BULLETIN NO. 8. NEW SERIES

REPORT

—OF—

AGRICULTURAL EXPRIMENT STATION,

Agricultural and Mechanical College,

AUBURN, ALA., - - - - NOVEMBER, 1889.

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Commercial Fertilizers.

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The Bulletins of this Station will be sent free to any farmer in the State, on application to the Director.

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†Prof. Mell has also charge of Meteorological Observations.

*The special work of the Biologist is the investigation of the diseases of plants caused by parasitic fungi and insects.

COMMERCIAL FERTILIZERS.

[BY N. T. LUPTON, CHEMIST.]

THEIR USE OF MODERN ORIGIN.

The use of fertilizers as articles of commerce is of modern origin. The fact that soils deteriorate by continued cultivation and removal of crops had long been observed before the cause was understood and the remedy applied. In the early history of this and other countries, the virgin soil produced abundantly and continued to do so without applications of any kind until the idea was prevalent that fertile soils are inexhaustible. The impoverishment however which eventually followed set men to thinking, and to devising means for the restoration of lost fertility. A close study of the soil, of the plant, and of the atmosphere, has revealed the relations they sustain to each other, and the conditions under which each can best contribute its part to the production of abundant crops.

THE COMPOSITION AND FORMATION OF SOIL.

An examination shows that soil is a mixture of more or less finely divided mineral and organic matter. This mineral matter consists of sand, clay, gravel, etc.; the organic matter of vegetable substances in various stages of decomposition. A closer examination, or analysis by the chemist, shows that these materials are composed of certain primary elements, united in fixed and definite proportions.

The geologist tells us of a time, in the far distant past, when the earth existed as a mass of melted matter, which, gradually cooling, formed a solid crust. Upon this was precipitated the condensed moisture of the atmosphere, loaded with all the waters of ocean, lake and river, in the form of aqueous vapor. The disintegrating action of this powerful agency, added to that of the atmosphere itself, acting mechanically and chemically, crumbled and pulverized the surface of this solid mass until it became ready for the introduction and growth of plants. These, at first scanty, germinated, matured, and decayed until vegetable mould had accumulated in sufficient quantity to sustain the growth of organic substances in rich profusion. The vast beds of coal, wherever found, result from masses of vegetable growth, accumulated long before man existed on the earth. The geological changes of the past, however great and long continued, were the same in kind as those now going on, and the same forces acting on similar materials are still producing corresponding results.

THE DETERIORATION OF SOILS.

The introduction of man into the world, with his varied material and artificial wants, modified to no little extent the conditions previously existing. At first, the earth spontaneously produced sufficient for his support, but as population increased, new wants were developed. Instead of consuming his food on the soil where it grew, and leaving there the residue to fertilize succeeding crops, he stripped the land of its growth and accumulated its products in towns and cities, and that which he did not consume was cast into the sea or wasted in many ways.

The forces of nature continued their renovating action by the production of new soil and by clothing the hills and valleys with vegetation, to supply the loss caused by man's extravagance, but eventually the richest lands of every civilized country were seen to be gradually but surely losing their power of production. This naturally led to an investigation of the conditions of plant growth and the means best adapted to restore and maintain a high degree of fertility. The results attained are the triumph of modern science and the boast of modern civilization.

THE COMPOSITION OF PLANTS.

The analysis of plants shows them to be composed of certain elements—from ten to fifteen in number. Ten of these are considered essential to plant growth, as follows:

Carbon,	Nitrogen,	Sulphur,	Potassium,	Magnesium,
Hydrogen,	Oxygen,	Phosphorus,	Calcium,	Iron,

Sodium, manganese, silicon, chlorine, with traces of bromine, iodine, flourine, and a few others, are generally found, but are not considered absolutely necessary to the growth of vegetation.

These same elements are found in the soil from which they are derived, and a few of them in the surrounding atmosphere. So abundant are most of them that only a few are likely to become exhausted where a proper system of cultivation is practised. These few constitute the valuable elements of

COMMERCIAL FERTILIZERS.

This term, as used in the Fertilizer laws of Alabama, "does not include common lime, land plaster, cotton seed, cotton seed meal, ashes, or common salt not in combination."

In estimating commercial values, only three constituents, viz., phosphoric acid in two of its forms of solubility, potash and nitrogen, are taken into account; not that these are more important to plant growth than others, but because they exist in such minute quantities in soils that they become exhausted very soon, and plants can not grow without them. So important for the manufacture of commercial fertilizers,are the raw materials containing these constituents that the earth has been searched and the seas explored to find localities where they exist. Millions of tons are used annually to supply the demands of modern agriculture.

SOURCES OF PHOSPHORIC ACID.

The chief sources of phosphoric acid are the bones of animals, guano, coprolites, or phosphatic nodules, mineral phosphates, and basic slag, generally known as Thomas' slag, or scoria.

The frame-work of vetebrate animals consists of bones composed of about one-third organic and two-thirds mineral matter. The mineral matter is almost entirely phosphate of lime, known to the chemist as tri-calcium phosphate. The organic matter found in fresh or raw bones undergoes rapid disintegration on exposure to the atmosphere, leaving the bone or tri-calcium phosphate as a white mass, insoluble in water. Now, the plant requires its food to be in a soluble condition before it can be appropriated, and science has met this demand by converting insoluble bone phosphate into a soluble form. Sulphuric acid, acting upon the ground bones, seizes upon a portion of the lime, unlocks the phosphoric acid and changes it to the desired form for plant food.

Following the teaching of science, numerous manufactories have been established for the conversion of these insoluble into soluble phosphates. The natural phosphates are not absolutely insoluble in water, and indeed are far from being so when in a finely divided state and in the presence of acids in the soil produced by the fermentation of organic matter. Hence ground bones, floats, and other forms of finely divided natural phosphates, have considerable value as fertilizers. Commercial acid phosphates are the results of the action of sulphuric acid on natural phosphates, which renders them soluble in water and better adapted to the necessities of plant growth. Phosphoric acid in commercial fertilizers exists in three forms of combination with lime, generally known as soluble, reverted, and insoluble. In Alabama these are called, in the act establishing the department of agriculture, *water soluble*, *citrate soluble*, and *acid soluble.*

The chemist, in analyzing a phosphate, first dissolves out and determines the phosphoric acid soluble in water, then acts upon the residue with a solution of ammonium citrate for thirty minutes, at a temperature of 65 degrees centigrade, to dissolve out the citrate soluble, then acts on the second residue with hydrochloric acid to find the amount called acid soluble. A fresh portion of the phosphate is now taken, and the total phosphoric acid determined. From this, the sum of the water soluble and acid soluble being taken, the remainder is citrate soluble.

The water soluble is easily converted into citrate soluble by means of lime, and, without the addition of anything, undergoes a gradual change, and hence is said to be *reverted*. These two forms, water and citrate soluble, are considered of equal value as plant food, and taken together are called *available* phosphoric acid. Animal charcoal, made from bones by driving off volatile matter, is known as bone black, and used in large quantities to decolorize and refine sugar and other organic products. This bone black, in the course of time, becomes too impure for further use and is turned over to the fertilizer manufacturers to be converted into acid phosphate.

Guano, the deposits and remains of countless flocks of birds which have inhabited from time immemorial the islands near the coast in tropical countries, is a prolific source of phosphoric acid. On some of these islands, such as the Peruvian, Patagonian, Falkland and Ichaboe, it seldom rains, and hence the phosphate from this source is rich in salts of ammonia. Its condition is such that plants readily appropriate its constituents as food.

Fossil bones, in connection with phosphatic nodules, in immense quantities, are found in South Carolina, and to some extent in other States and countries of the world. These are the remaihs of extinct animals which lived and died in the swamps, shallow seas and lakes of an age long anterior to the present.

It is estimated that over 4,000,000 tons of South Carolina phosphates have been used since their discovery some twenty or twenty-five years ago. These phosphates contain from 40 to 60 per cent. of phosphate of lime, and are now the most abundant source of phosphoric acid.

Mineral phosphates, such as apatite, phosphorite, etc., apart from those in connection with fossil bones, have not been used to any great extent in this country.

Basic slag, or Thomas' scoria, has of late years been used successfully as a source of phosphoric acid. Germany is said to have used 300,000 tons of this material during the past year. Many iron ores contain too large a percentage of phosphorus to be used in the manufacture of steel. Neither the smelting process, nor the ordinary process of converting pig iron into steel, removes the phosphorus contained in the ore. A few years ago a process was discovered in England and patented by Thomas and Gilchrist, which not only gets rid of the phosphorus in the steel, but leaves it in a condition to be used as a fertilizer. This process consists in converting the phosphorus into a phosphate of lime, by driving a powerful blast of air through the molten iron contained in a crucible lined with magnesian lime. The resulting lime phosphate contains from 15 to 25 per cent. of phosphoric acid in connection with a large per cent. of iron, and when reduced to a fine powder forms a good substitute for floats and ground bones. The iron ores of Alabama, similar to those in Europe, will doubtless in a few years be made to yield a slag sufficiently rich in phosphoric acid to serve as a commercial fertilizer. Experiments with this fertilizer, at the agricultural experiment station, have demonstrated its nature. Similar results have been obtained at other stations.

SOURCES OF POTASH.

Potash, a combination of the metal potassium and oxygen, is derived chiefly from kainit, muriate, wood and cotton seed hull ashes.

Kainit is found in some salt mines, notably in the mines of Stassfurt, Germany. It contains from 10 to 15 per cent. of potash in the form of sulphate, the remainder being salts of sodium and magnesium. In 1885, 87,635 tons were imported into the United States.

Muriate is also a product of salt mines, and contains from 40 to 50 per cent. of potash in the form of potassium chloride. In 1885, 21,196 tons of muriate were imported.

The ashes of all plants contain potash in considerable quantities, and furnish a limited supply for the manufacture of fertilizers.

SOURCES OF NITROGEN.

Nitrogen, the most expensive constituent of commercial fertilizers, exists abundantly in the atmosphere, but in a condition that renders it unavailable as plant food. It must for this purpose be in combination as nitrate, nitrite, ammonia or organic nitrogen.

Sodium nitrate, or Chili saltpetre, is extensively used as a source of nitrogen. In 1885, 55,902 tons were imported.

Ammonium sulphate from gas works is also used.

Refuse animal substances, such as dried *blood*, *tankage*, *fish scrap*, etc., are valuable sources of nitrogen, but in the South *cotton seed* and *cotton seed meal* are the most abundant sources of this element.

VALUE OF COTTON SEED AS A FERTILIZER.

A good sample of cotton seed meal contains about 7 per cent. of nitrogen, and in addition to this about 3 per cent. of phosphoric acid, and 1½ to 2 per cent. of potash. The cotton seed itself contains about 2½ per cent. of nitrogen, 1 1-5 per cent. of phosphoric acid and 1¼ per cent. of potash. One ton yields at the oil mill, on an average:

750	pounds of	meal.
1000	" "	hulls.
225	" "	oil.
25	" "	lint.

The hulls in one ton, when burned, yield about 15 pounds of ash. The oil and lint have no appreciable value as fertilizers, and very little more can be said of the hulls, as they contain a very large per cent. of woody fibre, and undergo decomposition slowly. Estimating the value of seed as a fertilizer, according to the valuation placed on its important constituents by the Department of Agriculture, it is worth $12.80 per ton, or 21⅓ cents per bushel. To the farmer, it has a greater value than this as a feed-stuff for cattle, and if the manure be carefully preserved, very little of its fertilizing value is lost in feeding. So the farmer, by careful management, can realize a double value from his cotton seed.

COMMERCIAL VALUES.

The law requires the Commissioner of Agriculture to publish an estimate of the commercial value of fertilizers offered for sale in the State, basing his calculations on the lowest per cent. of each constituent guaranteed by the manufacturer.

The following values are given for the ensuing season:

Water soluble phosphoric acid	7½	cents per pound.
Citrate " "	7½	" " "
Nitrogen " "	19½	" " "
Potash " "	5	" " "

While these figures are only approximate, they are useful to the farmer in deciding the relative value of different goods, and are a safe guide in making purchases. The calculations may be made as follows:

Multiply the per cent. of water soluble and citrate soluble phosphoric acid by $1.50; the per cent. of nitrogen by $3.90; the potash by $1, and add the products together. The sum will be the commercial value of one ton of the goods.

Take a fertilizer which shows the following composition

Water soluble phosphoric acid	7	per cent.
Citrate " "	2	" "
Nitrogen " "	2	" "
Potash " "	1½	" "

Then $1.50 by 9—$13 50, value of the phosphoric acid.
" 3.90 by 2— 7.80, " " nitrogen.
" 1.00 by 1½ 1.50, " " potash.

Total value..........$22.80.

The schedule of valuations adopted by several of the

Northern States for 1889, as published in the New Jersey Bulletin of July 15, is as follows:

Nitrogen in ammonia salts	19	cents	per	pound.
" " nitrates	17	"	"	"
Organic nitrogen	19	"	"	"
Phosphoric acid soluble in water	8	"	"	"
" " " " ammonia citrate	8	"	"	"
Phosphoric acid soluble insoluble	3	"	"	"
Potash as sulphate	6	"	"	"
" " muriate	4½	"	"	"

These do not differ materially from the values in Alabama, and, as stated in the bulletin, "are intended to represent the retail cash cost of these constituents in the raw materials before they are mixed to form a complete fertilizer." The nitrogen in cotton seed meal at $20 per ton is worth only a little over 14 cents per pound, and at this price is the cheapest form in which nitrogen, having a high agricultural value, can be gotten.

THE MANUFACTURE OF FERTILIZERS.

Any farmer can buy the raw materials, mix them together and thus manufacture his own fertilizers at much less cost than the same goods sell for in the market.

Composts are the cheapest of such mixtures, and indeed are the most satisfactory form in which fertilizing materials can be used, especially for permanent improvement of the soil. An excellent compost for general use may be made of cotton seed, barn yard manure, and acid phosphate, in the following proportions:

700 pounds of barn yard manure.
700 " " cotton seed.
600 " " acid phosphate.

Several methods are in vogue for mixing the materials. The most satisfactory is that used at the Experiment Station, and consists in mixing them on the smooth ground, one ton at a time. The barn yard manure and cotton seed are first mixed and thoroughly moistened with water, then rolled or mixed with the acid phosphate. The mixture is spread out from six to ten inches deep, another ton thoroughly moistened and mixed, is placed on this, and so on until the heap is from 4 to 6 feet high. This is allowed to stand at least six weeks before using.

The old method is to spread the barn yard manure on the ground from 3 to 4 inches deep, then the cotton seed, then acid phosphate. Add layer after layer until the heap is from 4 to 6 feet high, watering the mass until it is quite moist, and let stand about six weeks before using. When chopping down for use mix thoroughly.

A third method is to open a deep furrow, scatter in it the materials, either one at a time or previously mixed, and bed on them, thus dispensing with the compost heap.

To prepare a good commercial fertilizer for general application, a floor is needed upon which to mix the materials, and a hoe or a wooden mixer for stirring them together. Acid phosphate, cotton seed meal, and kainit or muriate are the materials required for a "complete" fertilizer, and may be mixed in the following proportions:

1000 pounds of acid phosphate.
800 " " cotton seed meal.
200 " " kainit.

If the land needs more phosphoric acid and less potash, use 1200 pounds of acid phosphate and 100 of kainit, or none at all, and if nitrogen is greatly needed in the soil, use 1000 pounds of cotton seed meal.

In the above formula, the per cent. of phosphoric acid, nitrogen and potash in the mixture will be about as follows:

1000 lbs. of phosphate containing 15 per cent. water and citrate soluble acid, yield	150	lbs. phos. acid.
800 lbs. of cotton seed meal with 3 per cent. phosphoric acid, yield	24	" " "
800 lbs. cotton seed meal with 7 per cent. nitrogen, yield	56	" nitrogen.
800 " " " " " 1.75 per cent. potash, "	14	" potash.
200 " kainit with 12 1-2 per cent potash yield........	25	" "

Thus we have in one ton	164 lbs. available phos. acid	--8.70	per cent.
" " "	56 " nitrogen..........	—2.80	" "
" " "	39 " potash............	—1.95	" "
Commercial value		$25.92	

THE ANALYSIS OF FERTILIZERS.

The law requires the manufacturer who sells his goods in Alabama to brand on each bag, or package, his guaranteed analysis of the fertilizer contained therein. To protect the farmer against fraud, an "official chemist" has been provided by the State, whose duty it is to furnish the Commissioner of Agriculture, a correct analysis of every sample of fertilizer sent to him by the commissioner, and every farmer in the State can obtain the services of the chemist, free of cost, to test the guarantee of the manufacturer, and if the goods do not come up to the guarantee, the law releases the purchaser from any obligation to pay for the fertilizer. Before this law went into operation, worthless fertilizers were brought into the State and sold without hindrance.

Protection is now afforded to both farmers and manufacturers, and very few attempts are made to misrepresent the composition and value of fertilizers offered for sale.

The analyses made in the laboratory since the last report, issued the 1st of April, and contained in this bulletin, embrace a variety of fertilizers which may be classed as follows:

Complete fertilizers........	79	Natural phosphates........	24
Acid phosphates............	19	Miscellaneous..............	22
Marls..........................	9		

PHOSPHATES WITH NITROGEN AND POTASH.

Station No.	NAMES OF FERTILIZERS.	BY WHOM SENT.	Phosphoric Acid. Water Soluble.	Phosphoric Acid. Citrate Soluble.	Phosphoric Acid. Acid Soluble.	Nitrogen.	Potash.	Commercial Value.
1236	Fertilizer	C F Walker, Alexander City, Ala	8.29	3.11	2.21	1.68	1.11	$24 76
1238	Guano	John Day, Cotton Hill, Ala	5.20	6.62	4.48	1.96	1.12	26 49
1250	Fertilizer	W R Hunnicutt & Son, Heflin, Ala	9.40	0.70	2.97	1.68	2.10	23 80
1251	"	W W Newberry, Dothan, Ala	6.95	2.48	1.76	1.75	2.45	23 41
1252	"	T J Cook, Bartlett, Ala	11.13	2.19	1.73	1.71	1.28	27 92
1253	Standard Fertilizer	J H Cash, Fernbank, Ala	5.52	2.13	1.81	2.94	2.65	25 58
1255	Eddystone Guano	R S Williams, Wetumpka, Ala	8.31	2.69	3.64	1.68	1.55	24 60
1256	Rainbow Guano	" " " "	8.40	3.85	2.39	0.98	1.64	23 83
1257	Home Mixture	W A Miller, Hardwicksburg, Ala	7.35	1.54	1.30	2.87	2.73	27 25
1262	Fertilizer	J Cochran Williams, Belcher, Ala	9.36	2.06	2.07	2.10	2.38	27 70
1263	"	A J Whitten, Sr, Alexander City, Ala	8.03	1.79	1.08	2.38	3.16	26 57
1264	"	W J Reynolds, Montevallo, Ala	8.25	1.72	1.95	1.75	1.78	23 55
1279	Webb's Excelsior	D W Proctor, Dillsburg, Ala	1.76	1.08	0.41	4.90	2.34	25 75
1267	Fertilizer	W J Reynolds, Montevallo, Ala	3.80	4.64	2.84	1.96	0.86	21 16
1268	"	S F Proctor, Dillsburg, Ala	5.16	1.99	1.68	3.57	1.69	26 33
1269	" (2)	W W Morris, Daleville, Ala	8.29	1.04	0.53	2.80	2.21	27 12
1270	" (1)	" " " "	9.42	1.70	2.10	1.40	1.00	23 14
1271	Bowker's Fertilizer	J R Caldwell, Chulafinnee, Ala	8.23	1.91	2.32	1.82	1.02	23 32
1272	Baker's Fertilizer	" " " "	6.72	3.35	2.10	1.68	1.54	23 19
1273	Soluble Pacific Guano	" " " "	6.43	3.80	2.90	1.96	0.96	23 94
1274	Eddystone Guano	" " " "	6.58	4.61	2.23	1.75	0.55	24 15
1275	Aurora Am. Phosphate	" " " "	7.14	1.97	1.08	2.66	1.68	25 71
1276	Ga. State Standard Superphosphate	W M Hardwick, Hardwicksburg, Ala	9.63	1.03	1.71	1.82	0.94	24 04
1277	Home Mixture Guano	" " " "	6.50	1.35	0.91	2.66	2.31	24 45
1280	Fertilizer	W C Menefee, Orion, Ala	8.23	2.50	4.01	1.96	0.89	24 62
1280	"	W W Morris, Daleville, Ala	9.81	5.14	2.24	1.89	1.38	26 67
1282	Sea Fowl Guano	W C Watson, Oakville, Ala	8.48	2.72	2.41	2.24	1.14	26 67

PHOSPHATES WITH NITROGEN AND PHOSPHATES—CONTINUED.

Station No.	NAMES OF FERTILIZERS.	BY WHOM SENT.	Phosphoric Acid. Water Soluble.	Phosphoric Acid. Citrate Soluble.	Phosphoric Acid. Acid Soluble.	Nitrogen.	Potash.	Commercial Value.
1283	Tinsley's Standard Fertilizer	H A Seale, Columbiana, Ala.	5.41	2.00	2.88	2.10	0.52	19 82
1284	Ammoniated Dis. Bone	W H Rhodes, Edwardville, Ala.	7.66	1.08	3.62	2.17	1.66	23 33
1285	Furman's Dis. Bone	" " " "	8.17	1.98	1.31	1.26	0.87	21 00
1286	Old Hickory Guano	Jordan, Manning & Co, Guntersville, Ala.	7 87	2.27	3.03	1.96	0.70	23 55
1287	" " "	" " " "	7.98	1.84	3.04	1.96	1.63	23 00
1288	Buffalo Bone Guano	J R Hicks, Weaver Station, Ala.	8 79	3.09	0.88	2 80	1.95	30 69
1289	Scott's A. A. Bone Guano	Albert R Head, Joy. Ala	9.13	3.16	2 64	1.68	0.98	24 46
1290	Patapsco Guano	R Nation, Bluntsville, Ala	9 15	0 82	3 20	1.61	1.00	22 22
1291	Horse Shoe Brand Animal Dis. Bone	W A Brown, Walnut Grove, Ala.	4 66	3 53	4.11	2.45	0.27	22 10
1292	Ga. Test Guano	J D Alen, Haleburg, Ala.	8 21	2.00	2.86	2.26	1.13	25 25
1293	Potapsco Guano	W S Johnson, Haleburg, Ala.	5.74	3.19	3.74	2.17	1.46	23 34
1194	Pacific Guano	" " " "	9 00	1.36	1.31	1.82	1.60	24 23
1295	Farmer's Stand. Phosphate	A S Davis, " "	7.25	1.91	1.63	1.96	1.44	22 82
1296	Americus Guano	" " " "	3 26	4 07	4.53	2.52	1.35	22 16
1297	Farmers Standard	J J Jackson, Hardwicksburg, Ala.	7.62	2.17	1.49	1 75	1 92	23 42
1299	Fertilizer	J R Lewis, Oatston, Ala	9.12	0.60	1.32	2.66	3 44	28 39
1300	"	W A Lee, " "	7 68	2.50	1.58	2.10	3 55	26 81
1301	Pure Dis. Animal Bone	W E Bradley, Abbeville, Ala.	11.80	2 65	1.48	1.40	...	27 13
1304	Fertilizer	Robert Nuckolls, Berry Station, Ala.	5.72	2.55	2.30	2.59	3 30	25 80
1305	Patapsco Guano	J H Grace, Hardwicksburg, Ala.	9 19	1.41	2.41	1 96	1 02	24 56
1306	Gossypium Guano	E N Willis, " "	6.72	1.89	2.43	2.24	1.92	23 56
1310	Fertilizer No. 1	A J McMurraine, Riverside, Ala.	7.25	1.85	1.32	2 26	1.37	25 37
1311	" " 2	" " " "	8.54	1.78	1.00	2.17	1.68	25 62
1312	"	R E Conyer, Hackneyville, Ala:	9.77	1.36	1.17	2.59	2 85	26 79
1313	Ammoniated Dis. Bone	J A Faulk, Hardwicksburg, Ala.	10.15	3.24	0.64	1.91	3 68	31 20
1314	Farmers Am'd. Dis. Bone	E A Chambers, Zornville, Ala.	7 48	1.74	2.79	1.96	1.19	22 66
1315	Home Mixture	T J Farmer & Co, Shortersville, Ala	7.04	1.61	0.95	2.31	3.14	25 10

1316	Gossypium Phospho	J T McDuff, Berry Station, Ala	7.39	2.05	1.69	2.24	2.14	25 03
1317	Farmers Standard Phosphate	A G Blackshear, Haleburg, Ala	6 72	3.43	1.08	1.68	1 96	23 73
1322	Ga. State Standard Superphosphates	E W Chambers, Zornville, Ala	8.65	0.98	2.67	1.75	2.37	23 63
1323	Compost	J S Newman, Auburn, Ala	2 51	3 08	1.18	3 01	1.17	21 28
1324	Ga. State Grange	T P Smith, Smithville, Ala	9.40	0.71	2.63	1.75	2.60	24 58
1325	Ga. State Grange Fertilizer	Howe Bros, Edwardsville, Ala	8.71	1.18	5.64	1.54	2.18	23 01
1340	Home Mixture	James Holton, Wesley, Ala	6 02	1.82	1.14	2.24	2.64	23 13
1342	Fertilizer	A J Conway, Peters, Ala	8.04	2.74	2.73	1.96	1.78	25 50
1343	"	J J Hester, Waverly, Ala	7.94	0 65	1.18	2.10	2 69	23 91
1344	Old Hickory	J R Brusher, Baileyton, Ala	7.56	2.32	2.46	1.96	1.05	23 51
1346	Old Hickory	E W Robertson, Joppa, Ala	6.87	2.77	3.66	2 03	0.94	23 31
1347	Zell's Guano	J P Raines, Peters, Ala	8.56	2 48	2.38	1.40	0.77	22 79
1348	B. S. Guano	Noah Carroll, Ozark, Ala	5.91	5.03	2 09	2.10	1.86	26 46
1351	Guano	Geo W Mott, Catalpa, Ala	7.66	0.93	2.93	2.24	0 96	22 57
1352	John Merryman & Co.'s Guano	W J Beverly, Rosewood, Ala	6.39	2.35	3.89	2.38	1.62	24 01
1353	Southern Am'd. Dis. Bone	" " " "	7.94	2.86	2 16	1 96	1.33	25 17
1354	Fertilizer	G B Langford, Barnes X Roads, Ala	9.06	2 32	1.65	1.96	1.65	26 36
1355	Eutaw Fertilizer	O T Jeter, LaFayette, Ala	7.41	2.57	2.82	2 24	1.50	25 20
1356	Fertilizer	J G Wester, Plano, Ala	6.31	2.15	1.29	1.82	1.03	20 81
1361	"	T L Woodham, Ozark, Ala	0.65	6.93	5.16	3.36	0.40	23 80
1376	"	W R Sims, Newton, Ala	9 00	1.99	1.47	1.96	2.91	27 03
1381	"	R D Richards, Belcher, Ala	2.15	7.75	5.05	2 24	0.78	24 36
1382	Baker's Stand. Guano	J T Adams, Chulafinnee, Ala	2.86	4 71	2 43	1.77	1 42	19 67
1384	Ober's Guano	Jos Gunierly, Haleburg, Ala	3.85	3.27	2.24	1.68	1.35	18 58
1489	Guano	S M Adams, Troy, Ala	7.85	1 80	2.59	1.89	1.00	22 84

Acid Phosphates.

Station No.	Name of Fertilizer.	By Whom Sent.	Phosphoric Acid. Water Soluble.	Phosphoric Acid. Citrate Soluble.	Phosphoric Acid. Acid Soluble.	Commercial Value.
1239	Eng'h Acid Phosphate	W.S.Herman, Autaugaville Ala	12.34	3.17	1.76	23.36
1246	Etiwan Dis. Bone...	Col. J. S. Newman, Auburn, Ala	9.65	4.06	3.53	20.56
1247	Dissolved Bone Black	" " " " "	13.97	3.00	0.07	25.45
1254	Phosphate..........	A. J. Bradley, Maple Grove, Ala	6.48	5.78	2.48	18.39
1259	Dissolved Bone Phos.	A. J. Huston, Talladega, Ala..	10.01	3.80	2.08	20.76
1261	Tinsley Acid Phos...	W. S. Merony, Montevallo, Ala	12.15	2.86	3.19	22.50
1278	Patapsco Acid Phos.	G. W. Hamil, Troy, Ala......	11.67	3.51	1.08	22.77
1298	Phosphate..........	W. B. Wingard, Glee, Ala ...	11.13	1.88	1.87	20.51
130,	Scott's Acid Phos...	E.N.Willis, Hardwicksburg, Ala	10.08	4.02	2 41	21.15
1308	Dissolved Bone Phos.	W. E. Brown, Haleburg, Ala..	7.68	3.02	1.68	16.05
1318	Phosphate..........	G. W. Hamil, Troy, Ala......	4.08	6.86	5.52	17.31
1339	Dissolved Bone Phos.	J. H. Patterson, Dean St'n, Ala	10.36	4.05	2 25	21.61
1338	Sterling Acid Phos..	C. C. Grout, Auburn, Ala....	11.88	2.63	0.69	21.71
1341	Sun'y So. Acid Phos.	Rainer Brothers, Troy, Ala...	3.84	8.61	3.37	18.66
1345	Dissolved Bone Phos,	D. L. Campbell, " "	12.07	4.86	1.79	25.37
1349	Phosphate..........	Thos. B. Kelly, Cluttsville, Ala	13.20	3.21	1.56	24.69

Miscellaneous Fertilizers.

Station No.	Name of Fertilizers.	By Whom Sent.	Phosphoric Acid. Water Soluble.	Phosphoric Acid. Citrate Soluble.	Phosphoric Acid. Acid Soluble.	Nitrogen.	Potash.
1248	Natural Phosphate..	Columbus Fert'zer Co., Ga	....	....	36.13	....	....
1249	" "	" " "	....	....	16.62	....	....
1258	Sulphate of Potash..	F.C.Potter, HainesCity, Ala	....	....	....	....	21.45
1260	Sodium Nitrate......	F. S. Roberts, Mobile, Ala	....	....	....	16.38	....
1302	Kainite.............	W. E. Bradley, Abbeville	....	....	....	....	14.30
1326	Swan Island Guano..	F. S. Roberts, Mobile, Ala	0.18	5.71	14.14	....	....
1375	Carib Guano........	J. C. Webb, Demopolis, Ala	....	....	21.42	0.56	0.12
1379	Muriate of Potash...	E.Ala.Fert'zer Co., Clayton	....	....	....	....	49.18
1383	Cotton Seed Meal...	Cent'l Oil Co., Montg'y, Ala	....	....	3.22	6.79	1.96
1394	Tankage	Columbus Fertilizer Co., Ga	....	....	9.64	8.19	....
1395	Tankage No.1 conc'td	S. D. Rees, Mobile, Ala..	....	....	1.07	11.67	....
1396	" No. 2 ground	" " "	....	....	17.80	5.67	....
1397	" No. 3 crush'd	" " "	....	....	17.45	5.67	....

MARLS.

Station No.	Name of Substance.	By Whom Sent.	Insoluble Matter.	Carbonate of Lime.	Phosphoric Acid.	Potash.
1239	Green Sand Marl...	J. M. Carter, Oateston, Ala. .	....	...	0.19	0.19
1265	Shell Marl	A. R. McDonald, Montg'y, Ala	....	87.60	0.21	....
1319	Clay & shells (white)	Knabe & Scott, Montg'y, Ala	...	54.00	0.21	....
1320	" " (black)	" " " "	...	36.00	0.09	....
1380	Marl............	W. J. Jones, Allenton, Ala ...	36 29	53.76	0.51	....
1385	Marl...............	A. B. Parks, Mt. Meigs, Ala..	28.50	57.86	0.19	....
1386	Marl..............	" " " " "	75.90	5.67	0.15	....
1387	Marl...............	J. M. Marshal, Allenton, Ala..	49.25	33.63	0.07	....
1390	Marl....	J. E. Rushing, Troy, Ala	36.45	49.86	trace	....

FERTILIZERS USED ON EXPERIMENT STATION, AUBURN, ALA.

1240–1247.	Phosphoric Acid. Water Soluble.	Phosphoric Acid. Citrate Soluble.	Phosphoric Acid. Acid Soluble.	Nitrogen.	Potash.
Kainite.......	.....	.....	.....	......	10.18
Muriate..............	....	......	....	......	52.51
Sulphate of Ammonia	....	......	......	20.44	.....
Nitrate of Soda......................	.....	......	....	15 40	.....
Dried Blood.........................	.....	......	.....	5.11	.....
Cotton Seed Meal....................	....	.....	3.52	7.35	1.61
Etiwan Dissolved Bone.................	9.65	4.06	3 53	....	.....
Dissolved Bone Black..................	13.97	3.00	0.17	....	.....

NATURAL PHOSPHATES FROM FLORIDA.—H. BUSSEY, COLUMBUS, GA.

1326–1334.	No. 1	2	3	4	5	6	7	8	9
Phosphoric Acid................	0.36	2.50	1.03	1.13	0 94	0.94	0.73	1.25	36.84
1336–1337 Phosphoric Acid......	0.46	0 65		...	....	..	...	...	.....

BAT MANURE FROM F. D. TINSLEY, SELMA, ALA.

1358–1360.	No. 1.	No. 2.	No. 3.
Phosphoric Acid...........................	2 88	18.30	7.09
Nitrogen..................................	4 83	...	...
Potash....................................	0 56	0.80	0.32

ROCKS SUPPOSED TO BE PHOSPHATIC FROM L. M. BASHINSKY, TROY, ALA.

1351–1373.	No. 1	2	3	4	5	6	7	8	9	10	11
Phosphoric Acid........	0 70	0.12	0 12	0 01	0.06	0.05	0 21	0.12	0 15	0 15	0.18

These specimens are varieties of Marl and Rotten Limestone and of no commercial value.