

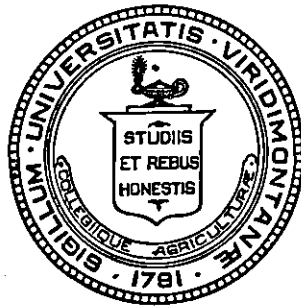
Commercial Fertilizers.

University of Vermont and State Agricultural College
Vermont Agricultural Experiment Station

BURLINGTON VERMONT

COMMERCIAL FEEDERS

By L. S. WALKER and R. W. RICE



Manufacturers have met the requirements of the Vermont law well during 1936. Thirteen brands of mixed goods and seven of crude stock failed to furnish all the plant food that was promised; however, shortage in the total amount of plant food guaranteed occurred in only nine of the 183 brands and exceeded three percent in only one case.

The sheep, cattle and goat manures, 10 in number, were as good as they were said to be. One brand was low in potash but showed no shortage of total plant food. Four contained altogether too much sand.

Most of the limes and limestones, 15 in number, were well above guaranty. However four were low in calcium oxide.

One brand of mixed goods which carried only eight percent of plant food, very much the lowest grade sold in Vermont since the eighties of the last century, contained organic nitrogen of inferior quality. The average fertilizer sold in Vermont during the past six years as well as this year was guaranteed to contain, and did contain, nearly three times as much plant food and better plant food and cost less than did this lowest of the lows. All the others were classed as "high analysis goods" containing 14 percent or more of plant food.

Fertilizer usage in 1935 and 1936, grouped on the tonnage basis by grades, is shown on page 20. The 1935 usage was 15,295 tons, a 17 percent increase over 1934, and that of 1936, 16,421 tons, a 7 percent increase over 1935. It is now approximately as large as it was during the latter part of the last decade.

The usage of superphosphate has increased very greatly of late, the 1935 tonnage being more than half as large again as the average 1931-1934 usage; and that in 1936 is approximately two and one-half times as great. Nearly one-third of this year's purchase of commercial fertilizer consisted of crude stocks whereas in 1931-1934 it amounted to but about one-fifth of the total.

A summary of data secured as to the acidity or non-acidity of the several brands is found on page 4. It would require an application to Vermont soils of 883 tons of limestone to neutralize the acidity developed by the 10,252 tons of complete fertilizer which were sold here this year. Nearly 5,000 tons of superphosphates were sold but this material, contrary to the impression naturally conveyed by the name commonly applied to it, "acid phosphate," is practically neutral in reaction.

Mixed fertilizer cost on the average \$40 per ton, or four dollars more than in 1935.

BULLETIN 409: COMMERCIAL FERTILIZERS

By L. S. WALKER AND E. F. BOYCE

The results of the 1936 inspection are set forth herewith in condensed form. The licenses cover: Complete mixed fertilizers, 117; crude stocks, 51; sheep, cattle and goat manures, 10; incomplete fertilizers, 3; limes, 19; total, 200.

The station sampling agents visited many Vermont cities, towns, villages and farms in the spring of 1936 and drew 348 samples from dealers' stocks representing 183 of the 200 brands licensed for sale. No samples were secured of 17 brands (7 complete fertilizers, 6 crude stocks and 4 limes and limestones) named below.

ARMOUR FERTILIZER WORKS, New York, N. Y.

Armours Big Crop Orchard 7-8-6; Armours Big Crop Fertilizer 4-8-8; 8-16-20; Superphosphate 20%; Muriate of Potash 50%.

BARRETT CO., New York, N. Y.

Arcadian Sulphate of Ammonia 20.56%.

CHILEAN NITRATE SALES CORP., New York, N. Y.

Standard Chilean Nitrate of Soda 15.25%; Chilean Nitrate of Soda Containing Potash 14-14.

CONSOLIDATED RENDERING CO., Boston, Mass.

Sulphate of Ammonia 20.50; Corenco 8-16-16.

PEOPLES TRUST CO., St. Albans, Vt.

Lime Kiln Waste.

ROGERS & HUBBARD CO., Portland, Conn.

Hubbard's All Soils All Crops 4-8-4; "Bone Base" Soluble Corn and Market Garden Manure; "Bone Base" Seeding Down Fertilizer.

HOOSAC VALLEY LIME CO., Adams, Mass.

Adams Land Lime; Hoosac Agricultural Limestone.

SOLVAY PROCESS CO., Syracuse, N. Y.

Solvay Pulverized Limestone.

The 13 brands of complete fertilizer and crude stock not sampled represent less than one percent of the total tonnage sold. Indeed only 20 tons were sold of 8 of these 13 unsampled brands. It often happens that a car arrives at a railroad station and its contents are hauled away within 24 hours and sown upon the land within a day or two. Moreover fertilizers are frequently delivered nowadays by truck direct from the factory or the jobber's warehouse to the very farms and onto the very fields on which they are promptly sown. Of course under such circumstances the station's sampling agents can not obtain samples. During recent years this group of unsampled brands has represented not more than four percent of the entire tonnage, and this year it represents only one percent of total sales, which seems as close a record as can be attained.

BRANDS SAMPLED AND ANALYZED

The condensed statements on the following pages indicate:

(1) Those brands of mixed goods which have fulfilled their guaranties (table I, pages 5 to 7). (2) Those brands of crude stock which conform to promise (table II, pages 8 and 9). (3) The 20 brands which contained less plant food than guaranteed (table III, pages 10 and 11). (4) Sheep, goat and cattle manures and limes and limestones (tables IV and V, pages 12 to 14).

Table I (pages 5 to 8) shows:

1. The names and addresses of licensees.
2. The brand names.
3. The "grades"—nitrogen, available phosphoric acid¹ and water-soluble potash.
4. The percentage of the total nitrogen in each brand present as nitrate, in ammoniacal form, in soluble and in insoluble organic forms.
5. The percentage of total phosphoric acid in each brand present in so-called available form.
6. The facts as to the quality of the organic nitrogen contents (by footnotes).
7. The source of potash, whether muriate, sulphate or nitrate (by footnotes).

Table II (pages 8 and 9) shows the analyses of the sundry crude stocks which were found to be equivalent to their guaranties.

Table III (pages 10 and 11) sets forth the facts as to 20 brands which failed to meet their guaranties. In 12 cases no actual shortage in total plant food occurred, due to the fact that the overruns more than offset the underruns. The shortages occurring in 8 brands are recorded in terms of percentage in the last column, ranging from 1 to 4 percent.

The acidity or basicity of each brand of mixed fertilizers sampled was determined. Twenty-nine of the 110 were found to be basic or "non-acid" in reaction, the residue were classed as acidic. The calcium carbonate (limestone) equivalents per ton of the latter ranged from 300 pounds per ton downward to zero and from zero upward to 350 pounds per ton for the former.

It does not seem expedient to publish the results secured on the several samples. However, any Vermont farmer who may wish to learn whether the brand he has used or contemplates using is or is not acidic and to what extent, will be advised as to the facts on request.

¹ Total phosphoric acid guaranty is usually 0.5 percent or 1.0 percent greater than is that of the available phosphoric acid and sometimes is identical with it.

I. MIXED FERTILIZERS SUBSTANTIALLY COMPLYING WITH GUARANTIES

Brand name	Percentage of total nitrogen				Percentage of total phosphoric acid in available form
	As nitrate	As ammonia	As soluble organic	As insoluble organic	
Acme Guano Co., 311 Marine Bank Bldg., Baltimore, Md.					
Acme 5/8/7 ¹	3	85	7	5	96
Acme 4/8/4	0	80	12	8	95
Acme 3/10/4	0	85	10	5	96
Acme 2/10/2	0	80	10	10	98
American Agricultural Chemical Co., 285 River St., North Weymouth, Mass.					
AA Double Strength Fertilizer 8/16/14	8	84	7	1	99
AA Top Dresser 7/6/6	10	81	4	5	91
AA Potato & Vegetable 5/8/7	5	90	3	2	97
AA Complete Manure with 10% Potash 4/8/10... ..	6	71	15	8	97
AA 4/8/8 Fertilizer	9	72	10	9	98
AA Peerless Fertilizer 4/8/7	8	86	4	2	94
AA Monarch Fertilizer 4/8/4	3	69	19	9	97
AA Corn Favorite 3/10/4	0	69	24	7	95
AA Prolific 10% Potash Fertilizer 2/8/10	1	67	24	8	95
Agrico for Potatoes Double Strength 8/16/20....	7	91	1	1	98
Agrico for Fruit 9/6/6	6	87	5	2	100
Agrico for Lawns, Trees & Shrubs 7/6/6	12	80	3	5	95
Agrico for Pastures & Top Dressing 7/6/6	14	80	2	4	95
Agrico for Aroostook with 10% Potash 5/8/10....	16	70	6	8	95
Agrico for Potatoes & Vegetables 5/8/7	7	82	10	1	94
Agrico for Corn 3/10/6	2	92	3	3	92
Bradley's XL Fertilizer 3/10/4	1	73	17	9	96
Apothecaries Hall Co., Box 1009, Waterbury, Conn.					
Liberty Special Fertilizer for Fruit 7/8/6	54	37	6	3	93
Liberty Potato & General Crops 4/8/10	12	65	14	9	96
Liberty Market Gardeners' Special 4/8/4	24	56	5	15	100
Armour Fertilizer Works, 120 Broadway, New York, N. Y.					
Armours Special Turf Fertilizer 10/8/6 ²	4	94	2	0	100
Armours Big Crop Fertilizer 8/16/16	8	87	5	0	100
Armours Big Crop Fertilizer 7/6/6	3	85	5	7	100
Armours Big Crop Fertilizer 5/8/7	9	66	10	15	91
Armours Big Crop Fertilizer 4/8/10	15	60	7	18	92
Armours Big Crop Fertilizer 4/12/4	12	74	1	13	93
Armours Big Crop Fertilizer 4/8/7	23	58	3	16	95
Armours Big Crop Fertilizer 4/8/4	15	67	3	15	91
Armours Big Crop Fertilizer 3/10/4	11	68	9	12	94
Armours Big Crop Fertilizer 2/10/2	14	64	9	13	95
Berkshire Chemical Co., 92 Howard Ave., Bridgeport, Conn.					
Berkshire Potato & Garden Special Fertilizer 5/8/7	17	59	8	16	96
Berkshire Long Island Special Fertilizer 4/8/7....	11	63	9	17	95
Berkshire Market Garden Fertilizer 4/8/4	9	56	15	20	97

All brands listed above "passed" in respect to the quality of their organic nitrogen contents and, save in two cases, carried potash in the form of muriate.

¹ Six-sevenths of potash as muriate; remainder as sulphate.

² One-tenth of potash as muriate; remainder as sulphate.

I. MIXED FERTILIZERS SUBSTANTIALLY COMPLYING WITH GUARANTIES

—continued

Brand name	Percentage of total nitrogen				Percentage of total phosphoric acid in available form
	As nitrate	As ammonia	As soluble organic	As insoluble organic	
Consolidated Rendering Co., 178 Atlantic Ave., Boston, Mass.					
Corenco 8/16/14 "Two in One"	12	74	10	4	96
Corenco 7/6/6 Complete Fruit & Top Dressing ...	14	74	8	4	100
Corenco 5/8/7 General Crop Manure	20	60	17	3	99
Corenco 4/8/10 Potato Grower	15	59	22	4	99
Corenco 4/12/4 Complete Manure	22	55	20	3	99
Corenco 4/8/8	21	51	28	0	99
Corenco 4/8/7 Market Garden	13	66	15	6	99
Corenco 4/8/4 Corn & Vegetable	18	52	27	3	99
Corenco 3/10/4 Animal Brand	23	45	29	3	99
Corenco 2/8/10 Potato & Oat Special	34	8	51	7	96
Eastern States Farmers' Exchange, Box 1482, Springfield, Mass.					
Eastern States 12/16/12 ¹	32	66	1	1	100
Eastern States 12/4/4	34	64	1	1	100
Eastern States 8/16/16 ²	22	74	3	1	98
Eastern States 8/12/20 ³	22	72	5	1	100
Eastern States 8/24/8 ⁴	29	64	4	3	98
Eastern States 6/8/6	25	69	3	3	98
Eastern States 4/12/4	17	71	9	3	98
Eastern States 4/8/8	16	75	6	3	100
Eastern States 0/14/6	0	0	0	0	95
Howard Hardware Co., Bellows Falls, Vt.					
Howard's Special Lawn, Flower and Garden 4/7/8	47	3	13	37	80
International Agricultural Corp., 38 Chauncy St., Boston, Mass.					
Caribee Market Garden 5/10/10 ⁵	39	32	2	27	95
International 5/8/7	16	68	11	5	96
International 7/6/6	9	76	9	5	99
International 4/8/10	16	68	12	4	92
International 4/8/4	15	70	12	3	100
Lowell Fertilizer Co., 178 Atlantic Ave., Boston, Mass.					
Lowell 5/8/7 Market Garden Manure	14	63	21	2	100
Lowell 4/8/7 Old General Crop Manure for Potatoes and Market Garden Crops	23	52	22	3	98
Lowell 4/8/4 Corn & Vegetable	19	53	25	3	95
Lowell 3/10/4 Animal Brand	28	40	29	3	95
Lowell 2/8/10 Vegetable & Grain	48	9	36	7	98

All brands listed above "passed" in respect to the quality of their organic nitrogen contents and, save in five cases, carried potash in the form of muriate.

¹ One-fourth of potash as muriate; remainder as nitrate.

² Three-fifths of potash as muriate; remainder as nitrate.

³ Three-fourths of potash as muriate; remainder as sulphate.

⁴ One-tenth of potash as muriate; remainder as nitrate.

⁵ Two-fifths of potash as muriate; remainder as sulphate.

I. MIXED FERTILIZERS SUBSTANTIALLY COMPLYING WITH GUARANTIES

Brand name	Percentage of total nitrogen				Percentage of total phosphoric acid in available form
	As nitrate	As ammonia	As soluble organic	As insoluble organic	
J. O. Middlebrook & Sons, 190 College St., Burlington, Vt.					
Midcö 7/6/6	0	91	5	4	93
Old Deerfield Fertilizer Co., Inc., 28 Sugarloaf St., South Deerfield, Mass.					
Valley Brand 7/6/6 ¹	40	47	10	3	100
Valley Brand 5/8/7	35	45	19	1	95
Valley Brand 4/8/10	36	45	17	2	99
Valley Brand 4/8/7	43	42	14	1	99
Valley Brand 4/8/4	35	47	16	2	100
Old Deerfield 3/10/6	22	30	40	8	94
Valley Brand 3/10/4	36	44	19	1	98
Valley Brand 2/8/10	22	44	34	0	99
Valley Brand 2/10/2	33	41	24	2	97
Rogers & Hubbard Co., Portland, Conn.					
"Bone Base" Oats & Top Dressing ²	93	1	0	6	83
Hubbard's Potato Fertilizer 5/8/7	11	51	26	12	87
Hubbard's Corn & Grain 2/12/4	5	61	18	16	87
Hubbard's High Potash 2/8/10	0	61	29	10	87
Red H Brand 7/6/6	7	92	0	1	90
Red H Brand 5/8/7	27	71	0	2	92
Red H Brand 4/8/10	17	79	2	2	92
Red H Brand 4/8/7	18	80	1	1	95
Red H Brand 4/8/4	16	78	4	2	91
Red H Brand 4/10/6	7	84	9	0	96
Standard Wholesale Phosphate & Acid Works, Inc., 1600 Continental Bldg., Baltimore, Md.					
Standard 5/8/7 ³	1	80	11	8	92
Standard 4/8/10	4	74	15	7	99
Standard 4/12/4	5	76	12	7	98
Standard 4/8/7 ⁴	0	77	14	9	96
Standard 4/8/4 ⁵	10	69	11	10	95
Standard 2/8/10	4	82	5	9	95
Standard 2/8/10 ⁶	0	64	27	9	93
Standard 2/10/2	4	76	8	12	94
Swift & Co. Fertilizer Works, 1305 Standard Oil Bldg., Baltimore, Md.					
Vigoro 4/12/4	11	86	3	0	93
Tennessee Corp., Lockland, Ohio					
Loma 5/10/4	7	85	2	6	92
Soil-Prep 4/2/2 ⁷	0	59	6	35	0

All brands listed above, with one exception, "passed" in respect to their organic nitrogen contents and, save in five cases, carried potash in the form of muriate.

¹ Four-fifths of potash as muriate; remainder as sulphate.
² Two-fifths of potash as muriate; remainder as sulphate.
³ Seven-tenths of potash as muriate; remainder as sulphate.
⁴ Two-thirds of potash as muriate; remainder as sulphate.
⁵ Three-fourths of potash as muriate; remainder as sulphate.
⁷ Contains organic nitrogen of inferior quality.

II. CRUDE STOCKS SUBSTANTIALLY COMPLYING WITH GUARANTIES

Nitrogenous materials	Nitrogen	
	Found	Guaranteed
<i>Nitrate of Soda</i>		
Barrett Co., New York, N. Y., "Arcadian"	16.26	16
<i>Sulphate of Ammonia</i>		
American Agricultural Chemical Co.	20.80	20.50
Armour Fertilizer Works	20.74	20.50
Barrett Co.	20.86	20.56
Eastern States Farmers' Exchange, "Eastern States, Special Dried"	20.94	20.50
Ford Motor Co., "Ford Refined"	21.22	20.80
<i>Air-nitrogen Products</i>		
American Cyanamid Co., "21% 'Aero' Cyanamid Granular"	20.94	21
Eastern States Farmers' Exchange, "Eastern States Calnitro"	20.94	20.5

Nitrogenous and phosphatic materials	Nitrogen		Total phosphoric acid	
	Found	Guar.	Found	Guar.
<i>Ammo-Phos</i>				
American Cyanamid Co., "Ammo-Phos 11/48/0"	11.31	11	51.60	*
<i>Ground Bone and Tankage</i>				
American Agricultural Chemical Co., "Fine"	2.71	2.47	25.94	23
Apothecaries Hall Co.	3.81	2.47	24.90	23
Armour Fertilizer Works, "Armours"	2.50	2.47	26.74	23
Breck, Jos. & Sons Corp., "Breck's—Steamed"	2.93	2.47	23.76	22.88
Consolidated Rendering Co., "Ground Tankage"	7.75	7.41	13.22	9.15
Consolidated Rendering Co., "Corencó"	2.44	2.47	26.38	23
Eastern States Farmers' Exchange, "Eastern States Steamed"	3.18	2.50	24.22	23
Dr. Heinz Co., "Heinz Odorless"	0.90	1	33.58	29
Master Meat Products Co., "Master"	4.09	4	24.86	25
Old Deerfield Fertilizer Co., Inc., "Old Deer- field Steamed"	2.40	2.47	24.86	20
Rogers & Hubbard Co., "Strictly Pure Fine"	3.93	3.70	23.86	20
Rogers & Hubbard Co., "Fine"	2.94	2.47	24.46	23
Rynveld, F. & Sons, Inc., "Rynveld's"	3.28	2.47	23.92	22
Standard Wholesale Phosphate & Acid Works, Inc., "Standard Animal Tankage"	8.10	7.40	9.88	9.15
Swift & Co. Fertilizer Works	2.62	2.47	27.10	23

* Available phosphoric acid guaranteed 48%; found 51.12%.

Phosphatic materials	Phosphoric Acid			
	Found	Total Guar.	Found	Available Guar.
<i>Superphosphate (Acid Phosphate)</i>				
Acme Guano Co., "Acme 16%"	17.60	..	17.04	16
American Agricultural Chemical Co., "AA 16%"	18.66	..	17.56	16
Apothecaries Hall Co.	19.34	..	18.66	16
Armour Fertilizer Works, "Armours Big Crop 16%"	17.74	..	17.74	16
Berkshire Chemical Co., "Berkshire 16%"	18	..	17.46	16
Consolidated Rendering Co.	18.10	..	18.10	16
Eastern States Farmers' Exchange, "Eastern States 20%"	21.94	..	21.48	20
Eastern States Farmers' Exchange, Eastern States 40% Double	41.20	40.50	41.20	40
International Agricultural Corp., "International 16%"	17.90	..	17.06	16
Old Deerfield Fertilizer Co., Inc., "Old Deerfield"	17.88	..	17.28	16
Rogers & Hubbard Co., "Hubbard's"	19.16	..	18.10	16
Standard Wholesale Phosphate & Acid Works, Inc., "Standard 16%"	17.80	..	17.20	16
Standard Wholesale Phosphate & Acid Works, Inc., "Standard 20%"	21.14	..	20.64	20

Potassic materials	Potash	
	Found	Guaranteed
<i>Muriate of Potash</i>		
Eastern States Farmers' Exchange, "Eastern States"	60.18	60
Old Deerfield Fertilizer Co., Inc., "Old Deerfield"	51.42	50
Rogers & Hubbard Co.	52.38	50
Standard Wholesale Phosphate & Acid Works, Inc., "N. V. Genuine German"	51.76	50

III. THIRTEEN BRANDS OF MIXED GOODS AND SIX OF CRUDE STOCK FAILING TO MAKE GOOD THEIR GUARANTIES

Manufacturers and Brands	Nitrogen found					Phosphoric acid found		Potash found			Shortage
	As nitrates	As ammonia	Soluble organic	Insoluble organic	Total	Total	Available	Total	As muriate	In other forms	
Acme Guano Co., Acme 4/8/10.....		3.85	0.16	0.15	4.16	8.76	8.38	9.54	8.37	1.17	None
Amer. Agr. Chem. Co., AA Hi-Test 10/20/20	1.14	8.86	0.12	0.35	10.47	22.48	22.08	19.70	16.74	2.96	None
Amer. Agr. Chem. Co., AA 6/8/6	0.33	4.75	0.67	0.29	6.04	9.26	9.08	5.58	5.58	...	None
Amer. Agr. Chem. Co., Agrico for New England 4/8/10†	0.35	3.28	0.18	0.11	3.92	9.68	9.17	9.51	9.51	...	None
Amer. Agr. Chem. Co., Bradley's Complete Manure with 10% Potash 4/8/10.....	0.29	2.80	0.54	0.35	3.98	9.20	8.66	9.59	9.59	...	None
Amer. Agr. Chem. Co., Muriate of Potash 50†	...	...	...	...	...	...	...	48.10	48.10	...	4%
Armour Fertilizer Wks., Armours Big Crop 8/16/14	0.83	6.77	...	0.04	7.64	16.60	16.26	14.08	14.08	...	None
Chilean Nitrate Sales Corp., Champion Nitrate of Soda 16†.....	15.76	...	...	...	15.76	...	...	...	...	...	2%
Consol. Rendering Co., Corenco 8/16/20 "Two in One"†	1.02	5.88	1.27	0.25	8.42	18.22	17.76	19.16	19.16	...	None
Consol. Rendering Co., Corenco 7/13/11 "It Cuts the Cost"†.....	1.59	4.08	0.97	0.56	7.20	14.95	14.49	8.86	8.86	...	1%

† Analysis represents average of two samples.

III. THIRTEEN BRANDS OF MIXED GOODS AND SEVEN OF CRUDE STOCK FAILING TO MAKE GOOD THEIR GUARANTIES

—concluded

Manufacturers and Brands	Nitrogen found					Phosphoric acid found		Potash found			Shortage
	As nitrates	As ammonia	Soluble organic	Insoluble organic	Total	Total	Available	Total	As muriate	In other forms	
Consol. Rendering Co., Corenco Nitrate of Soda 16†	15.77	...	...	...	15.77	...	...	...	...	...	1%
Consol. Rendering Co., Muriate of Potash 50†	...	...	...	...	...	...	...	49.72	49.72	...	1%
Eastern Sts. Farmers' Exch., Eastern States 8/20/12	2.36	5.81	0.16	0.22	8.55	19.18	18.76	13.66	11.96	1.70	None
Eastern Sts. Farmers' Exch., Eastern States 4/16/20†	0.84	2.87	0.64	0.15	4.50	18.63	18.63	18.71	18.71	...	None
Lowell Fertilizer Co., Lowell 7/6/6 Complete Fruit & Top Dressing†	1.05	4.76	0.67	0.29	6.77	7.00	6.62	6.08	6.08	...	None
Lowell Fertilizer Co., Lowell 4/8/10 Potato Grower†	0.92	2.35	1.07	0.11	4.45	9.16	8.86	9.58	9.58	...	None
Rogers & Hubbard Co., Red H 8/16/14†	...	6.78	0.75	0.40	7.93	17.46	17.19	13.48	13.48	...	None
Std. Wholesale Phosphate & Acid Wks., Inc., Standard Sulphate of Ammonia 20.56	20.36	...	...	...	20.36	...	...	...	...	...	1%
Std. Wholesale Phosphate & Acid Wks., Inc., Standard Bone Meal 2.47-23	...	...	...	...	2.94	22.36	...	...	...	...	1%

† Analysis represents average of two samples.

COMMERCIAL FERTILIZERS

IV. SHEEP, GOAT AND CATTLE MANURES

Manufacturers and Brands	Moisture	Organic and volatile matter	Insoluble matter (sand)	Nitrogen		Phosphoric acid		Potash	
				Found	Guaranteed	Found	Guaranteed	Found	Guaranteed
American Agricultural Chemical Co.									
Pulverized Sheep & Goat Manure...	6.45	35.53	33.58	1.26	1.25	1.08	1	3.45	2
Armour Fertilizer Works									
Sheep & Goat Manure.....	6.80	38.63	28.58	1.31	1.25	0.98	1	3.78	2
Consolidated Rendering Co.									
Corenco Sheep Manure.....	6.99	49.66	13.23	1.64	1.25	1.15	1	4.67	2
International Agricultural Corp.									
International Caribee Sheep Manure	7.98	45.00	16.89	1.61	1.02	1.08	0.50	4.90	2
Old Deerfield Fertilizer Co., Inc.									
Old Deerfield Sheep & Goat Manure	5.95	47.48	39.00	1.71	1.25	0.92	1	2.56	1
Premier Poultry Manure Co.									
Premier Brand Pulverized Sheep Manure	4.73	58.28	16.21	1.67	1.65	3.49	1	2.73	2
Premier Brand Shredded Cattle Manure	6.49	76.79	3.57	2.27	1.65	2.20	0.85	1.72	2
Pulverized Manure Co.									
Wizard Brand Pulverized Sheep Manure	6.88	69.00	13.54	1.92	2	1.40	1	2.70	2
Rogers & Hubbard Co.									
Hubbard Sheep & Goat Manure.....	8.82	42.86	16.69	1.59	1.25	1.24	1	3.94	2
Rynveld, F., & Sons, Inc.									
Moo Cow Natural Fertilizer.....	6.20	48.95	34.70	1.43	1.48	0.92	0.81	1.86	1.8

There seems to have been a slight increase in the volume of sheep, goat and cattle manure sales during the past two years. This class of fertilizer has its place in the market, but the purchaser should choose carefully, as, indeed, everybody should who buys a fertilizer. Prices varied from about \$36 to \$53 per ton, averaging \$45, which is slightly less than last year. The guaranties of the several brands do not vary materially and often bear little relation to the actual composition of the material which is sold. Thus one brand contained 3.5 times as much phosphoric acid as it was said to carry; five brands from 2. to 2.5 times as much potash as they were said to contain. One may best judge their relative values by referring to the actual analyses. A lot in which the organic matter content is low and that of insoluble matter is high should be looked at askance on that account. Dried manures ought not to carry more than 20 percent of insoluble matter or sand.

On the whole these manures met guaranties well. One was somewhat short of its potash guaranty, but its nitrogen and phosphoric acid contents were well above guaranty; and it contained little insoluble matter and much organic matter. In other words, while technically it is faulty, actually it is—for its class—of good grade.

V. AGRICULTURAL LIME PRODUCTS

Manufacturer and Brand	Lime (CaO) found	Lime (CaO) guaranteed	Magnesia (MgO) found	Magnesia (MgO) guaranteed	Total carbonates (CaCO ₃ + MgCO ₃) found	Total carbonates (CaCO ₃ + MgCO ₃) guaranteed	Insoluble matter SiO ₂	Mechanical analysis				
								Percentage passing 20-mesh sieve	Percentage passing 40-mesh sieve	Percentage passing 60-mesh sieve	Percentage passing 80-mesh sieve	Percentage passing 100-mesh sieve
Hydrated Limes												
Brewer & Co., Inc., Worcester, Mass.												
Brewer's Sure Crop Agricultural Hydrated Lime	61.04	60	1.78	1	33.98	...	1.65	...	...	...	...	...
Producto Agricultural Lime.....	60.96	60	1.44	1	40.95	...	1.44	...	...	...	...	...
Fonda Lime Kilns, St. Albans, Vt.												
Fonda Agricultural Lime	61.80	60	1.48	0.5	39.58	...	2.33	...	...	...	...	...
Millard, H. E., Annville, Penna.												
Sweet-Arrow Hydrated Lime.....	64.64	70	2.32	1.5	31.25	1	0.42	...	...	...	...	...
Swanton Lime Works, Swanton, Vt.												
Agricultural Lime	60.56	60	2.24	0.3	38.44	30	1.68	...	...	...	...	...
Vermarco Lime Co., West Rutland, Vt.												
Vermarco Agricultural Hydrated Lime.....	70.62	68	2.12	1	14.24	...	0.76	...	...	...	...	...
Ground Limestones												
Aiken, Herrick, Amsden, Vt.												
Amlico Land Lime (Limestone).....	30.55	30	17.01	16	90.09	93	7.87	91	48	35	28	27
Amer. Agr. Chem. Co., N. Weymouth, Mass.												
Pownal Agricultural Limestone.....	45.50	45	6.80	5	95.42	90	4.58	100	87	82	77	75
Andrews, L. B., & Son, Wilmington, Vt.												
Agricultural Limestone	29.66	23	15.21	16.75	84.73	89.5	15.27	99	83	71	58	54

V. AGRICULTURAL LIME PRODUCTS—concluded

Manufacturer and Brand	Lime (CaO) found	Lime (CaO) guaranteed	Magnesia (MgO) found	Magnesia (MgO) guaranteed	Total carbonates (CaCO ₃ + MgCO ₃) found	Total carbonates (CaCO ₃ + MgCO ₃) guaranteed	Insoluble matter SiO ₂	Mechanical analysis				
								Percentage passing 20-mesh sieve	Percentage passing 40-mesh sieve	Percentage passing 60-mesh sieve	Percentage passing 80-mesh sieve	Percentage passing 100-mesh sieve
Ground Limestones—concluded												
Bishop, A. G., Perkinsville, Vt.												
Perkinsville Land Lime (Limestone).....	35.42	30	15.30	15	95.21	90	4.70	87	49	28	18	16
Brewer & Co., Inc., Worcester, Mass.												
Producto Agricultural Limestone.....	50.12	40	30.2	1	95.75	90	4.25	100	92	76	66	64
Dominion Lime Co., Lime Ridge, Que.												
Dudswell Brand Ground Limestone.....	50.64	52	2.29	1	95.15	94	4.85	99	87	81	77	76
Vermarco Lime Co., West Rutland, Vt.												
Vermarco Agricultural Limestone.....	53.04	54	1.78	1	98.38	96	1.62	100	100	98	93	90
Vivie, Edward, Plymouth-Union, Vt.												
Plymouth Land Lime (Limestone).....	30.84	40	19.90	11	96.68	95	3.32	94	91	76	71	70
Lime Ashes												
Brewer & Co., Inc., Worcester, Mass.												
Lime Kiln Ashes.....	47.64	42	3.96	2	45.61	...	8.06	...	...	...	...	...

Fifteen of the 19 lime products licensed for sale were analyzed.

H. E. Millard's Sweet-Arrow Hydrated Lime was low in calcium oxide. This material has been sold in package form at chain stores during the past three years and each year it has failed to meet its calcium oxide guaranty.

L. B. Andrews & Son's Agricultural Limestone was low in magnesium oxide and combined carbonates which was offset somewhat by a high calcium oxide content.

The Dominion Lime Company's Dudswell Limestone and the Vermarco Lime Company's Vermarco Agricultural Limestone were slightly low in respect to their calcium oxide contents but above guaranty in combined carbonates. Edward Vivie's Plymouth Land Lime (Limestone) contained only about three-fourths its guaranteed calcium oxide content but nearly twice that of magnesium oxide. In other words, his guaranty does not accurately represent what he is selling, namely, a dolomitic limestone.

Four of the eight samples of limestone tested were in excellent mechanical condition, 70 percent or more passing a 100-mesh sieve; two dolomitic limestones were ground altogether too coarsely.

RESULTS OF FERTILIZER INSPECTION

(a) AS TO QUANTITY OF PLANT FOOD

The 110 brands of mixed goods analyzed in 1936 taken as a whole were better than last year (tables I and III, pages 5 to 9). Thirteen of the 330 guaranties (3.9 percent) were not maintained, whereas the comparable figures in 1935 were 23, 341, 6.7 percent. One shortage amounted to less than 0.25 percent, seven were between 0.25 and 0.50 percent; two above 0.50 but less than one percent; and only three exceeded one percent. The distribution was as follows: Nitrogen, 2, available phosphoric acid, 1 and potash, 10. Thirteen brands failed to meet guaranties, but total plant food shortages of from two to four percent were found in only two cases. One could hardly ask for a better result.

Four complete brands should be mentioned: Consolidated Rendering Company's 8/16/20 and 7/13/11 are somewhat off balance, having a low potash content, but in both instances the available phosphoric acid figure is high, no plant food shortage occurring in the one case and only a one percent shortage in the other. Two Eastern States Farmers' Exchange brands 8/20/12 and 4/16/20 are out of balance,

the first being low in available phosphoric acid and high in potash and the second low in potash and high in available phosphoric acid. No shortage of total plant food occurred in either case.

Thirty-eight of the 45 brands of crude stock met their guaranties. A muriate of potash registered by the American Agricultural Company guaranteed 50 percent potash contained barely 48 percent, being—on the 100 percent basis—four percent short of guaranty; a bone meal sold by the Standard Wholesale Phosphate & Acid Works, Inc., was two-thirds of a percent short in phosphoric acid, which was almost made good by a surplus of nitrogen. The other five shortages were very slight, 0.19, 0.24, 0.23 percents on a 16 percent guaranty; 0.20 percent on a 20.56 percent guaranty, 0.28 percent on a 50 percent guaranty. Purveyors of nitrate of soda crowd their guaranties altogether too closely.

Taking each brand of mixed fertilizer analyzed as a unit in the computation, regardless of the amount sold, 4.94 percent nitrogen was guaranteed and 5.14 percent furnished; 9.37 percent available phosphoric acid was guaranteed and 9.99 percent, furnished; 7.61 percent potash was guaranteed and 7.92 percent, furnished; 0.20 percent more nitrogen, 0.62 percent more available phosphoric acid and 0.31 percent more potash being furnished than was guaranteed. For each 100 pounds of plant food guaranteed 105 pounds were furnished.

The following efficiency table shows average overruns and under-runs.

EFFICIENCY TABLE

	Brands	Brands meeting guaranty in all respects	Total guaranties	Guaranties made good	Guaranties not fulfilled	0.11-0.25% below	0.25-0.50% below	0.50-1% below	More than 1% below	Average overrun over guaranty		
										Nitrogen	Available phos-phoric acid	Potash
Acme Guano Co.	5	4	15	14	1	..	1	..	..	0.10	0.29	0.04
American Agricultural Chemical Co.	21	17	63	59	4	..	4	..	..	0.05	0.78	0.05
Apothecaries Hall Co.	3	3	9	9	..	..	..	..	..	0.22	0.89	0.54
Armour Fertilizer Works	11	10	33	32	1	..	1	..	..	0.04	0.40	0.26
Berkshire Chemical Co.	3	3	9	9	..	..	..	..	..	0.09	0.36	0.24
Consolidated Rendering Co. and subsidiary	19	15	57	53	4	1	1	1	1	0.23	0.86	0.06
Eastern States Farmers' Exchange..	10	8	30	28	2	..	..	..	2	0.42	0.63	0.78
Howard Hardware Co.	1	1	3	3	..	..	..	..	..	0.42	0.24	-0.18
International Agricultural Corp....	5	5	15	15	..	..	..	..	..	0.07	0.16	-0.03
Middlebrook, J. O. & Sons	1	1	3	3	..	..	..	..	..	-0.06	0.36	0.31
Old Deerfield Fertilizer Co.	9	9	27	27	..	..	..	..	..	0.27	0.49	0.48
Rogers & Hubbard Co.	11	10	33	32	1	..	..	1	..	0.36	0.73	0.68
Standard Wholesale Phosphate & Acid Works, Inc.	8	8	24	24	..	..	..	..	..	0.44	0.52	0.70
Swift & Co. Fertilizer Works	1	1	3	3	..	..	..	..	..	0.54	1.10	0.74
Tennessee Corporation	2	2	6	6	..	..	..	..	..	0.06	0.39	0.26
Totals and averages (15 companies, each a unit)	110	97	330	317	13	1	7	2	3	0.22	0.55	0.33
Averages (110 brands, each taken as a unit) .....	..	..	..	..	..	..	..	..	..	0.21	0.62	0.31

A review of the trade for the past 10 years in mixed fertilizers seems worth while.

BRANDS OF MIXED FERTILIZER LICENSED AND ANALYZED 1927-1936

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Licensed	140	115	137	138	152	160	125	111	128	117
Collected	115	98	108	116	131	134	110	91	114	110
Not found on sale	25	17	29	22	21	26	15	20	14	7

The approximate average guaranteed composition of fertilizers sold during the 10 years—each brand taken as a unit—is shown below.

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Nitrogen	3½	3½	3¼	3¾	4½	4¾	5½	4¾	4¾	4½
Available phos-phoric acid	8½	8¾	8¾	10	10	10	9¾	9½	9½	9¾
Potash	6	6½	6	6¾	7½	7	7½	7¼	7¾	7¾
Total plant food*..	17½	18¼	18	20¾	21½	21¾	22¾	21¼	21¾	21½

* Nitrogen, available phosphoric acid, potash.

The guaranteed composition of the average mixed fertilizer (each brand taken as a unit) is very slightly higher than that sold in 1935. The average total plant food content as thus calculated has held about the same since 1930. Low grades have almost disappeared, and many double strength formulas are now on sale. The percentage of deficiencies is less than last year, and the mixed goods were fully as good as they have been of late years; and, as has been pointed out, the shortages are usually very small ones.

DEFICIENCIES (MIXED FERTILIZERS)

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Analyzed	118	98	108	116	131	134	110	91	114	110
Up to guaranty	96	77	91	106	107	116	95	82	94	97
Deficient	22	21	17	10	24	18	15	9	20	13
Percentage of deficiency	19	22	16	9	18	13	14	10	18	12

(b) AS TO QUALITY OF PLANT FOOD

Nitrogen.—The following table shows the quality of nitrogen used by the various manufacturers, the figures representing averages for their several brands.

Manufacturer	Total	Nitrogen			
		In nitrate form	In ammonia form	In soluble organic form	In insoluble organic form
Acme Guano Co.	3.70	0.03	3.14	0.28	0.25
American Agricultural Chemical Co.	5.38	0.41	4.34	0.39	0.24
Apothecaries Hall Co.	5.22	1.77	2.63	0.40	0.42
Armour Fertilizer Works	5.41	0.50	4.23	0.26	0.42
Berkshire Chemical Co.	4.42	0.55	2.62	0.48	0.78
Consolidated Rendering Co....	5.22	0.95	3.17	0.89	0.21
Eastern States Farmers' Exchange	7.82	2.05	5.31	0.29	0.17
Howard Hardware Co.	4.42	2.07	0.15	0.56	1.64
International Agricultural Corp.	5.07	0.92	3.20	0.49	0.46
Lowell Fertilizer Co.....	4.40	0.94	2.35	0.96	0.15
Middlebrook, J. O. & Sons	6.94	...	6.31	0.38	0.25
Old Deerfield Fertilizer Co., Inc.	4.05	1.43	1.76	0.78	0.08
Rogers & Hubbard Co.	5.08	1.20	3.30	0.33	0.25
Standard Wholesale Phosphate & Acid Works, Inc.	3.94	0.14	2.97	0.49	0.34
Swift & Co. Fertilizer Works..	4.54	0.51	3.91	0.12	...
Tennessee Corp.	4.56	0.18	3.34	0.18	0.86
Average	5.14	0.86	3.51	0.48	0.29

On the average, 68 percent of the total nitrogen was derived from sulphate or phosphate of ammonia, undoubtedly mostly from sulphate;

17 percent from nitrate of soda and potash, undoubtedly mostly from the former; 9 percent from water soluble organic and 6 percent from water insoluble organic sources. In other words, 94 percent was water soluble. The remaining 6 percent, derived from organic materials and insoluble in water, has been tested in the laboratory by means of the standard A. O. A. C. alkaline permanganate method, which determines its "activity." In cases where this is below 50 percent, the neutral permanganate method was also used. When the result secured indicates an activity of 80 percent by the latter and below 50 percent by the former method, the organic nitrogen is deemed to be of inferior quality. The results were: Below 50 percent, 1; 50-55 percent, 73; 55-65 percent, 9; 65-80 percent, 15; 80 percent or more, 7; no organic nitrogen, 5.

The only brand which carried inferior organic nitrogen is Soil-Prep, 4/2/2, manufactured by the Tennessee Corporation. This fertilizer is a mixture of commercial fertilizer and humus or peat. As a matter of fact, very little is sold in Vermont. With this exception the quality of the organic nitrogen was above reproach.

Phosphoric Acid.—On the average, 96 percent of the total phosphoric acid found in the complete fertilizers was in the so-called available form. With few exceptions its source is superphosphate, a standard product long and successfully used. A few brands contained bone or ammonium phosphate, both excellent materials.

Potash.—Thirteen of the complete fertilizers contained potash in forms other than muriate. Three of these 13 contained some nitrate of potash as well as muriate, while 10 carried both muriate and sulphate of potash. All three of these potash salts are standard materials.

FERTILIZER USAGE

The following tables show the total tonnages sold during the years 1931 to 1936 inclusive. There was an increase of 2,208 tons sold in 1935 over 1934, and of 1,126 tons in 1936 over 1935. This year about one-third of the total tonnage consists of crude stocks, that of superphosphate increasing 1,500 tons, or about 10 percent over last year. Other crude stocks also showed a slight increase. Sixty-two percent of the mixed fertilizer tonnage is made up of the 3/10-12/3-6, 4/8/4, 4/8/10, 5/8/7 and 8-10/16-30/14-20 grades. There was a decided drop in the 19-24 percent and a considerable increase in the 32-44 percent grades, which shows the trend toward the usage of higher grade fertilizer.

	1931	1932	1933	1934	1935	1935	1936	1936
Total tonnages	15,031	11,767	9,520	13,087	15,295	%	16,421	%
Superphosphate	2,368	1,838	1,701	2,363	3,181	20.8	4,904	30.
Nitrate of soda	226	180	103	119	276	1.8	238	1.5
Sulphate of ammonia	64	105	63	44	83	0.5	162	1.
Bone and tankage	65	103	110	99	95	0.6	145	1.
Muriate of potash	92	98	32	38	42	0.3	66	0.5
Sheep, goat, cattle and poultry	181	160	115	92	131	0.9	111	0.7
1/9-10/3-4	419	....	....	....	....	....	....	....
2/8/2	358	....	....	....	....	....	....	....
2/9-10/2-4	275	534	330	476	81	0.5	27	0.1
2/12/2-4	320	290	196	67	58	0.4	46	0.2
2/8/10	1,102	769	556	549	517	3.4	419	2.6
3/8/4	1,407	....	....	....	54	0.3	....	....
3/10-12/3-6	587	1,364	1,075	1,461	1,962	12.8	1,574	9.6
4/8/4	691	606	716	1,376	1,737	11.4	1,585	10
4/8/7	337	624	653	780	833	5.5	557	3.4
4/6/10	1,683	....	....	....	2	....	....	....
4/10-12/4-6	585	1,227	414	479	569	3.7	560	3.4
4/8/10 .....	....	1,156	904	1,351	1,387	9.1	1,476	9.
5/8/7	1,575	590	697	1,093	1,078	7.	959	5.7
7/6-8/5-6	268	291	278	333	557	3.6	461	2.8
8-10/16-30/14-20	635	499	477	700	870	5.7	1,149	7.
Miscellaneous	1,793	1,333	1,100	1,667	1,782	11.7	1,982	11.5

It will be noted that the low grades 1/9-10/3-4 and 2/8/2 so popular—but unjustly so—in bygone years disappeared four years ago, and they are not missed. The 3/8/4 and 4/6/10 grades, constituting one-fifth of the total tonnage sold in 1931, have also disappeared.

As measured by percentages of the total tonnage, Vermont farmers have recently increased their crude stock purchases and decreased those of complete fertilizers and sheep, etc., manures. Doubtless the stress laid by educational and governmental agencies on the advisability of using superphosphate in the stable as well as on the land, is largely responsible for this very considerable change. Whereas in 1931-34 approximately four tons out of five were complete fertilizers, in 1935 the figures were three of four and in 1936 two of three.

The percentages of the different classes of fertilizers sold, based on tonnage sales during the past five years are set forth below.

	1932	1933	1934	1935	1936
Brands carrying 14-15% plant food	5.6%	3.5%	4. %	0.9%	0.1%
Brands carrying 16-18% plant food	17.7	19.	19.7	21.8	16.2
Brands carrying 19-24% plant food	47.3	42.6	44.5	43.2	28.7
Brands carrying 25-31% plant food	1.1	0.7	0.9	0.8	0.1
Brands carrying 32-44% plant food	4.4	7.9	6.4	7.6	19.6
Brands carrying 45% plant food	1.7	0.4	0.1	0.1	0.1
Superphosphate	15.5	18.	18.1	21.4	30.7
Crude stocks (other than superphosphate)	4.1	3.2	2.3	3.3	3.8
Sheep, goat, cattle and poultry manures...	1.4	1.2	0.7	0.9	0.7

FERTILIZER GRADES

The figures below show the distribution of each manufacturer's goods by grades. Nearly one-half of the brands contain 19 and 20 percent of plant food and about one-fourth carry 22 percent or more.

DISTRIBUTION OF GRADES AMONG MANUFACTURERS

	Total	14% and +	47-63%	38-44%	26-32%	22-24%	21%	20%	19%	18%	17%	16%	15%	14%	8%
Acme Guano Co.	5	5	.	.	.	1	.	1	.	.	1	1	.	1	.
American Agricultural Chemical Co.	21	21	1	2	.	4	1	5	5	.	2	1	.	.	.
Apothecaries Hall Co.	3	3	.	.	.	1	1	.	.	.	.	1	.	.	.
Armour Fertilizer Works.....	11	11	.	2	.	2	.	2	2	.	1	1	.	1	.
Berkshire Chemical Co.....	3	3	.	.	.	.	.	1	1	.	.	1	.	.	.
Consolidated Rendering Co. and subsidiary	19	19	.	2	1	2	.	6	4	.	2	2	.	.	.
Eastern States Farmers' Exchange	10	10	.	6	.	.	.	4	.	.	.	.	.	.	.
Howard Hardware Co.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.
International Agricultural Corp.	5	5	.	.	.	2	.	1	1	.	.	1	.	.	.
Middlebrook, J. O. & Sons....	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.
Old Deerfield Fertilizer Co., Inc.	9	9	.	.	.	1	.	2	3	.	1	1	.	1	.
Rogers & Hubbard Co.	11	11	.	1	.	1	1	3	3	1	.	1	.	.	.
Standard Wholesale Phosphate & Acid Works, Inc.	8	8	.	.	.	1	.	3	1	.	1	1	.	1	.
Swift & Co., Fertilizer Works.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.
Tennessee Corp.	2	1	.	.	.	.	.	.	1	.	.	.	.	.	1*
Totals	110	109	1	13	1	15	3	29	23	1	8	11	0	4	1

* Soil-Prep. 4/2/2.

The following table sets forth on a percentage basis the situation as to grades during the past 10 years :

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
	%	%	%	%	%	%	%	%	%	%
8-11 percent total plant food.	0	0	0	0	0	0	1*	1*	1*	1*
12-13 percent total plant food.	6	4	4	4	4	0	0	0	0	0
14-15 percent total plant food.	23	21	21	18	16	10	7	7	5	4
16-17 percent total plant food.	12	13	13	12	12	17	17	17	21	17
18-19 percent total plant food.	16	16	14	11	11	19	21	21	20	21
20 or more percent total plant food	43	46	48	55	57	54	54	54	53	57

* Soil-Prep. 4/2/2.

COST OF A POUND OF PLANT FOOD IN THE VARIOUS GRADES IN 1936

High analysis	14	280	\$30	10.7 cts.
High analysis	16	320	32	10. "
High analysis	18	360	38	10.6 "
High analysis	20	400	31	7.8 "
High analysis	22	440	36	8.2 "
High analysis	40	800	46	5.8 "

PRICE DATA

COMPARISONS BETWEEN 1935 AND 1936 TON PRICES

Grade	'35	'36	Grade	'35	'36	Grade	'35	'36
2/ 8/10	\$34	\$32	4/ 8/10	\$35	\$36	8/ 5/ 8	\$..	\$54
2/10/ 2	28	30	4/12/ 4	31	31	8/12/20	..	45
2/12/ 4	39	38	4/16/20	..	41	8/16/14	51	53
3/ 8/ 4	30	..	5/ 8/ 7	37	36	8/16/16	47	45
3/10/ 4	30	31	5/ 8/10	39	37	8/16/20	..	56
3/10/ 6	34	35	6/ 8/ 6	30	28	8/24/ 8	..	45
4/ 8/ 4	31	32	7/ 6/ 6	37	38	9/ 6/ 6	..	43
4/ 8/ 7	33	32	7/13/11	..	45	10/ 8/ 6	..	55
4/ 8/ 8	29	28				12/16/12	..	53

TEN-YEAR AVERAGES

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
Approximate average retail prices	\$42	\$42	\$44	\$44	\$45	\$36	\$34	\$39	\$36	\$40
Approximate average pounds plant food per ton	353	365	360	435	433	432	453	424	434	438
Approximate average price per pound of plant food (cents)...	11.9	11.5	12.2	10.1	10.4	8.4	7.5	9.2	8.3	9.1
Percentage of pre-war prices	117	113	120	100	102	86	77	94	83	89
Percentage of 1916 prices	85	82	87	72	73	60	54	66	58	62

In the above three tables the cost of a pound of plant food in various grades is set forth, as well as a comparison between 1935 and 1936 prices per ton by grades and a ten-year average. The ton price data are obtained by the sampling agents during the spring directly from local selling agents, and they probably represent fairly well the prevailing prices. On the average they are about four dollars per ton more than they were in 1935. The cost per pound of total plant food in the various grades is about the same. It is now, as it has always been, cheaper to purchase a high-grade than a low-grade fertilizer, pound for pound of plant food.

The ten-year average table gives a cross-section of the market during that time. The price of the average pound of plant food is a trifle

higher nowadays than formerly, but the farmer gets more pounds of plant food for a dollar.

ACID AND NON-ACID FERTILIZERS

For several years interest has been shown throughout the Northeast in respect to the acid or non-acid characteristics of fertilizers. Definitions of these two types were proposed at the last meeting of the Association of Official Agricultural Chemists, and the following statements have been adopted as "tentative":

"An acid forming fertilizer is one that is capable of increasing the residual acidity of the soil.

"A non-acid forming fertilizer is one that is not capable of increasing the residual acidity of the soil."

A method for determining the relative acidity or basicity of a fertilizer has been developed by Dr. W. H. Pierre, Associate Agronomist of West Virginia Station, widely used and tentatively adopted as a reasonably accurate means of determining fertilizer reactions in the soil. The final result is stated as the net acid- or base-balance of the fertilizer expressed as pounds of calcium carbonate equivalent per ton. If, for example, a ton of fertilizer having a net acidity of 400 pounds of calcium carbonate, as thus determined, is sown upon an acre of land, it is assumed that 400 pounds of ground limestone must be applied, if the acidity developed by such application is to be counteracted.

All of the complete brands analyzed this year have been tested by this method. The calcium carbonate equivalents per ton range from 300 to 5 pounds per ton for those in the acid-grade class and from zero to 350 pounds for those which are listed as non-acid or basic. This test was applied to a few samples in 1935. Every one of these fertilizers thus tested last year is less acid this year, as thus measured, than it was in 1935, which would seem to indicate that manufacturers are trying to obviate this acid condition of their output.

The following table summarizes the data showing both acid and non-acid results, calculated on the basis of total tonnage of the different brands of complete fertilizers sold in Vermont.

SUMMARY OF DATA ON ACID AND NON-ACID MIXED FERTILIZERS

Tonnage of acid and non-acid fertilizer sold in Vermont in 1936		Effect of acid and non-acid fertilizer expressed in tons of calcium carbonate (CaCO ₃) based on tonnage sold	
Acid	8,433	Acid	949
Non-acid	1,819	Non-acid	66
Total	10,252	Net acidity	883

There were 162 tons of sulphate of ammonia, as such, sold in Vermont in 1936. About 200 tons of ground limestone would counteract the acidity these 162 tons would induce.

The warning set forth in last year's fertilizer bulletin may well be repeated.

"Soil acidity is a serious matter. Vermont soils as a whole tend to be somewhat acid and they are becoming more so as the years pass by. Speaking in general terms, acid soils are usually less productive than those who are neutral or nearly neutral in reaction. The dangers incident to the continued use of acid-producing and acid-increasing fertilizers is a matter of concern which every fertilizer user should take to heart.

"Lime in some form, usually ground limestone, should be sown with a free hand and at frequent intervals in order to correct the acidity which is developed by the use of many of the present-day commercial fertilizers. In practice when a pound of sulphate of ammonia is sown on the soil as such or as an ingredient of a fertilizer, 1.2 pounds of ground limestone are needed if the acidity it develops is to be neutralized. Presumably fertilizer manufacturers, if asked, will indicate how much acid-forming material they are using in any given brand. Many now use ground dolomitic limestone as a filler in part to counteract this undesirable tendency of an otherwise admirable form of plant food which, despite its one fault, manufacturers are thoroughly justified in using and are not to be condemned for using.

"Many Vermont soils are fairly well stocked with lime, since they are of a calcareous origin; however, some sandy soils may need lime, especially those which have been exposed to the leaching effect of rain and which have been heavily cropped, especially when heavy applications of acid-forming fertilizers have been made for some years. Farmers may use such fertilizers freely and safely if they lime their soils occasionally. County agents will determine soil lime requirements for their constituents without charge if they are asked to do so."

In this connection the following excerpts from an address delivered at the last Convention of the National Fertilizer Association by the Director of the Virginia (Truck) Station, Dr. H. H. Timmerley, seem particularly pertinent:

"One of the more important innovations during the past few years has been the production of non-acid-forming mixed fertilizers. Only those who have closely followed the effects of acid-forming fertilizers over a period of time can fully realize their detrimental effects. Previous to 1925 mixed fertilizers were basic or only slightly acid. Since that time they have become increasingly acid-forming, except when neutralized with basic materials. . . . A striking example of this increasing acidity is shown in the soils on the Eastern Shore of Virginia where over 40 percent of the several thousand samples taken from 1932 to 1934 showed reaction values below pH 5.0, although many growers used lime regularly. One ton of an average truck crop fertilizer may contain sufficient acid-forming material to lower the reaction of the average sandy loam soil as much as .3 pH. Over a period of five years

without the use of lime, a fairly productive soil may readily become relatively unproductive even for acid-tolerant crops like potatoes. According to Maryland reports, topdressers in some cases required as much as 700 pounds of limestone for neutralization. Acid-forming topdressers are still being sold in many of our eastern and southeastern States. . . . Records in other states also show a marked increase in acidity. When relatively small quantities of fertilizer are used . . . the rate of acid formation (may be) slower, but nevertheless insidious, and ultimately results in a depleted condition of soil fertility.

"It has been estimated that the average fertilizer has a potential acidity requiring 150 pounds of calcium carbonate for neutralization. Even at this low figure, approximately 700,000 tons of limestone would be needed annually for neutralizing the acid-forming materials in the fertilizers used in the eastern and southern states where, with a few exceptions, soils are . . . low in organic matter and naturally fairly acid. Probably one of the reasons that the injurious effect of the use of acid-forming fertilizers has been underestimated is the fact that the injurious effect of excessive soil acidity has not been fully realized by growers and fertilizer manufacturers.

"Injury from conditions associated with soil acidity is principally due to aluminum toxicity and unavailability of nutrients. It has recently been found that the amount of toxic aluminum present at a definite degree of acidity varies with the type of soil colloid. In the highly weathered Norfolk fine sand, acid sensitive plants may be injured at pH 5.5, while in a highly organic soil, as the Portsmouth, the upper limit at which injury occurs may be as low as pH 4.8. In . . . heavy soils and those containing large amounts of organic matter . . . the reaction is less readily changed by acid-forming materials. For these reasons crops in the East and Southeast, where the lighter types of soils predominate, have suffered most seriously. It is also on these lighter soils that larger amounts of fertilizers are used.

"Certain crops, such as alfalfa, spinach, lettuce, beets, and onions, are very sensitive to even small quantities of soluble aluminum, while other crops, such as potatoes and tobacco, are tolerant. However, the continued use of acid-forming fertilizer has rendered many soils too acid even for such tolerant crops as potatoes. In fact, conditions associated with excessive soil acidity are probably injurious to practically all of our food and forage crops. The use of acid-forming fertilizers is particularly detrimental to potatoes because soils are usually maintained in a moderately acid condition to control scab and any additional acidity greatly reduces crop yields. In addition to injury from aluminum toxicity, plants may suffer from lack of magnesium and calcium, and the proper calcium/potassium balance is often disrupted in strongly acid soils. This prevents the effective utilization of potash applied in the fertilizer and heavy applications of potash may even prove detrimental.

"The rate of phosphorus fixation is greatly accelerated under conditions of extreme acidity.¹ Undoubtedly much of the phosphorus applied in mixed fertilizers is rendered unavailable to the plants in a relatively short time on strongly acid soils. Hester in working with

¹ In this connection see Vt. Sta., Bul. 356 (1933).

Norfolk sandy loam soils in eastern Virginia has shown that slightly acid soils (pH 6.1) contained approximately eight times as much water-soluble phosphorus and more than ten times as much sodium acetate-soluble phosphorus than strongly acid soils (pH 4.5).

"In addition to the ultimate effect on soil and plant growth of the continuous use of acid fertilizers, we have noted both in commercial fields and in test plats a marked effect on the immediate crop to which acid-forming fertilizers have been applied. Many fields of beets, spinach, and other acid-sensitive crops have been completely ruined by one application of acid-forming fertilizers. Parker has shown in experiments with spinach in Virginia that an application of 1,500 pounds per acre of an acid-forming 6-6-5 fertilizer produced a yield of only 1,319 pounds of spinach whereas a fertilizer made of neutral salts produced 5,404 pounds. The spinach produced on plats where acid-forming fertilizer was used of so poor quality that it was unsaleable. Since acid-forming materials may have so detrimental an effect on the immediate crop to which the fertilizer is applied, it is apparent that the rapidity of action of the ground limestone used as a neutralizing agent in producing a neutral fertilizer is of great importance.

"In order to get information from a number of sources as quickly as possible, a subcommittee of 12 on fertilizer reaction was appointed by the American Society of Agronomy in 1934 to conduct experiments with limestone of different degrees of fineness and with other materials as a neutralizing agent in mixed fertilizers. The results in regard to the use of limestone of different degrees of fineness showed that material coarser than 40-mesh had very little effect on reducing acidity during the period in which the crop was grown. Forty- to 60-mesh material was slightly more effective while 80- to 100-mesh was satisfactory. Basing down the limestone with the fertilizer gave more effective results than when this material was mixed immediately before application. Raw rock phosphate proved to be absolutely worthless as a neutralizing agent.

"There was remarkably close agreement in the results obtained by the different investigators. In Virginia, in addition to testing the effect of these materials on soil reaction, sorghum, spinach, and collards were grown on Sassafras sandy loam soil with an original reaction of pH 6.2. The source of nitrogen was sulphate of ammonia and the neutralizing was raw rock phosphate and dolomitic limestone of different degrees of fineness. Spinach and collards made practically no growth in the soils treated with the acid-forming fertilizer or with the fertilizer neutralized with rock phosphate or with limestone coarser than 20-mesh. Twenty- to 60-mesh limestone gave relatively poor growth as compared with that of 80- to 100-mesh or where the fertilizer was produced by the use of neutral salts. Even sorghum, which is generally considered fairly resistant to acid soil conditions, showed a marked response to the finer mesh limestone. It was also shown that the use of the finest mesh dolomitic limestone reduced the amount of toxic aluminum to one-fifth of that liberated by the acid-forming fertilizers, and more than doubled the amount of available magnesium.

"Alabama and South Carolina have regulations requiring a guarantee of acidity or basicity in fertilizer mixtures. It is hoped that the ferti-

lizer trade in the future will give definite assistance in the promulgation of similar legislation in the other eastern and southeastern states where large amounts of fertilizer are used. It will be of immense value to the grower to know that after he has limed his soil to bring it to the proper reaction for his crops he will be able to maintain that condition by the use of non-acid-forming fertilizers."

SOIL TESTS

Several rapid, simple and inexpensive soil and plant tests have been recently devised. They might be likened to the Babcock milk test and are, in a way, analogous to it. Shortages in plant food and their nature are thus determined closely enough to serve farm purposes. In bygone days county agents, fertilizer salesmen or station or extension specialists have not felt any too sure that their advice was sound when they have made recommendations as to fertilizer usage in any given case, because they did not know how much or how little nitrogen, phosphoric acid, potash, lime were present in the soil and how available they were to plant uses. They have freely made recommendations but, if at all candid, they have made them with tongue in cheek and fingers crossed. Their suggestions represented only best guesses, for no ready means existed of estimating, even roughly, how much available plant food there was in the soil. Pot, plot and field trials in which various amounts of nitrogen, available phosphoric acid and potash have been used on specific soils, although conducted in the most accurate manner possible, gave results which varied from year to year because of factors other than that of the available soil supply of plant food; and, furthermore, the results were not applicable to other types of soils or, indeed, on the same soil elsewhere located and at another level of fertility, owing to different cropping, handling, topography or to other causes. Hence it is that the advent is welcome of rapid, simple, inexpensive and readily applied tests which afford prompt and reasonable accurate results.

Much work remains to be done along this line, but it seems safe to predict that, say 10 years hence, more accurate diagnoses of soil needs may be made than can be made today; more definite statements may be made than can be made today, as to the amounts of this, that or the other form of plant food which should be applied as fertilizer; and that 20 and 30 years hence, even better work will be done. Because of the newness of these tests and a lack of knowledge as to some of their limitations, it is often hard to interpret the results they afford, and sometimes quite incorrect diagnoses may be made. These should not be attempted by inexperienced persons. However, experience can only be gained as a result of trial, and it is hoped that if and when

county agents, for example, make tests and misinterpret results the old couplet from childhood's recitation piece will be remembered:

"Don't view me with a critic's eye
But pass my imperfections by."

These tests are still in their swaddling clothes, not perfect in all details but, notwithstanding, of much value as a means of indicating plant food deficiencies and as a basis for more certain recommendations as to fertilizer usage. They are in use in most states, and where most widely and carefully used have been found most helpful. They are being used more generally in the corn belt states than elsewhere, although they are being employed to quite an extent in New England, especially in the truck garden regions. It is said on good authority that many Virginia truck farmers have secured such good responses to fertilizer usage, based on recommendations which were themselves based on the results secured with these rapid chemical tests, and the annual testing of each field on their farms has become a routine matter. Plant saps have been tested as well as soils and have afforded helpful diagnostic indications of plant nutrient deficiencies.

As has just been said, the tests are new. Many methods have been suggested and many commercial outfits are on the market. This complicates the situation to some extent. For example, methods devised for use in the Middle West on soils on which fertilizers have only recently been used may not be well adapted to conditions in the Northeast where soils have been cropped for two or more centuries and fertilizers bought for two generations. To be of real service the methods employed in a given section must prove applicable to its specific soils and the results should check fairly well with the general run of field trials with sundry crops.