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Commercial Fertilizers

A Report Covering the Biennium 1929-1930

Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

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LETTER OF TRANSMITTAL

To His Excellency

The Governor of Oregon

Sir:

In accordance with the provisions of Title 18, Chapter 15, Oregon Code of 1930, the following report of activities in the administration of the foregoing law is respectfully submitted.

JAMES T. JARDINE,
Director.

December 31, 1930.

Commercial Fertilizers

By

J. S. Jones and C. F. Whitaker

The intent of the Oregon State Fertilizer Law is plain. It is to insure users of commercial fertilizers a means of judging quality in the many products offered them for fertilizing purposes. Manufacturing and compounding of fertilizers is essentially a chemical industry. The raw materials brought to the fertilizer trade are so many and so varied in chemical composition that manufacturing and compounding must be done under chemical supervision if products guaranteed in composition are finally to reach the market. Consumers can afford to buy none other than guaranteed products, for in whatever form offered the cost of plant food elements artificially produced is an item to be reckoned with seriously when those elements are used in any kind of crop production.

To prevent chaotic conditions that might otherwise easily creep into the fertilizer trade to the detriment alike of the manufacturer and the consumer, the State Fertilizer Law sets forth specifically the conditions under which commercial fertilizers may be offered for sale in Oregon. The enforcing agency is the Agricultural Experiment Station through its Director and department of Chemistry. Provision is made for the publication of analytical data from check-up analyses on manufacturers' guarantees on composition, and of "such additional information as circumstances may advise." Circumstances at this time warrant, in addition to the tabulation of check-up analytical data, a brief discussion of certain facts regarding the chemical nature of fertilizing materials that are fundamental to prudent buying. This report covers the biennium ending with December, 1930.

FERTILIZER ELEMENTS ARE LIMITED IN NUMBER

Of the fifteen or sixteen chemical elements proved long ago to be essential to the growth of all plants, an abundance of experimental evidence has clearly shown that any one of four or five may become limiting factors in crop growth. None is absolutely lacking in any soil; but unless each is available in the soil solution in superabundance when needed, crop growth is hindered—perhaps beyond recovery. Soil minerals and soil organic matter, both of which hold these nutrient elements in reserve in insoluble form, may be relatively low in amount, or for various reasons too sluggish in supplying the soil solution with sufficient amounts to meet the exacting requirements of this or that crop. Long experience has shown the practicability of increasing soil fertility as necessity or convenience may require, through additions from time to time of various kinds of materials to supplement the soil's original supply of plant food elements. The fertilizer trade of the present day is the result of organized effort on the part of manufacturers to meet producers' requirements in this direction.

Fertilizers are sold for the purpose of carrying to the soil one or more of the following chemical elements: nitrogen (N), phosphorus (P), potassium (K), and sulfur (S). The first-named element becomes a soil constituent naturally through biological activities and accumulation of plant residues. The original source of this nitrogen is the atmosphere. Four-fifths of our atmosphere is nitrogen. For use in commercial fertilizer form, its combination with some other elements to form solid compounds is essential. One such compound, sodium nitrate, occurs naturally in vast accumulations in the high plateau region of South America, and for many decades was practically the sole source of inorganic nitrogen for fertilizing and manufacturing purposes the world over. Atmospheric nitrogen, however, is now being "fixed" by various industrial processes. Consequently this inexhaustible source of nitrogen is at present much more heavily drawn upon for use in agriculture and other industries than it could possibly be through the activities of biological agencies alone. The story of "nitrogen fixation" for use in industry is intensely interesting and must be read by those who would be up-to-date in fertilizer literature.

Phosphorus, potassium, and sulfur are native to all soils in the sense that each is a component of one or more soil-forming minerals. Like nitrogen, however, each accumulates to some extent in surface soils in organic combinations, as crop or plant residues accumulate. The concentration of phosphorus, potassium, and sulfur-carrying minerals, and of sulfur in elemental form in various parts of the earth in workable deposits of greater or less magnitude, creates a supply on which fertilizer manufacturers throughout the civilized world draw for the raw materials which enter into their finished products.

SOURCES OF RAW MATERIALS OF THE FERTILIZER TRADE

The problem of the consumer is at best a difficult one. Assuming that he has decided what particular element or combination of elements he is going to fertilize with, he has still to determine what combinations of quickly acting compounds with more slowly acting ones will be most economical and otherwise most satisfactory in meeting his particular objective. Fortunately there is a wealth of accumulated information that makes this problem of the present-day consumer simpler by far than it was in times not so long past. That information is obtainable in bulletin form from State and Federal experiment station organizations, from carefully edited books, and from perfectly reliable trade journals. Users of commercial fertilizers have much to gain by keeping in touch with these sources of information, all of which are based upon actual experimentation. Discussion here must of necessity be limited to sources and characteristic properties of materials and compounds that carry into the fertilizer trade one or more of the four fertilizing elements enumerated in the preceding section.

NITROGEN CARRIERS

Nitrogen is readily obtainable from dealers in either organic or inorganic form. Familiar examples of the first are the blood meals and the tankages. In these materials nitrogen is largely in the form of animal protein, and therefore for the most part insoluble in water. Protein, soluble or insoluble, requires the action of specific soil bacteria, favorable moisture and temperature conditions, and appreciable time to undergo the transformations that result in the formation of corresponding amounts of the water-soluble ammonia (NH_3) and nitrate (NO_3) nitrogen, in which form nitrogen must be to become usable by growing plants. Blood meals and tankages, then, are by-products of the packing-houses and fish canneries, suitably processed by the manufacturers to supply to the trade a source of more or less slowly available nitrogen. Naturally materials of this kind will be selected by the consumer for the benefit of such crops as may be given the stimulating effects of nitrogen throughout their growing season. Urea and bone-meals are also carriers of nitrogen in organic combination. It is not so easy to standardize organic carriers of nitrogen. Nevertheless, each must carry a guarantee of its nitrogen content when offered for sale in Oregon.

In the inorganic form the purchaser has his choice of nitrogen in the form of nitrate nitrogen (NO_3), ammoniacal nitrogen (NH_3) and cyanamid nitrogen (CN_2). The first not only is water soluble but is in the form that most readily gains entrance to plant roots. The nitrates are immediately available for plant use. If not quickly taken up by plant roots inevitable loss by leaching takes place if rainfall is appreciable. Ammoniacal nitrogen and cyanamid nitrogen are a little slower in action than nitrate nitrogen, but more lasting than nitrate nitrogen because of the necessary transformation of each through biological agencies to nitrate nitrogen for plant use. Quite naturally, again, the consumer will be guided in his choice of inorganic nitrogen by relative cost per unit and the urgency of nitrogen stimulation in the very earliest stages of plant growth. Nitrate nitrogen, as previously noted, may be of natural occurrence, or it may result from the fixation of atmospheric nitrogen by modern manufacturing processes. Sodium nitrate (Chile saltpeter) is an example of the first, calcium nitrate of the second. Ammonium sulfate, a carrier of nitrogen in ammonia form, may be a product of the coking industry, or it may be a product of nitrogen fixation by one of several manufacturing processes. Calcium cyanamide or "cyanamid" is always a product of nitrogen fixation. All nitrogen compounds are guaranteed on the basis of their total content of the element nitrogen. Nitrogen perhaps ranks first in importance in the fertilizer industry.

Dealers in Oregon are prepared to furnish any of the above-mentioned compounds of nitrogen and several others, as Calurea, leunasalpeter, and Ammophos. These products are uniform in composition and highly standardized. There is practically no chance of error in the guarantee of the manufacturer in the matter of their nitrogen content. Improvements in nitrogen fixation processes and large-scale manufacturing operations have accomplished in the past decade a very decided decrease in the cost of fertilizer nitrogen to the consumer.

THE PHOSPHORUS CARRIERS

Phosphorus, too, comes into the fertilizer trade from various sources. If it comes as a by-product of the packing-houses and fish industries, it is commonly thought of as being in organic combination. Strictly speaking, that is not the case; phosphorus in bones, like the phosphorus in phosphate rock, is combined with calcium, forming the well known tri-calcium phosphate, $Ca_3(PO_4)_2$. For reasons not fully understood, this compound when associated with the organic structure of bone is far more soluble in water and neutral ammonium citrate solution than is the same compound when as rock phosphate it occurs in vast mineralized deposits in various parts of the earth. Availability of phosphorus from various sources to growing crops has been rather closely correlated by agronomists with its solubility in the reagents mentioned. For that reason bone and other slaughter-house by-products are generally more readily taken by consumers for phosphorus fertilization than even the most finely powdered rock phosphate, sometimes called floats. It should be noted, however, that never more than 50 percent of the total phosphorous content of bone-meals and tankages is available phosphorus.

Bones from whatever source may come into the fertilizer trade in raw condition or after processing to decrease and degelatinize them. In any event they should be finely ground, for the availability of their phosphorous content as determined by solubility in water and neutral ammonium citrate solution in a large measure depends upon their mechanical disintegration. Unfortunately now and then a bone-meal is found on the market in this state so coarsely ground that the availability of its phosphorous content is called sharply in question. Consumers should refuse bone-meals not finely ground. Raw bone-beal contains more nitrogen and less phosphorus than does steamed bone-meal.

ROCK PHOSPHATE AS A SOURCE OF PHOSPHORUS

As a source of phosphorus for fertilizers, bone-meals and tankages are inadequate in amount to meet the requirements of the producers. Manufacturers have recourse always to the mineralized form of phosphorus in rock phosphate which occurs in vast deposits in various parts of the world. That which reaches the Pacific Northwest is of foreign as well as domestic origin. Our nearest domestic sources of supply are the deposits in eastern Idaho and western Wyoming.

If rock phosphate were pure tri-calcium phosphate its content of phosphorus would be 20 percent. The purity of that which reaches the fertilizer trade ranges from 60 to 80 percent. The accompanying rock debris is valueless from a fertilizer standpoint. Here and there in this country and elsewhere direct use has been made of very finely ground rock phosphate for fertilizing purposes. With the same expenditure of money more pounds of phosphorus can be bought in that form than in any other, but the practicability of using raw rock phosphate is questionable because of its relative insolubility in soil solutions. For those who would experiment with it as a source of phosphorus, the suggestion is made that soils to which it is applied should be given also a plentiful supply of organic matter of a kind that will undergo rapid decomposition. Tri-calcium phosphate is more soluble in soil water highly charged with carbon dioxide than it is in water not so charged. Experiments are being undertaken here to determine whether rock phosphates have any appreciable degree of availability in the sense of that term applied in the preceding section to the phosphorus of bone-meals. In the meantime, except as they can afford to experiment, those for whom phosphorus fertilization is a necessity had best expend their money for the more soluble forms. Fortunately rock phosphate is readily converted into those more soluble forms. For that reason alone our native deposits of rock phosphate take on an enormous economic value.

SUPERPHOSPHATE

It is relatively easy on either a laboratory or a commercial scale to displace from tri-calcium phosphate, $Ca_3(PO_4)_2$, a part of its calcium content with the hydrogen of sulfuric acid. When treated with sulfuric acid the tri-calcium compound yields monocalcium phosphate, $CaH_4(PO_4)_2$. This water-soluble compound always reaches the fertilizer trade mixed with various kinds of rock debris, and with calcium sulfate, $CaSO_4.2\,H_2O$, another product of the reaction between sulfuric acid and tri-calcium phosphate. This mixture is the superphosphate of the fertilizer trade. Superphosphate carries practically all of its phosphorus to the soil in available form. In that respect superphosphate as a phosphorus carrier is comparable with sodium and calcium nitrates as nitrogen carriers. The percentage of phosphorus in superphosphate is practically one-half of its percentage in the original rock. In converting rock phosphate to superphosphate, then, there is a gain in solubility and a loss in the percentage of phosphorus carried by the finished product.

Finally, and this discussion of phosphorus carriers would not be complete without reference to it, note should be taken by all users of commercial fertilizers that the most up-to-date method of converting rock phosphate to the water-soluble monocalcium compound is accomplished with phosphoric acid (H_3PO_4) instead of sulfuric acid (H_2SO_4). The result is monocalcium phosphate unmixed with calcium sulfate, and consequently a compound much richer in its percentage of phosphorus than is superphosphate. This product is the "treble superphosphate" of the fertilizer trade, so-called because if made from the same grade of rock phosphate it contains something like two and one-half times the percentage of phosphorus contained in superphosphate made by the sulfuric acid process.

GUARANTEES ON PHOSPHORUS CARRIERS ESPECIALLY IMPORTANT

Phosphorous-carrying compounds and mixtures containing them are always guaranteed on the basis of their content of available phosphoric acid (P_2O_5) and insoluble phosphoric acid. "Available" means that portion which readily goes into solution in the soil water, and is therefore immediately usable by growing plants. The "insoluble" portion is not without value, but its availability to growing plants is somewhat on the order of the phosphorus in mineralized rock phosphate. There are very reliable methods for determining the content of available phosphoric acid in mixtures of the phosphorus carriers. For it the purchaser can reasonably be asked to pay at least as much per pound as is asked for phosphoric acid in the form of superphosphate.

As in the purchase of nitrogen-containing compounds, so in the purchase of phosphorus-containing ones, the user of commercial fertilizer will be on the alert in learning from his dealer not only the percentage of phosphorus the compound may carry, but the source or sources of this exceedingly important fertilizing element and the degree of its availability.

POTASSIUM CARRIERS

Sources of potassium in this connection can be much more quickly disposed of. There are fewer of them than is the case for nitrogen or phosphorous. Potassium, too, comes into the fertilizer trade in less varied form than either nitrogen or phosphorus. The most commonly used forms are the muriate of potash (KCl) and the sulfate of potash (K_2SO_4). Both are of a high degree of purity, and from their actual content of potassium there is not much basis for a choice between them.

Users of potassium carriers will note with considerable satisfaction that production of high-grade muriate of potash has reached such proportions on the Pacific Coast as to make possible the purchase at home of nearly 25 percent of the total amount used for fertilizing purposes in the United States at this particular time. Extensive experimental work is under way in various parts of the United States to determine the feasibility of certain processes designed to recover potassium commercially from potassium-carrying rocks. Eventually potassium compounds from that source will augment the amount now being recovered from the brine of Searles Lake in southern California. In view of these facts it would seem that, as noted for nitrogen, the trend of prices for potassium-carrying compounds in the fertilizer trade should be downward. It is entirely possible, of course, that water-insoluble potassium-carrying compounds might be made a part of the fertilizer mixture. At present, however, the fertilizer trade does not recognize in fertilizer mixtures any other than water-soluble potassium compounds. In whatever form potassium is sold, alone or in mixtures, its equivalent in potassium oxide (K_2O) is always guaranteed.

SULFUR CARRIERS

Sulfur-carrying compounds in the fertilizer trade, like the potassium-carrying ones, are limited in number. Ammonium sulfate, of course, although purchased primarily for its nitrogen content, carries sulfur as well. So also does superphosphate, purchased primarily for its content of phosphoric acid. Neither ammonium sulfate nor superphosphate, however, will be asked for should one wish a material for its sulfur content alone. For sulfur, dealers have recourse to gypsum ($CaSO_4.2\,H_2O$) deposits, some of which are near at hand in the western Intermountain region, and to deposits of elemental sulfur in our own and other countries. Gypsum, land-plaster, deposits with which we have become acquainted through enforcement of the state law governing the sale of agricultural limes, are of a high percentage of purity. Gypsum has other uses, but in the fertilizer trade it is valued for its content of sulfur. The guaranteed analyses should make it relatively easy for the purchaser to decide which particular brand of those available on the market is the cheapest. Gypsum is guaranteed under the State Agricultural Lime law. Elemental sulfur is obtainable in practically pure form, but at times relatively low grade sulfur is also on the market here, apparently as a by-product of some other industry. Here again the purchaser will make use of the guarantee on the tags which must accompany every shipment of commercial fertilizer. It makes a vast deal of difference in expenditure of money whether one is quoted on 80 percent sulfur or 98 percent sulfur. In the one case he will get for the money expended for one ton of sulfur 1,600 pounds of the fertilizing element in question. In the other he will get 1,960 pounds. Sulfur, like nitrogen, is guaranteed on the basis of the element. Like nitrogen, too, in organic and ammoniacal form, sulfur must undergo oxidation in the soil to become useful to growing plants. The transformation is accomplished by sulfofying bacteria, with which soils in general seem to be well supplied.

COMPOSITION IS A GUIDE TO THE PURCHASER

The purchaser of fertilizers may buy of his dealer the "simples" of the fertilizer trade or their mixtures, as best suits his own convenience. The simples are compounds that are valued for the one fertilizing element each may carry, as sodium nitrate ($NaNO_3$) for nitrogen, superphosphate for phosphoric acid (P_2O_5), potassium chloride for potash (K_2O). As between two simples valued for the same fertilizing element, as sodium nitrate and ammonium sulfate, simple calculation enables one to determine which is the cheaper form of that element—in this case nitrogen. Suppose the price quoted on sodium nitrate guaranteed to contain 15 percent of nitrogen is $50 per ton, and the price quoted on ammonium sulfate guaranteed to contain 20 percent of nitrogen is $54 per ton. It is plain that in the case of nitrate of soda 300 pounds of nitrogen are being offered for $50—16⅔¢ per pound. It is equally plain that in sulfate of ammonia 400 pounds of nitrogen are being offered for $54—13.5¢ per pound.

Again, suppose that superphosphate guaranteed to contain 18 percent of phosphoric acid is quoted at $20 per ton. In this case it is plain that phosphoric acid (P_2O_5) is rated at 5.5¢ per pound. Finally, suppose that sulfate of potash, guaranteed for 50 percent potash (K_2O) and muriate of potash, guaranteed also for 50 percent potash, are quoted at $59 and $48 respectively per ton. It is clear that potash is valued at 5.9¢ and 4.8¢ per pound, respectively.

Quotations on simples can always be obtained by users of fertilizers from dealers. Such quotations are basic, in that they determine the minimum price, exclusive of mixing charges, for which each fertilizing element can be sold in mixtures. Purchasers who familiarize themselves each year with the basic prices of these fertilizing elements are in a position to use them effectively in checking up on the reasonableness of quotations given them on mixed goods, and as the basis upon which to judge the relative merits of comparative prices. There are other considerations involved, of course, but the basic prices for nitrogen, phosphoric acid and potash in the simples used must, in a large measure, control the price of mixed goods. These prices, too, provide the only basis for settlement of differences between purchaser and seller if the goods purchased do not come up to their guarantee in composition. An example will illustrate the application of basic prices on simples to the valuation of mixed fertilizers.

In the fertilizer trade 1 percent is equivalent to 1 unit, and this on the ton basis is 20 pounds. The basic unit price of nitrogen, then, in the nitrate of soda just mentioned is $3.33⅓ ($50 ÷ 15). For nitrogen in ammonia form the unit price is \$2.70 (\$54 ÷ 20). In the same way the unit price of phosphoric acid in superphosphate is \$1.00 (\$18 ÷ 18), and that for potash in sulfate of potash and muriate of potash is \$1.18 and 96¢ respectively (\$59 ÷ 50 and \$48 ÷ 50). It is evident that in applying these figures on mixed fertilizers one must know the percentage amount of each form of nitrogen carrier and the percentage amount of each form of potassium carrier. This information can be given, of course, by the dealer or manufacturer.

In placing a value on the phosphoric-acid content of mixed fertilizers an additional one for phosphoric acid in insoluble form is necessary. Bone-meals and tankages are used freely in mixed fertilizers, but of their total content of phosphoric acid not more than 50 percent is available. A question arises at once with regard to the value per unit that shall be given the insoluble fraction. That the insoluble phosphoric acid fraction from the sources just mentioned has some ultimate value for fertilizing purposes cannot well be questioned, even though no direct experimental evidence is obtainable on the time element involved. Perhaps for this insoluble fraction a rating of 30 percent of the value accorded to the available fraction is approximately fair. At least that rating will be given here in illustrating one method that can be used by the purchaser of mixed goods in arriving at what might be considered a fair price for what is being offered him. Data derived by this method of calculation are tabulated below for use:

BASIC PRICES OF PLANT FOOD ELEMENTS PER POUND AND PER UNIT

Element and form	Per pound	Per unit
Nitrogen, N, available	\$0.16⅔	\$3.33⅓
Phosphoric acid, P_2O_5, available	0.05	1.00
Phosphoric acid, P_2O_5, insoluble	0.015	.30
Potash, K_2O, water soluble	0.059	1.18

Choosing now a mixed fertilizer guaranteed as follows:

	%
Nitrogen, N, total	6.00
Phosphoric acid, P_2O_5, available	8.00
Phosphoric acid, P_2O_5, insoluble	8.00
Potash, K_2O, water soluble	4.00

The basic prices indicated above by the pound and by the unit may be used to calculate the equivalent price per ton:

Using the Price per Pound

6 × 20 = 120, pounds of N in one ton,	120 × \$0.16⅔ =	\$20.00
8 × 20 = 160, pounds of P_2O_5 available in one ton,	160 × 0.05 =	8.00
8 × 20 = 160, pounds of P_2O_5 insoluble in one ton,	160 × .015 =	2.40
4 × 20 = 80, pounds of K_2O water soluble in one ton,	80 × ,059 =	4.72
	Basic value per ton....	\$35.12

Using the Price per Unit

Nitrogen, N,	6 × \$3.33⅓ =	\$20.00
Phosphoric acid, P_2O_5, available	8 × \$1.00 =	8.00
Phosphoric acid, P_2O_5, insoluble	8 × \$0.30 =	2.40
Potash, K_2O, water soluble	4 × \$1.18 =	4.72
	Basic value per ton....	\$35.12

LOW AND HIGH GRADE FERTILIZERS

In contrast with earlier days of the fertilizer industry, materials which are now brought together for the manufacturer of mixed fertilizers are highly standardized, and at the same time decidedly richer in the fertilizing elements each one carries. Once convinced of their utility, users of fertilizers are open to the suggestion that more concentrated forms in the long run will prove to be the cheaper because of certain savings that can be made by the manufacturer in the way of mixing, storage, and transportation charges. The successful development of nitrogen-fixation processes in the past decade has given other industries larger amounts of high-percentage nitrogen compounds than they can use. A natural outlet for the surplus is the fertilizer trade. Indeed, the original stimulus for the development of the nitrogen-fixation industry was the need of agriculture in that direction.

The introduction of calcium nitrate, cyanamid, leunasalpeter, ammonium phosphate and urea makes possible now the use in the fertilizer trade of nitrogen compounds ranging up to as high as 46 percent in the element nitrogen. In much the same way improved methods of manufacture have given the fertilizer trade superphosphates much richer in their content of phosphoric acid than were the very best of the superphosphates produced a few years ago. The introduction of new processes of recovering phosphoric acid from phosphate rock, moreover, has brought about the manufacture of "treble-superphosphate," a compound that contains something like 2½ times the percentage of phosphoric acid contained in the older forms of superphosphate. Compounds of phosphorus containing 50 percent of phosphoric acid, 100 percent available, are now commonplace in the fertilizer trade. Even low-grade potash salts that once were common in the fertilizer trade seem to be giving way to the almost technically pure sulfate and muriate of potash.

Adoption by fertilizer users of these more concentrated products of the fertilizer trade no doubt is hindered to some extent by the inability of the user to distribute them upon the soil with the same degree of uniformity that is possible in the case of older and more bulky ones. Fortunately this situation is stimulating activity on the part of manufacturers of farm machinery in the contrivance of improved forms of fertilizer distributing machines. Progress already made in this direction indicates that the problems involved here may soon be settled to the entire satisfaction of fertilizer users.

It is true that in a large measure these "high analysis" simples are being used as simples for fertilizing purposes by those whose program of fertilization calls for the use of one element only, but their generous use in mixtures also is evident and proof of the fact that users generally are inclined to profit by whatever saving manufacturers can make in the way of mixing and transportation costs on these more highly concentrated mixtures. The trend in manufacture and use is decidedly toward the more highly concentrated simples and mixtures. While a few years ago a total of 15 percent of nitrogen, phosphoric acid and potash stamped that mixture as high grade, today a total of 20 percent or even 22 percent of those same ingredients causes no comment.

THE LABELING OF FERTILIZER CONTAINERS

The Oregon State Fertilizer Law makes it plain that no brand of commercial fertilizer or material intended for manurial purposes can be legally on the market in this state until the party responsible for it has been granted a license and a permit by the Director of the Agricultural Experiment Station for its sale. Each license and permit must be renewed annually in January. The law also requires the plain labeling of every lot,

Brand Name

Number, Letter, or Trade Mark

Formula

Guaranteed Analysis

Nitrogen (N) Total - - - - - - - - -	..................%
Phosphoric acid (P_2O_5) available - - -	..................%
Phosphoric acid (P_2O_5) insoluble - - -	..................%
Phosphoric acid (P_2O_5) Total - - - - -	..................%
Potash (K_2O) soluble in water - - - -	..................%

Made from

....

....

Firm name of Manufacturer, Importer or Dealer
and Place of Business

Net Weight

parcel or package of commercial fertilizer offered on the market for $5 or more per ton. The label must inform the purchaser of the following: its name, brand and trademark; name of manufacturer, importer, or dealer; place of manufacture, net weight, and the chemical analysis indicative of the form and percentage claimed for each fertilizing element.

It has been the custom to require of each applicant for a license and permit all of this information on the license application forms in the detail indicated in Section 1 of the Fertilizer Law. For the sake of greater uniformity than has heretofore prevailed, a form of label for use by manufacturers, importers, and dealers is herewith suggested (page 14). It is concise in statement and fulfills the plain intent of Section 1, unburdened of all of its detail. Common use by manufacturers and dealers of the suggested form will undoubtedly be very keenly appreciated by purchasers.

Available phosphoric acid is the sum of water-soluble phosphoric acid and that which is soluble in neutral ammonium citrate solution, sometimes spoken of as reverted phosphoric acid.

There is a growing tendency in the Northwest on the part of manufacturers to use in the brand name an expression that is indicative at once of the composition guaranteed. The formula "3-8-6" is perfectly legitimate and has much to recommend it. Such expressions are common in the large fertilizer-using sections of the United States. It is necessary, however, to warn manufacturers and dealers against their improper use. Users of these expressions will be held strictly to the significance attached to them by the Association of Official Agricultural Chemists and the National Fertilizer Association. The first figure means total nitrogen in percent; the second figure means available—that is, the sum of water-soluble and reverted phosphoric acid in percent; the third figure means water-soluble potash in percent. These expressions or formulae may be modified to the extent of including in them a figure indicative of the percentage content of insoluble phosphoric acid. If in the example just cited there is 8 percent of insoluble phosphoric acid in addition to the 8 percent of available phosphoric acid, that expression may be changed to read 3-[8-8]-6. The first figure, then, means total nitrogen in percent. The first figure inside the bracket means available phosphoric acid in percent. The second figure inside the bracket means insoluble phosphoric acid in percent. The last figure means water-soluble potash in percent. In no case may these formulae be used to the exclusion of a statement of the guaranteed analysis.

CHECK-UP ANALYSES FOR THE BIENNIUM 1929-1930

In Table I are given detailed results of chemical analyses of all brands of fertilizers sold in Oregon during the biennium 1929-1930. The form of statement is identical with that used in previous reports. The different columns show the guaranteed amounts of total nitrogen, ammonia nitrogen, organic nitrogen, and nitrate nitrogen; the total phosphoric acid and the parts thereof that are available and unavailable; and the water-soluble potash. In the same columns below the amounts guaranteed by the manufacturers are given the results of chemical analyses made by the Chemistry department of the Agricultural Experiment Station on samples collected from different sources. As a rule, these samples were collected when fertilizers were moving most rapidly from manufacturer to consumer. Now and then samples were obtained previous to the heavy run of the fertilizer season, and sometimes following it.

TABLE I. GUARANTEED AND FOUND ANALYSES OF FERTILIZERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen (N)				Phosphoric Acid (P_2O_5)			Potash (K_2O)	Sources of materials used in mixed fertilizers
				Total	In Ammonia form	In Nitrate form	In Organic form	Total	Available*	Insoluble	Water soluble	
				%	%	%	%	%	%	%	%	
Red Steer "B"........	Swift & Co.	Portland, Ore.	Guar. '29	1.6	1.2	....	0.4	13.0	12.0	1.0	3.0	Sulfate of ammonia. superphosphate. tankage. sulfate of potash.
			Found	**1.6**	**1.2**	....	**0.4**	**13.4**	....	....	**4.1**	
			Guar. '30	2.0	1.6	....	0.4	14.4	14.0	0.4	4.0	
			Found	**2.3**	**1.6**	....	**0.7**	**15.9**	**15.2**	**0.7**	**4.8**	
Red Steer "C"........	Swift & Co.	Portland, Ore.	Guar. '29	2.5	1.0	....	1.5	10.6	10.0	0.6	7.0	Sulfate of ammonia. superphosphate. tankage, muriate of potash.
			Found	**3.2**	**1.4**	....	**1.8**	**11.6**	....	....	**7.7**	
			Guar. '30	3.0	1.5	0.7	0.8	10.6	10.0	0.6	7.0	
			Found	**2.7**	**1.5**	**0.7**	**0.5**	**13.6**	**13.2**	**0.4**	**7.3**	
Red Steer "D"........	Swift & Co.	Portland, Ore.	Guar. '29	3.3	2.5	....	0.8	7.7	7.0	0.7	6.0	Sulfate of ammonia. superphosphate. tankage. muriate of potash.
			Found	**3.4**	**1.2**	....	**2.2**	**8.0**	....	....	**7.1**	
			Guar. '30	4.0	1.4	1.6	1.0	7.7	7.0	0.7	6.0	
			Found	**3.5**	**1.5**	**1.4**	**0.6**	**8.9**	**6.7**	**2.2**	**7.0**	
Red Steer "E"........	Swift & Co.	Portland, Ore.	Guar. '29	2.5	....	1.9	0.6	10.6	10.0	0.6	10.0	Sulfate of ammonia, superphosphate. tankage, muriate of potash.
			Found	**2.4**	....	**2.1**	**0.3**	**11.4**	....	....	**10.1**	
			Guar. '30	3.0	1.6	0.7	0.7	10.6	10.0	0.6	10.0	
			Found	**2.8**	**1.2**	**0.9**	**0.7**	**9.3**	**5.1**	**4.2**	**12.3**	
Red Steer "Berry"..	Swift & Co.	Portland, Ore.	Guar. '29	4.9	3.7	....	1.2	7.8	7.0	0.8	8.0	Sulfate of ammonia. superphosphate. tankage. muriate of potash.
			Found	**4.6**	**1.0**	....	**3.6**	**9.0**	....	....	**8.5**	
			Guar. '30	5.0	2.0	2.0	1.0	7.8	7.0	0.8	8.0	
			Found	**4.8**	**1.9**	**1.8**	**1.1**	**8.5**	**6.3**	**2.2**	**9.6**	
Red Steer "Onion"..	Swift & Co.	Portland, Ore.	Guar. '29	2.5	0.9	0.9	0.6	11.5	10.0	1.5	20.0	Nitrate of soda. sulfate of ammonia. steam bone. tankage. muriate of potash.
			Found	**2.5**	**1.6**	**0.7**	**0.2**	**13.3**	....	....	**20.1**	
			Guar. '30	2.5	1.5	0.2	0.8	11.5	10.0	1.5	20.0	
			Found	**2.3**	**1.5**	**0.3**	**0.5**	**11.6**	**5.6**	**6.0**	**22.0**	

Red Steer "Hop Dressing"	Swift & Co.	Portland, Ore.	Guar. '29 Found	9.0 6.5	3.4 5.8	3.4 --------	2.2 0.7	14.9 12.3	9.0 --------	5.9 --------	4.0 3.8	Sulfate of ammonia, superphosphate, steam bone.
			Guar. '30 Found	8.0 6.3	3.2 4.0	2.6 1.9	2.2 0.4	8.7 10.7	8.2 7.1	0.5 3.6	4.0 4.4	
Vigoro	Swift & Co.	Portland, Ore.	Guar. '29 Found	3.3 4.1	3.2 3.9	0.1 0.2	-------- --------	12.0 14.2	12.0 --------	-------- --------	4.0 3.6	Sulfate of ammonia, nitrate of soda, superphosphate, sulfate of potash.
			Guar. '30 Found	4.0 3.7	3.9 3.3	0.1 0.2	-------- 0.2	12.1 14.9	12.0 14.5	0.1 0.4	4.0 4.2	
Swift's No. 1 Tankage	Swift and Co.	Portland, Ore.	Guar. '29 Found	4.9 4.9	-------- --------	-------- --------	4.9 4.9	17.3 13.1	12.0 --------	5.3 --------	-------- --------	Tankage, blood, superphosphate, bone-meal.
			Guar. '30 Found	5.0 4.5	-------- --------	-------- --------	5.0 4.5	14.0 14.8	12.0 5.7	2.0 9.1	-------- --------	
Swift's No. 5 Tankage	Swift and Co.	Portland, Ore.	Guar. '29 Found	4.1 4.4	-------- --------	-------- --------	4.1 4.4	14.7 11.1	8.0 --------	6.7 --------	-------- --------	Tankage, superphosphate.
			Guar. '30 Found	4.0 3.4	-------- --------	-------- --------	4.0 3.4	13.5 11.9	8.0 3.8	5.5 9.5	-------- --------	
Red Steer Fish Meal	Swift and Co.	Portland, Ore.	Guar. '29 Found	6.5 6.5	-------- --------	-------- --------	6.5 6.5	16.0 20.5	8.0 --------	8.0 --------	-------- --------	Salmon meal, steam bone.
			Guar. '30 Found	7.0 4.5	-------- --------	-------- --------	7.0 4.5	18.0 22.4	9.0 5.4	9.0 17.0	-------- --------	
Ruby Morcrop	Chas. H. Lilly Co.	Seattle, Wash.	Guar. Found '29	1.0 1.2	-------- 0.5	-------- --------	-------- --------	10.0 11.5	9.5 --------	0.5 --------	10.0 9.9	Sulfate of ammonia, nitrate of soda, cyanamid, urea, fish, blood, sheep guano, superphosphate, bone flour, muriate of potash, sulfate of potash.
Morcrop "B"	Chas. H. Lilly Co.	Seattle, Wash.	Guar. Found '29 Found '30	2.0 3.1 2.3	1.0 1.9 1.3	-------- -------- --------	1.0 1.2 1.0	10.0 11.6 10.9	9.2 -------- 9.9	0.8 -------- 1.0	2.0 3.1 2.1	Sulfate of ammonia, cyanamid, fish-meal, urea, blood, superphosphate, bone-meal, muriate of potash, sulfate of potash, sheep guano.

*Available P_2O_5 is the sum of water-soluble and reverted P_2O_5. See Par. C of Section 1 of the Oregon State Fertilizer Law.

TABLE I (Continued). GUARANTEED AND FOUND ANALYSES OF FERTILIZERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address		Guaranteed and found: Nitrogen (N) Total	Nitrogen (N) In Ammonia form	Nitrogen (N) In Nitrate form	Nitrogen (N) In Organic form	Phosphoric Acid (P_2O_5) Total	Phosphoric Acid (P_2O_5) Available*	Phosphoric Acid (P_2O_5) Insoluble	Potash (K_2O) Water soluble	Sources of materials used in mixed fertilizers
				%	%	%	%	%	%	%	%	
Morcrop "M"	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	3.0	1.5	....	1.5	10.0	9.2	0.8	10.0	Sulfate of ammonia, cyanamid, fish-meal, urea, blood, superphosphate, bone-meal, muriate of potash, sulfate of potash, sheep guano.
			Found '29	3.3	2.2	....	1.1	11.4	....	....	9.0	
			Found '30	3.2	1.5	....	1.7	10.7	9.1	1.6	11.0	
Morcrop "L"	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	5.0	3.0	....	2.0	6.0	5.3	0.7	8.0	Sulfate of ammonia, urea, fish-meal, blood, guano, superphosphate, muriate of potash, sulfate of potash.
			Found '29	5.5	3.6	....	1.9	7.8	....	....	9.2	
			Found '30	5.3	4.3	....	1.0	7.7	6.9	0.8	8.5	
Morcrop "K"	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	3.0	2.0	....	1.0	10.0	9.2	0.8	7.0	Sulfate of ammonia, urea, fish-meal, blood, guano, superphosphate, muriate of potash, sulfate of potash.
			Found '29	3.4	....	2.2	1.2	11.5	....	....	6.6	
			Found '30	3.3	2.3	....	1.0	10.3	9.5	0.8	7.5	
Garden Morcrop	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	5.0	1.5	0.5	3.0	10.0	7.0	3.0	5.0	Urea, ammonium sulfate, calcium nitrate, blood, fish-meal, bone-meal, superphosphate, sulfate of potash.
			Found '29	....	....	....	....	....	....	....	....	
			Found '30	5.6	2.7	0.5	2.4	11.9	6.7	5.2	5.2	
Lawn Morcrop	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	6.0	4.5	....	1.5	1.5	1.0	0.5	1.0	Sulfate of ammonia, bone-meal, superphosphate, muriate of potash.
			Found '29	7.1	6.2	....	0.9	3.8	....	....	2.5	
			Found '30	7.0	6.1	....	0.9	1.9	1.4	0.5	2.1	

Electro Morcrop	Chas. H. Lilly Co.	Seattle, Wash.	Guar. Found '29 Found '30	1.0 0.9 -------	------- 0.2 -------	------- ------- -------	1.0 0.7 -------	17.0 18.7 -------	10.0 ------- -------	7.0 ------- -------	1.0 1.1 -------	Urea, basic phosphate, muriate of potash.
Diamond "A"	Portland Seed Co.	Portland, Ore.	Guar. Found '29 Found '30	2.0 1.8 2.1	0.7 1.4 1.5	0.7 0.5 0.4	0.5 ------- 0.2	10.6 12.5 11.4	10.0 ------- 5.9	0.6 ------- 5.5	2.0 2.7 2.3	Nitrate of soda, sulfate of ammonia, tankage, muriate of potash.
Diamond "B"	Portland Seed Co.	Portland, Ore.	Guar. Found '29 Found '30	3.0 3.3 3.0	1.1 1.6 2.0	1.1 1.0 0.6	0.7 0.7 0.4	7.7 9.2 7.1	7.0 ------- 6.5	0.7 ------- 0.6	10.0 10.4 9.8	Nitrate of soda, sulfate of ammonia, tankage, muriate of potash.
Diamond Lawn and Garden	Portland Seed Co.	Portland, Ore.	Guar. Found '29 Found '30	4.0 3.6 3.9	1.5 1.6 3.0	1.5 2.1 -------	1.0 ------- 0.9	7.7 9.0 8.2	7.0 ------- 4.1	0.7 ------- 4.1	3.0 3.8 2.1	Nitrate of soda, sulfate of ammonia, tankage, muriate of potash.
Diamond Fruit and Berry	Portland Seed Co.	Portland, Ore.	Guar. Found '29 Found '30	4.0 5.3 3.9	1.5 1.8 1.8	1.5 1.6 1.2	1.0 1.9 0.9	6.5 7.2 9.8	6.0 ------- 6.1	0.5 ------- 2.8	8.0 8.3 6.6	Nitrate of soda, sulfate of ammonia, tankage, muriate of potash.
Magnolia 3-10-7	Magnolia Fertilizer Co.	Seattle, Wash.	Guar. Found	3.0 -------	1.5 -------	0.5 -------	1.0 -------	10.0 -------	8.0 -------	2.0 -------	7.0 -------	Nitrate of soda, sulfate of ammonia, muriate of potash, sulfate of potash, superphosphate, cyanamid, fish-meal, tankage, sheep guano, blood, bone-meal.
Magnolia 5-6-8	Magnolia Fertilizer Co.	Seattle, Wash.	Guar. Found '29 Found '30	5.0 4.8 5.0	2.5 2.8 3.2	1.0 1.0 1.0	1.5 1.0 0.8	6.0 7.5 8.7	4.0 ------- -------	2.0 ------- -------	8.0 8.4 6.1	Nitrate of soda, fish-meal, sulfate of ammonia, bone-meal, superphosphate, tankage, sheep guano, cyanamid, muriate of potash.
Magnolia 6-10-6	Magnolia Fertilizer Co.	Seattle, Wash.	Guar. '30 Found	6.0 6.0	2.0 2.9	2.0 0.8	2.0 2.3	10.0 14.4	8.0 6.7	2.0 7.7	6.0 7.2	Nitrate of soda, sulfate of ammonia, muriate of potash, superphosphate, tankage, bone-meal, blood.

*Available P_2O_5 is the sum of water-soluble and reverted P_2O_5. See Par. C of Section 1 of the Oregon State Fertilzer Law.

TABLE I (Continued). GUARANTEED AND FOUND ANALYSES OF FERTILIZERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address		Guaranteed and found: Nitrogen (N): Total	Nitrogen (N): In Ammonia form	Nitrogen (N): In Nitrate form	Nitrogen (N): In Organic form	Phosphoric Acid (P_2O_5): Total	Phosphoric Acid (P_2O_5): Available*	Phosphoric Acid (P_2O_5): Insoluble	Potash (K_2O): Water soluble	Sources of materials used in mixed fertilizers
				%	%	%	%	%	%	%	%	
"PEP" Brand "O"	Marine Products Co.	Seattle, Wash.	Guar. Found '29	6.0 5.9	0.5 -----	3.0 4.2	2.5 1.7	10.0 11.6	6.0 -------	4.0 -------	4.0 6.0	Leunasalpeter, bone-meal, tankage, superphosphate, fish or whale meat, muriate of potash.
"PEP" Brand "I"	Marine Products Co.	Seattle, Wash.	Guar. Found '29	1.0 1.3	------- -------	------- -------	1.0 1.3	10.0 11.7	6.0 -------	4.0 -------	10.0 7.6	Tankage, superphosphate, bone-meal, muriate of potash.
"PEP" Brand "E"	Marine Products Co.	Seattle, Wash.	Guar. Found '29	3.0 2.9	0.2 -------	1.5 1.0	1.2 1.9	8.0 11.2	5.0 -------	3.0 -------	6.0 6.4	Blood, bone-meal, leunasalpeter, tankage, fish, superphosphate, sheep manure, muriate of potash.
"PEP" Brand "C"	Marine Products Co.	Seattle, Wash.	Guar. Found '29	3.0 1.4	------- -------	------- -------	3.0 1.4	10.0 12.4	7.0 -------	3.0 -------	10.0 12.0	Tankage, fish-meal, superphosphate, bone-meal, muriate of potash.
Oregon Lawn Dressing	Feeds and Fertilizers Inc.	Portland, Ore.	Guar. Found '29	4.0 4.3	------- -------	------- -------	4.0 4.3	7.0 8.0	3.6 -------	3.4 -------	2.0 2.4	Tankage, raw bone, superphosphate, muriate of potash, sheep manure.
Q. A. Marvel	Routledge Seed & Floral Co.	Portland, Ore.	Guar. Found '29 Found '30	6.0 5.3 6.5	------- ------- 4.9	------- 5.3 0.8	------- ------- -------	9.0 8.7 11.1	8.0 ------- 9.8	1.0 ------- 1.3	5.0 5.4 5.2	
Stim-U-Plant	Stimuplant Laboratories, Inc.	Long Island City, New York, N. Y.	Guar. Found '29 Found '30	11.0 10.2 11.6	------- 9.9 11.6	------- 0.3 -------	------- ------- -------	12.4 16.1 16.5	12.0 ------- -------	0.4 ------- -------	15.0 16.6 12.8	Potassium nitrate, potassium oxide, superphosphate, ammonia salts.

Fulton's Plantabbs..	Plantabbs Corp.	Baltimore, Md.	Guar. Found	11.0	4.0	7.0	....	17.0	15.0	2.0	20.0	Ammonium phosphate, potassium nitrate.
Gills Garden Grow..	Gill Bros. Seed Co.	Portland, Ore.	Guar. Found '29 Found '30	3.3 3.1 2.3	....	....	....	10.0 11.1 9.5	.... 7.7	.... 1.7	2.3 6.8 5.2	Fish, tankage, blood, bone-meal, nitrate of soda, muriate of potash, superphosphate, sulfate of ammonia.
Gills Garden Grow..	Gill Bros. Seed Co. (Mineral mixture not registered)	Portland, Ore.	Found '30	3.5	....	....	....	10.1	9.8	0.3	8.9	
Kalox	The Halfhill Co.	Los Angeles, Cal.	Guar. Found '30	6.0 6.0	3.0 3.1	3.0 2.8	.... 0.1	8.0 9.7	8.0 6.3	.... 3.4	4.0 4.4	Nitrate of soda, sulfate of ammonia, superphosphate, muriate of potash.
Nitrophoska No. 1..	The Pacifica Guano and Fertilizer Co.	Berkeley, Cal.	Guar. Found '29 Found '30	15.0 16.0 14.8	13.4 14.3 13.0	1.6 1.7 1.8	....	30.0 39.6 32.8	30.0 .... 32.5	....	15.0 14.4 13.5	
Nitrate of Soda........	Swift & Co.	Portland, Ore.	Guar. Found '29 Found '30	15.0 15.2 15.6	....	15.0 15.2 15.6	....	....	....	....	....	
Nitrate of Soda........	Chas. H. Lilly Co.	Seattle, Wash.	Guar. Found '29 Found '30	15.5 15.4 15.9	....	15.5 15.4 15.9	....	....	....	....	....	
Nitrate of Soda........	Balfour, Guthrie & Co.	Portland, Ore.	Guar. Found '29 Found '30	14.0 15.3	....	14.0 15.3	....	....	....	....	....	
Nitrate of Soda........	Magnolia Fertilizer Co.	Seattle, Wash.	Guar. Found '30	15.0	....	15.0	....	....	....	....	....	
Nitrate of Lime........	Hood River Apple Growers	Hood River, Ore.	Guar. Found '29	14.5 14.6	....	14.5 14.6	....	....	....	....	....	
			Guar. Found '30	15.0 15.7	....	15.0 15.7	....	....	....	....	....	
Sulfate of Ammonia	Swift & Co.	Portland, Ore.	Guar. Found '29 Found '30	20.6 20.5 20.7	20.6 20.5 20.7	....	....	....	....	....	....	
Sulfate of Ammonia	Chas. H. Lilly Co.	Seattle, Wash.	Guar. Found '29 Found '30	20.0 20.5 20.8	20.0 20.5 20.8	....	....	....	....	....	....	

*Available P_2O_5 is the sum of water-soluble and reverted P_2O_5. See Par. C of Section 1 of the Oregon State Fertilzer Law.

TABLE I (Continued). GUARANTEED AND FOUND ANALYSES OF FERTILIZERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address		Guaranteed and found: Nitrogen (N): Total	In Ammonia form	In Nitrate form	In Organic form	Phosphoric Acid (P_2O_5): Total	Available*	Insoluble	Potash (K_2O): Water soluble	Sources of materials used in mixed fertilizers
				%	%	%	%	%	%	%	%	
Sulfate of Ammonia	Magnolia Fertilizer Co.	Seattle, Wash.	Guar.	20.0	20.0	....	....	....	....	....	....	
			Found '29	20.1	20.1	....	....	....	....	....	....	
			Found '30	20.6	20.6	....	....	....	....	....	....	
Sulfate of Ammonia	Ford Motor Co.	Dearborn, Mich.	Guar.	20.8	20.8	....	....	....	....	....	....	
			Found '29	20.5	20.5	....	....	....	....	....	....	
			Found '30	20.4	20.4	....	....	....	....	....	....	
Sulfate of Ammonia	The Barrett Co.	New York, N. Y.	Guar.	20.5	20.5	....	....	....	....	....	....	
			Found '29	....	....	....	....	....	....	....	....	
			Guar.	20.6	20.6	....	....	....	....	....	....	
			Found '30	20.8	20.8	....	....	....	....	....	....	
Leunasalpeter	Hood River Apple Growers	Hood River, Ore.	Guar.	26.0	19.5	6.5	....	....	....	....	....	
			Found '29	25.5	19.4	6.1	....	....	....	....	....	
Cyanamid	American Cyanamid Sales Co.	Azusa, Cal.	Guar.	21.0	....	....	21.0	....	....	....	....	
			Found '29	20.9	....	....	20.9	....	....	....	....	
Calurea	The Pacific Guano & Fertilizer Co.	Berkeley, Cal.	Guar.	....	....	....	....	....	....	....	....	
			Found '29	30.0	....	....	....	....	....	....	....	
Blood	Swift & Co.	Portland, Ore.	Guar.	13.2	....	....	13.2	....	....	....	....	
			Found '29	15.7	....	....	15.7	....	....	....	....	
			Guar.	13.0	....	....	13.0	....	....	....	....	
			Found '30	12.4	....	....	12.4	....	....	....	....	
Superphosphate	Swift & Co.	Portland, Ore.	Guar.	....	....	....	....	18.4	18.2	0.2	....	
			Found '29	....	....	....	....	....	19.3	....	....	
			Guar.	....	....	....	....	18.7	18.5	0.2	....	
			Found '30	....	....	....	....	24.8	24.7	0.1	....	

Superphosphate	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	......	......	......	......	19.0	18.5	0.5	......
			Found '29	......	......	......	......	......	16.1	......	......
			Guar.	......	......	......	......	18.5	18.0	0.5	......
			Found '30	......	......	......	......	18.5	17.5	1.0	......
Superphosphate	Portland Seed Co.	Portland, Ore.	Guar.	......	......	......	......	18.0	17.5	0.5	......
			Found '29	......	......	......	......	......	18.4	......	......
			Found '30	......	......	......	......	18.5	17.5	1.0	......
Superphosphate	C. C. Cate & Co.	Portland, Ore.	Guar.	......	......	......	......	......	16.0	......	......
			Found '29	......	......	......	......	......	20.2	......	......
			Guar.	......	......	......	......	......	16.5	......	......
			Found '30	......	......	......	......	18.1	17.8	0.3	......
Superphosphate	Balfour, Guthrie & Co.	Portland, Ore.	Guar.	......	......	......	......	17.0	16.5	......	......
			Found '29	......	......	......	......	......	......	......	......
			Guar.	......	......	......	......	......	16.0	......	......
			Found '30	......	......	......	......	22.2	21.9	0.3	......
Superphosphate	The Mountain Copper Co.	San Francisco, Cal.	Guar.	......	......	......	......	18.0	17.5	......	......
			Found '29	......	......	......	......	......	19.2	......	......
			Found '30	......	......	......	......	22.6	22.3	0.3	......
Treble Superphosphate	The Mountain Copper Co.	San Francisco, Cal.	Guar.	......	......	......	......	45.0	44.0	......	......
			Found '29	......	......	......	......	......	......	......	......
			Found '30	......	......	......	......	......	......	......	......
Ammo-Phos A..........	American Cyanamid Sales Co.	Azusa, Cal.	Guar.	11.0	10.5	......	......	46.0	46.0	......	......
			Found '29	......	......	......	......	......	......	......	......
			Found '30	......	......	......	......	......	......	......	......
Ammo-Phos B..........	American Cyanamid Sales Co.	Azusa, Cal.	Guar.	16.5	16.0	......	......	20.0	20.0	......	......
			Found '29	......	16.0	......	......	21.8	......	......	......
			Found '30	......	16.4	......	......	23.2	......	......	......
Phosphate Rock........	F. M. Mills Co.	Cokeville, Wyo.	Guar.	......	......	......	......	30.0	......	30.0	......
			Found '30	......	......	......	......	31.2	......	......	......
Muriate of Potash....	Swift & Co.	Portland, Ore.	Guar.	......	......	......	......	......	......	......	50.0
			Found '29	......	......	......	......	......	......	......	49.5
			Found '30	......	......	......	......	......	......	......	49.6
Muriate of Potash....	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	......	......	......	......	......	......	......	50.0
			Found '29	......	......	......	......	......	......	......	50.1
			Found '30	......	......	......	......	......	......	......	49.5
Muriate of Potash....	C. C. Cate & Co.	Portland, Ore.	Guar.	......	......	......	......	......	......	......	52.0
			Found '30	......	......	......	......	......	......	......	50.1

*Available P_2O_5 is the sum of water-soluble and reverted P_2O_5. See Par. C of Section 1 of the Oregon State Fertilzer Law.

TABLE I (Continued). GUARANTEED AND FOUND ANALYSES OF FERTILIZERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address		Guaranteed and found: Nitrogen (N): Total	Nitrogen (N): In Ammonia form	Nitrogen (N): In Nitrate form	Nitrogen (N): In Organic form	Phosphoric Acid (P_2O_5): Total	Phosphoric Acid (P_2O_5): Available*	Phosphoric Acid (P_2O_5): Insoluble	Potash (K_2O): Water soluble	Sources of materials used in mixed fertilizers
				%	%	%	%	%	%	%	%	
Muriate of Potash	The Mountain Copper Co.	San Francisco, Cal.	Guar.	-------	-------	-------	-------	-------	-------	-------	50.0	
			Found '29	-------	-------	-------	-------	-------	-------	-------	-------	
Muriate of Potash	Balfour Guthrie & Co.	Portland, Ore.	Guar.	-------	-------	-------	-------	-------	-------	-------	50.0	
			Found '29	-------	-------	-------	-------	-------	-------	-------	50.4	
Sulfate of Potash	Swift & Co.	Portland, Ore.	Guar.	-------	-------	-------	-------	-------	-------	-------	50.0	
			Found '29	-------	-------	-------	-------	-------	-------	-------	50.3	
			Guar.	-------	-------	-------	-------	-------	-------	-------	51.0	
			Found '30	-------	-------	-------	-------	-------	-------	-------	50.1	
Sulfate of Potash	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	-------	-------	-------	-------	-------	-------	-------	50.0	
			Found '29	-------	-------	-------	-------	-------	-------	-------	49.8	
			Found '30	-------	-------	-------	-------	-------	-------	-------	49.7	
Sheep Guano	Swift & Co.	Portland, Ore.	Guar.	1.6	-------	-------	1.6	0.8	0.7	0.1	1.5	
			Found '29	1.6	-------	-------	1.6	1.5	-------	-------	2.4	
			Guar.	1.6	-------	-------	1.6	1.5	0.7	0.8	2.0	
			Found '30	1.7	-------	-------	1.7	1.7	-------	-------	2.4	
Sheep Guano	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	1.0	-------	-------	1.0	1.0	-------	-------	1.0	
			Found '29	1.1	-------	-------	1.1	1.5	-------	-------	0.7	
Sheep Guano	Portland Seed Co.	Portland, Ore.	Guar.	1.2	-------	-------	1.2	1.2	-------	-------	1.7	
			Found '29	1.3	-------	-------	1.3	1.6	-------	-------	2.3	
			Found '30	1.2	-------	-------	1.2	1.5	-------	-------	1.5	
Sheep Guano	Gill Bros. Seed Co.	Portland, Ore.	Guar.	1.6	-------	-------	1.6	1.2	-------	-------	2.0	
			Found '29	1.7	-------	-------	1.7	1.7	-------	-------	2.7	
			Found '30	1.1	-------	-------	1.1	1.5	-------	-------	1.8	

Sheep Guano "Groz-it"	Pacific Manure & Fertilizer Co.	San Francisco, Cal.	Guar.	1.6	....	....	1.6	0.7	....	....	3.0
			Found '29	1.5	....	....	1.5	1.0	....	....	2.6
			Guar.	1.5	....	....	1.5	0.7	....	....	3.0
			Found '30	....	....	....	....	....	....	....	....
Sheep Guano "Shaniko"	C. McConkey	Portland, Ore.	Guar.	1.2	....	....	1.2	1.0	....	....	1.5
			Found '30	....	....	....	....	....	....	....	....
Sheep Guano "H. O."	Routledge Seed & Floral Co.	Portland, Ore.	Guar.	1.6	....	....	1.6	1.2	....	....	3.0
			Found '29	1.5	....	....	1.5	1.0	....	....	3.1
			Found '30	1.3	....	....	1.3	0.9	....	....	2.9
Sheep Guano "Merino Brand"	Feeds and Fertilizers, Inc.	Portland, Ore.	Guar.	1.0	....	....	1.0	1.0	....	....	1.5
			Found '29	1.5	....	....	1.5	1.8	....	....	2.5
Sheep Guano	Magnolia Fertilizer Co.	Seattle, Wash.	Guar.	1.0	....	....	1.0	1.0	....	....	1.0
			Found '29	....	....	....	....	....	....	....	....
Sheep Guano	The Berry Growers Packing Co.	Gresham, Ore.	Guar.	1.7	....	....	1.7	1.5	....	....	1.7
			Found '29	1.9	....	....	1.9	1.7	....	....	1.8
Sheep Guano "Oregon-Montana"	Willamette Valley Grain Co.	Portland, Ore.	Guar.	1.5	....	....	1.5	1.2	....	....	2.0
			Found '29	1.6	....	....	1.6	1.6	....	....	2.9
Steam Bone Meal	Swift & Co.	Portland, Ore.	Guar.	2.1	....	....	2.1	24.0	12.0	12.0	....
			Found '29	3.2	....	....	3.2	29.0	....	....	....
			Guar.	2.0	....	....	2.0	28.0	14.0	14.0	....
			Found '30	2.3	....	....	2.3	28.1	6.9	21.2	....
Steam Bone Meal	Magnolia Fertilizer Co.	Seattle, Wash.	Guar.	3.0	....	....	3.0	22.0	11.0	11.0	....
			Found '30	†5.1	....	....	5.1	21.3	4.0	17.3	....
				2.7	....	....	2.7	25.2	8.8	16.4	....
Steam Bone Meal	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	1.0	....	....	1.0	30.0	15.0	15.0	....
			Found '29	1.0	....	....	1.0	36.9	....	....	....
			Guar.	1.0	....	....	1.0	30.0	10.0	20.0	....
			Found '30	1.3	....	....	1.3	34.0	11.6	22.4	....
Steam Bone Meal	Marine Products Co.	Seattle, Wash.	Guar.	1.0	....	....	1.0	26.0	13.0	13.0	....
			Found '29	....	....	....	....	....	....	....	....
			Guar.	1.0	....	....	1.0	26.0	10.0	16.0	....
			Found '30	....	....	....	....	....	....	....	....

*Available P_2O_5 is the sum of water-soluble and reverted P_2O_5. See Par. C of Section 1 of the Oregon State Fertilzer Law.
†Raw bone-meal, not registered.

TABLE I (Continued). GUARANTEED AND FOUND ANALYSES OF FERTILIZERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen (N) Total	Nitrogen (N) In Ammonia form	Nitrogen (N) In Nitrate form	Nitrogen (N) In Organic form	Phosphoric Acid (P_2O_5) Total	Phosphoric Acid (P_2O_5) Available*	Phosphoric Acid (P_2O_5) Insoluble	Potash (K_2O) Water soluble	Sources of materials used in mixed fertilizers
				%	%	%	%	%	%	%	%	
Steam Bone Meal....	Balfour, Guthrie & Co.	Portland, Ore.	Guar.	1.0	....	....	1.0	31.0	15.0	16.0	....	
			Found '30	1.0	....	....	1.0	33.6	7.4	26.2	....	
Steam Bone Meal....	Mailliard & Schmiedell	Portland, Ore.	Guar	1.0	....	....	1.0	31.0	15.0	16.0	....	
			Found '29	1.0	....	....	1.0	36.9	....	....	....	
			Found '30	1.2	....	....	1.2	34.3	11.8	22.5	....	
Steam Bone Meal....	Feeds and Fertilizers, Inc.	Portland, Ore.	Guar.	2.0	....	....	2.0	21.0	11.0	10.0	....	
			Found '29	0.8	....	....	0.8	33.8	....	....	....	
Tankage	Magnolia Fertilizer Co.	Seattle, Wash.	Guar.	6.0	....	....	6.0	10.0	5.0	5.0	....	
			Found '30	5.9	....	....	5.9	9.6	....	....	....	
Tankage	Feeds and Fertilizers, Inc.	Portland, Ore.	Guar.	4.1	....	....	4.1	8.0	4.0	4.0	....	
			Found '29	4.9	....	....	4.9	11.2	....	....	....	
Tankage	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	4.0	....	....	4.0	12.0	....	....	....	
			Found '29	3.9	....	....	3.9	14.4	....	....	....	
Fish	Marine Products Co.	Seattle, Wash.	Guar.	6.0	....	....	6.0	6.0	3.0	3.0	....	
			Found	....	....	....	....	....	....	....	....	
Fish	Gill Bros. Seed Co.	Portland, Ore.	Guar.	8.0	....	....	8.0	6.0	....	....	....	
			Found '29	9.2	....	....	9.2	5.6	....	....	....	
			Guar.	8.2	....	....	8.2	6.0	....	....	....	
			Found '30	10.9	....	....	10.9	5.2	3.4	1.8	....	
Fish	Feeds and Fertilizers, Inc.	Portland, Ore.	Guar.	6.5	....	....	6.5	8.0	4.0	4.0	....	
			Found '29	7.6	....	....	7.6	7.1	....	....	....	
Fish	Chas. H. Lilly Co.	Seattle, Wash.	Guar.	8.0	....	....	8.0	6.0	3.0	3.0	....	
			Found '29	7.6	....	....	7.6	9.8	....	....	....	

				Guaranteed and found	
				Sulfur	
Sulfur	Pacific Coast Supply Co.	Portland, Ore	Guar. Found '29 Found '30	% 99.5 sulfur	
Toro Brand Activated Sulfur Compound	San Francisco Sulfur Co.	San Francisco, Cal	Guar. Found '29 Found '30	80.0 sulfur	
A-1 Commercial Sulfur	Western Sulfur Industries, Inc.	San Francisco, Cal	Guar. Found '29	98.0 sulfur	
Bac-Sul	Western Sulfur Industries, Inc.	San Francisco, Cal	Guar. Found '29	95.0 sulfur	

*Available P_2O_5 is the sum of water-soluble and reverted P_2O_5. See Par. C of Section 1 of the Oregon State Fertilzer Law.

GUARANTEES UNDER THE AGRICULTURAL LIME LAW

The State Legislature in 1917 enacted a law to regulate the sale of agricultural lime. Agricultural lime includes two kinds of products—those derived from limestone rock, and the gypsums or land-plasters. The first are used primarily for the correction of soil acidity; the second are really sulfur fertilizers.

LIME ROCK AND ITS PRODUCTS

Calcium carbonate, $CaCO_3$, is the active compound in lime rock. Some deposits of lime rock are almost pure calcium carbonate; others are very low in their content of that compound. The high-percentage lime rocks are highly valued for other than agricultural purposes. They are burned to produce calcium oxide, CaO, which in turn figures prominently in many industrial processes. Burning of limestone rock for agricultural use is no longer a common practice. Raw lime rock ground so fine that a large fraction of it will pass through a 100-mesh screen is used most extensively for the neutralization of soil acidity. Since in actual content of calcium carbonate, raw rock varies between wide limits with origin or source, purchasers have abundant reason for being cautious in placing orders. Lime rock where calcium-carbonate content is 98 or 99 percent is far more valuable pound for pound in neutralizing soil acidity than one in which the content of the active ingredient is only 60 percent. If one can purchase finely ground raw rock of 98 percent purity at $6.00 per ton, it is evident that its content of actual calcium carbonate will cost a trifle more than 61.3¢ per unit ($\$6 \div 98 = \$0.613$). Now, if a cheaper rock is offered him, the purchaser can readily tell for himself whether the price is reasonable, provided there is a guarantee on its percentage of calcium carbonate. If that percentage is 60, the purchaser will get 60 units of calcium carbonate. If we apply the unit cost of calcium carbonate in the higher grade rock to this one, its cost should approximate $3.70 per ton ($\$0.613 \times 60$).

GYPSUM OR LAND-PLASTER

In gypsum the active ingredient is sulfur. Sulfur in the Pacific Northwest has proved to be a valuable fertilizer for various legumes—particularly alfalfa and red clover. Several brands of gypsum or land-plaster are offered for sale in Oregon. Calculations similar to those used in the preceding section will enable the purchaser easily to arrive at relative values for each of the several brands, if the guarantees are known and the quotations on any one brand be used as a standard of cost.

The State Lime Law requires that every form of agricultural lime be registered by those responsible for it with the chemist of the Agricultural Experiment Station. Registration must be renewed annually in January. The law is intended to safeguard the interests of the consumers of agricultural lime by insuring proper and plain labeling of packages and bulk shipments and the guarantee of the percentage content of the active ingredients. In Tables II and III are given the results of inspection work on limestone rock and its products for each of the two years, 1929 and 1930 In Table IV are given in condensed form the analytical work on the gypsums for both years. Gypsum will be found on sale wherever the legumes are prominently grown. Naturally the sale of limestone rock for agricultural purposes is restricted to those sections of the state where acid soils predominate.

TABLE II. GUARANTEED AND FOUND ANALYSES OF AGRICULTURAL LIMES SOLD IN OREGON IN 1929

Name or brand	Manufacturer	Address	Guaranteed and found				
				Calcium carbonate $CaCO_3$	Calcium hydrate $Ca(OH)_2$	Magnesium carbonate $MgCO_3$	Total neutralizing power in terms of calcium carbonate $CaCO_3$
				%	%	%	%
Fine Crushed Limestone	Orcas Lime Co.	Seattle, Washington	Guar. Found	91.1 -------	5.8 -------	------- -------	99.0 -------
Ground Lime Rock	March Construction Co.	Dallas, Oregon	Guar. Found	71.0 -------	------- -------	2.7 -------	74.0 77.0
Agricultural Slack Lime	Washington Brick Lime & Sewer Pipe Co.	Portland, Oregon	Guar. Found	20.0 -------	60.0 -------	6.0 -------	108.0 -------
Golden Gate Ag. Lime	Pacific Portland Cement Co.	Portland, Oregon	Guar. Found	95.0 -------	------- -------	------- -------	------- 96.3
H. O. Lime	Orcas Lime Co.	Seattle, Washington	Guar. Found	69.0 -------	26.0 -------	2.0 -------	103.0 103.4
Fertilime	Spaulding Bldg. Materials Depot	Portland, Oregon	Guar Found	60.0 (CaO)	------- -------	------- -------	112.0 130.0
Agricultural Slack Lime	Lively Lime Products Co.	Gold Hill, Oregon	Guar. Found	12.0 -------	70.0 -------	2.0 -------	105.0 118.8
Agricultural Hydrate Fertilime	Black Marble & Lime Co.	Enterprise, Oregon	Guar. Found	------- -------	96.4 -------	0.7 -------	125.0 133.0
Ag. Hydrate and Ground Limestone	Black Marble & Lime Co.	Enterprise, Oregon	Guar. Found	50.0 -------	50.0 -------	------- -------	115.0 144.2
Marble Rock Hydrated Lime	Idaho Lime Co.	Bossburg, Washington	Guar. Found	------- -------	92.0 -------	------- -------	------- 126.5

TABLE III. GUARANTEED AND FOUND ANALYSES OF AGRICULTURAL LIMES SOLD IN OREGON IN 1930

Name or brand	Manufacturer	Address	Guaranteed and found				
				Calcium carbonate $CaCO_3$	Calcium hydrate $Ca(OH)_2$	Magnesium carbonate $MgCO_3$	Total neutralizing power in terms of calcium carbonate $CaCO_3$
				%	%	%	%
Golden Gate Ag. Lime..	Pacific Portland Cement Co.	Portland, Oregon	Guar.	95.0	-------	0.5	-------
			Found	-------	-------	-------	**95.7**
H. O. Lime........................	Orcas Lime Co.	Seattle, Washington	Guar.	69.0	26.0	1.0	103.0
			Found	-------	-------	-------	**110.7**
Crushed Limestone.........	Orcas Lime Co.	Seattle, Washington	Guar.	91.1	5.8	1.0	99.0
			Found	-------	-------	-------	-------
Agricultural Slack Lime	Lively Lime Products Co.	Gold Hill, Oregon	Guar.	12.0	70.0	2.0	105.0
			Found	-------	-------	-------	-------
Ground Limestone...........	March Construction Co.	Dallas, Oregon	Guar.	71.0	-------	2.7	74.0
			Found	-------	-------	-------	**70.0**
"Skookum" Ag. Lime.....	Clearwater Lime Co.	Orofino, Idaho	Guar.	95.0	-------	1.0	96.0
			Found	-------	-------	-------	**95.5**
"Chieftain" Fertilime.....	Black Marble & Lime Co.	La Grande, Oregon	Guar.	92.0	-------	1.3	170.0
			Found	(CaO)	-------	(MgO)	**130.6**

TABLE IV. GUARANTEED AND FOUND ANALYSES OF LAND-PLASTERS SOLD IN OREGON 1929-1930

Name or brand	Manufacturer	Address		Hydrated calcium sulfate $CaSO_4 \cdot 2H_2O$ guaranteed and found
				%
Nephi (Utah) Land Plaster	Nephi Plaster and Manufacturing Co.	Salt Lake City, Utah	Guar. Found '29 Found '30	92.0 ....
Jumbo Land Plaster	Jumbo Plaster and Cement Co.	Sigurd, Utah	Guar. Found '29 Found '30	97.5 97.4 97.3
Empire Agricultural Gypsum	Pacific Portland Cement Co.	Portland, Oregon	Guar. '29 Found Guar. '30 Found	93.0 92.8 92.0 92.9
Ben Franklin Agri. Gypsum	United States Gypsum Co.	Chicago, Illinois	Guar. Found '29 Found '30	90.5 ...... 89.0
Land Plaster	American Keene Cement Co.	Sigurd, Utah	Guar. '29 Found '29 Guar. '30 Found '30	98.9 ...... 97.0 97.3
Bumper Harvest Agri. Gypsum	Standard Gypsum Co.	San Francisco, California	Guar. Found '29 Found '30	93.0 94.8 94.4

SUMMARY

The intent of the Oregon Fertilizer Law is to insure users of commercial fertilizers a means of judging quality in the various combinations of materials offered them for fertilizing purposes. To this end the law provides for the licensing of responsible dealers and the labeling in plain terms of every lot or parcel of commercial fertilizer sold or exposed for sale in Oregon. Enforcement of the law rests with the Chemistry department of the Agricultural Experiment Station.

Fertilizers are products of the chemical industry. To promote intelligent buying of commercial fertilizers occasion is taken in the publication of this report to include a brief discussion of the chemical nature of materials that impart value to the finished product of the manufacturer. With quotations on "simples" which manufacturers and dealers readily supply to intending purchasers, the user can easily compute the actual relative values on the various brands of commercial fertilizers offered him. Choice is made relatively easy if only in addition the user also knows whether quickly acting or the more slowly acting ingredients are for him most desirable. In cases of doubt the Chemistry department of the Experiment Station is prepared to give an unbiased opinion.

The results of recent inspection work and contact with manufacturers and dealers show the trend of the fertilizer trade to be in the direction of the more concentrated forms of nitrogen, phosphorus, and the potassium-carrying compounds. This fact brings to the front again the need for improved forms of fertilizer distributing machinery.

Inspection work for the biennium has revealed on the part of manufacturers and dealers in fertilizers and agricultural limes generally a very high regard for the various provisions of the Oregon laws governing the sale of those products. Manufacturers and dealers have been asked by letter to cooperate further in the adoption of a more uniform statement required by law for the labels. Analytical data are given in full for the two years' inspection work on both fertilizers and agricultural limes.