | 12.00 | . . . | . . . | 2.94 | 2.00 | . . . | . . . |
| 23. "Ammoniated Dissolved Bone," | 16.40 | 6.10 | 1.93 | 4.20 | 12.23 | . . . | 8.03 | 8.00 | 2.75 | 2.00 | 0.72 | 0.54 |
| 24. "Horseshoe Brand Tobacco Grower, or Compound," | 16.30 | 4.17 | 3.57 | 5.09 | 12.83 | . . . | 7.74 | 7.00 | 3.16 | 3.00 | 1.36 | 1.08 |
| 25. "National Bone Dust," | 12.92 | . . . | . . . | . . . | 15.30 | 10.00 | . . . | . . . | 2.87 | 2.00 | . . . | . . . |

## LAWS OF THE STATE OF TENNESSEE REGARDING THE SALE AND INSPECTION OF COMMERCIAL FERTILIZERS.

SECTION 1. *Be it enacted by the General Assembly of the State of Tennessee*, That all commercial fertilizers sold or offered for sale in this State shall, by stamp or otherwise, distinctly set forth in each package or parcel the chemical analysis of such fertilizers, the name and manufacturer, also the place and date of manufacture, and furthermore each of said packages or parcels shall be freely submitted to inspection as herein provided, and shall bear a certificate of inspection (or tag) furnished by the Commissioner of Agriculture, and showing authority from the State to sell such fertilizers: *provided*, that fertilizers sold for less than ten dollars per ton shall not be subject to the provisions of this Act.

SEC. 2. *Be it further enacted*, That none of said fertilizers shall be sold in said State unless their analyses shall show a given per cent. of ammonia, potash, and available phosphoric acid, each one or more to be prescribed by the Commissioner of Agriculture; and all contracts for fertilizers condemned by this section shall be void after this Act is of force.

SEC. 3. *Be it further enacted*, That before exposure for sale each package or parcel of said feriilizers shall be inspected as herein provided, and for each ton or fraction of a ton so inspected the sum of fifty cents shall be paid by the vendor to the inspector or said Commissioner, as may be directed, and that said fees of fifty cents shall be applied first to the expense of inspection, then to analyses, tests, etc., for the benefit of agriculture as herein provided.

SEC. 4. *Be it further enacted*, That the Commissioner of Agriculture shall have power to make the rules and regulations necessary to effect the purpose of this Act, and he shall have further power to appoint inspectors, not exceeding four, at points most convenient to the parties interested therein, and said inspectors shall hold office at the pleasure of said Commissioner.

SEC. 5. *Be it further enacted*, That each of said inspectors, before entering office, shall give bond and security in the sum of two thousand dollars for faithful discharge of duty. He shall on the receipt of the fees, inspect promptly all fertilizers presented to him for that purpose, taking samples and disposing of them as directed, and doing other work connected with the inspection of fertilizers; and for his services he shall receive, as compensation proportioned to the work, a sum not exceeding one-third of the fees by him collected, and in no case to exceed five hundred dollars *per annum*.

SEC. 6. *Be it further enacted*, That all the specimens of fertilizers collected by said inspectors shall by them be sent, as the said Commissioner may instruct, to the Director of the Experiment Station inaugurated by the Board of Trustees of the University of Tennessee, and located at Knoxville, on the University farm, there to be analyzed, tested, and reported as needed for the benefit of agriculture; and said Experiment Station is hereby recognized as the Experiment Station for the State of Tennessee, and to be controlled under the rules now existing and by the Board of Trustees of the University of Tennessee.

SEC. 7. *Be it further enacted*, That the Trustees of the University of Tennessee shall be required to make reports biennially to the Governor of the State, on the assembling of each Legislature, of all the work done under this Act—to-wit: the number of packages, parcels, and tons inspected, the number of analyses made, whether on public or private account, how many of each class, the amount of inspection fees collected, what disposition was made of the same, the cost of making the analyses, and the balance of cash receipts on hand.

SEC. 8. *Be it further enacted*, That the Legislature may amend this Act at any time, and whenever the receipts arising from inspection fees shall become larger than may be necessary to pay reasonable and just fees for making the analyses and a fair compensation to the University for its outlay and trouble, the Legislature may establish additional experiment stations in Middle and West Tennessee, and the surplus of the funds in the University of Tennessee arising from the sources named shall, upon the order of the Governor, be turned into the Treasury of the State for the purpose of sustaining and supporting such additional experiment stations for making analyses, etc., as may be established in Middle and West Tennessee by any subsequent Legislature; *provided*, the provisions of this Act shall not apply to cotton-seed meal and home-made manures.

SEC. 9. *Be it further enacted*, That the chemical analyses of the State shall be done under oath to deal impartially and faithfully, and the official certificate of the chemist shall be competent testimony in the courts of this State.

SEC. 10. *Be it further enacted*, That all the income over and above the costs of inspection (salaries, express, and tags) shall be paid promptly at the end of each month to the Treasurer of the University of Tennessee, to be applied to said tests and analyses of said fertilizers, and to other experiments at the said station connected with the test of said fertilizers; and furthermore, each inspector shall send the said Treasurer a monthly statement, itemized, of the receipts and expenditures for the month just preceding at his place of inspection, and the said Treasurer must keep and report a separate account of this fund.

SEC. 11. *Be it further enacted*, That any person or persons violating any of the provisions of this Act shall be guilty of a misdemeanor, and on conviction shall be fined not less than one hundred nor more than five hundred dollars for each offense, and the proceeds of said fine be turned over to the station above mentioned.

SEC. 12. *Be it further enacted*, That all laws and parts of laws in conflict with any of the provisions of this Act are hereby repealed.

Passed March 24, 1883.

W. L. LEDGERWOOD,
*Speaker of the House of Representatives.*

Approved March 29, 1883.

B. F. ALEXANDER,
*Speaker of the Senate.*

W. B. BATE,
*Governor.*

In accordance with Section 2 of the above Act, it is hereby prescribed that *Acid Phosphates* or *Dissolved Bones* (not ammoniated) must contain not less than 12 per cent. of available Phosphoric Acid; and all *Ammoniated Superphosphates* must contain not less than 8 per cent. of available Phosphoric Acid, two per cent. of Ammonia and one per cent. of Potash, or if they contain less than two per cent. of Ammonia or less than one per cent. of Potash, they must then contain less than ten per cent. of available Phosphoric Acid.

B. M. HORD, *Commissioner.*