STATION CIRCULAR 87 JANUARY, 1929

Commercial Fertilizers

1929 Edition

Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

SUMMARY

Farmers are advised to study this bulletin carefully in order to understand the meaning of the guaranteed analysis given on the tag or label and the method of estimating commercial fertilizer costs.

The Oregon Fertilizer Control Law administered by the Chemistry department of the Oregon Agricultural Experiment Station protects purchasers of commercial fertilizers against misrepresentation of the plant-food content by unscrupulous manufacturers.

The agricultural or crop-producing value of a fertilizer and the commercial value or selling price have no true relation. A discussion is given that distinguishes between the two terms.

The purchase of a commercial fertilizer is essentially the purchase of the plant foods, nitrogen, phosphorus, potassium, and sulfur. The manner in which the plant foods are combined in commercial fertilizers is described.

The consumer is advised to purchase the high-grade fertilizers; i.e., fertilizers having a total plant-food content of 15 percent or more.

The commercial sheep manures show wide variations in quality. Especial care should be taken to note the guaranteed composition stated on the tags.

A method is given whereby the approximate cost of a fertilizer may be estimated. Comparisons may then be made of the commercial value of the various brands produced by different manufacturers.

A table is given showing the guaranteed and the found composition of all fertilizers sold in Oregon during 1927-1928.

Brief reference is made to the Oregon Agricultural Lime Law and a table is given showing the different brands of gypsum and limestone sold in the state during 1927-1928.

Commercial Fertilizers

By

R. H. Robinson, C. F. Whitaker, and D. E. Bullis

In the purchase of no other commodity offered on the market today is the consumer more liable to fraud than he is in the buying of fertilizers. As a protection, therefore, to both the consumer and the honest manufacturer a law was passed governing the sale of commercial fertilizers in Oregon.

The Oregon State Fertilizer Law enacted in 1906 provides for the official registering and correct labeling of all fertilizers prior to their sale in the state. In December of each year manufacturers are required to submit to the Chemistry department of the Oregon Agricultural Experiment Station a certificate of registration for each brand of fertilizer that will be sold by them during the ensuing calendar year. This certificate is a guarantee statement indicating clearly for the fertilizer its percentage content of plant food elements and the source or sources of those elements. Subsequently when any amount of fertilizer is offered for sale each brand must be labeled in a manner to show its guaranteed composition. If a new brand is placed upon the market at any time during the year the manufacturer or agent must first file a similar certificate declaring the composition of the fertilizer before it is sold or offered for sale.

ADVICE TO FARMERS

Farmers and others who purchase fertilizers should study this bulletin carefully and buy from the manufacturers who maintain their guarantee. They should avail themselves of the opportunity offered by the Chemistry department of the Oregon Experiment Station to learn fully regarding the quality of any one or more of the different brands offered on the market.

The Fertilizer Law provides for the proper labeling of all commercial fertilizers, but it cannot prevent the sale of the poor grade brands that may sell for as high a price as is charged for high grade brands. The buyer should therefore examine the label or tag for the amount of the guaranteed plant food constituents and be sure that he understands the meaning of the terms.

In order that the consumer may be protected against the unscrupulous manufacturer or agent, the department of Agricultural Chemistry endeavors to collect and analyze annually at least one sample of every brand sold in the state. The manufacturers of such brands as are found to be below the guarantee as certified on the label or tag are notified and requested to make the necessary correction. In the event that the composition of the fertilizer is not made to conform with the guarantee, consumers, county agents, and others interested are advised of the circumstances in order that they may avoid the use of such brands as do not come up to specifications. The Fertilizer Law then provides that court proceedings be taken against the manufacturer. Thus far no drastic action has been found necessary although in several cases the manu-

facturers have been required to remix their material to bring ingredients up to the guaranteed composition.

The amount of commercial fertilizer used annually in Oregon is small in comparison with the amounts used in the states of the Middle West and the East. This fact is probably due to the prevailing belief that commercial fertilizers are as yet unnecessary in this state, and because their agricultural value from an economic standpoint has not been sufficiently recognized. Owing to more intensified and more specialized farming, however, opinion is gradually changing, and each year we note a substantial increase in the quantity of commercial fertilizers used. During the year just passed more than 8,000 tons of fertilizer materials were sold in Oregon.

The importance of maintaining soil fertility by replacing those elements removed from the soil by similar elements or plant foods found in manure or commercial fertilizers cannot be overemphasized. Since on most farms the amount of manure available is not sufficient to maintain the fertility of the soil, it is frequently necessary to employ a commercial fertilizer. The number of soil constituents or plant foods liable to rapid exhaustion by the annual removal of crops is limited in most cases to five elements: nitrogen, phosphorus, potassium, sulfur, and calcium. The more common terminology for these plant foods is respectively nitrogen, phosphoric acid, potash, sulfur, and lime. Each year the growing crop takes from the soil hundreds of pounds of these elements, and it is obvious that ultimately the quantity contained in the soil will become so low as to make profitable cropping impossible.

At present the departments of Soils and Chemistry of the Oregon Agricultural Experiment Station, in cooperation with the Bureau of Soils of the U. S. Department of Agriculture, are making a soil survey of the state which includes the location of the different soil types and chemical and physical analyses of the main types. A study is being made of the results that may be obtained by the application of certain fertilizers on these types. Meanwhile if fertilizers are to be used intelligently, a few simple trial experiments on a small scale may have to be conducted by the consumer to determine local needs. It would be advisable for each farmer to make trial applications on a small area, using the different fertilizers suggested by experiment station specialists, county agricultural agents, and fertilizer agents in order to ascertain what plant food or combination of plant foods will prove best and most profitable.

It is generally conceded that the fertilizer to be used on any soil depends somewhat upon the previous crop raised, the amount of manure that has been applied in the past, the soil type, and the crop to be grown. Suggestions may be obtained concerning the fertilizer that should be used on a particular soil by writing to the Oregon Agricultural Experiment Station, giving full information regarding the location, soil type, crops grown in the past, the crop to be grown, and other data that may be deemed advisable. In general, it may be said that on a particular soil a grower is warranted in using any fertilizer that yields additional crop values equal to or above the actual cost of the fertilizer applied. In some cases, especially for the growing of certain truck crops, it may be found profitable to fertilize lands that are judged rich. The greatest success attending the use of commercial fertilizers depends probably upon the individual farmer's wisdom or good judgment in observing the ordinary rules necessary for good farming.

AGRICULTURAL VALUE VERSUS COMMERCIAL VALUE

The agricultural value of a fertilizer depends upon its crop-producing power. The commercial value of a fertilizer is its price, that is, its cost per ton on the market. The commercial valuation of a certain fertilizer does not, therefore, have any close relation to its agricultural or crop-producing value on a given farm or soil. On account of the scarcity of a certain fertilizer, as is exemplified by the condition that prevailed during the war regarding potash, the market price may be abnormally high during one or more seasons. The crop-producing or agricultural value, however, is not subject to such fluctuations. Furthermore, the agricultural value of a certain fertilizer on one particular soil may be high as indicated by a large increase in crop production of the fertilized plot over the unfertilized plot, while the cost per ton of that particular fertilizer may be comparatively low. This same fertilizer, on the other hand, may not give any increase in crop production when applied to another soil type in the same or in a different locality where a different crop is grown. Thus is seen the importance of first ascertaining the actual agricultural value or crop-producing power of a fertilizer before investing heavily in it. Judging from the crop to be grown, the type of soil, etc., we might conclude that a certain fertilizer would give good results; but in order absolutely to determine this point it would be necessary to make an actual application of it to the soil and observe its effect upon the crop. As previously stated, a few trials on small experimental plots, fertilized and unfertilized and growing the same crop, will be found most economical.

FERTILIZER INGREDIENTS

In order that fertilizers may be used more intelligently, and that a wiser choice may be exercised in the purchase of commercial brands, a definite knowledge of their composition and source is necessary. We shall have occasion to use frequently the terms "mixed" or "complete" fertilizers, "simples," "available" and "unavailable" plant foods, and it is desirable that we define them in order that the subject-matter discussed may be more easily understood.

Simples. For the sake of convenience and in order to distinguish between the materials used in "mixed" fertilizers and the mixed fertilizers themselves we call the former "simples." Simples are usually definite substances that are either by-products of some industry or are elements mined and prepared specifically for the one or more elements of plant food they contain. For example, tankage, bone-meal, and the like are by-products of the packing-house; nitrate of soda and superphosphates are prepared for the one plant food each contains, namely, nitrogen and phosphorus, respectively. At present the following simples are used in Oregon: superphosphate, nitrate of soda, muriate of potash, sulfate of potash, sulfur, blood meal or dried blood, sulfate of ammonia, fish-meal, tankage, bone-meal, and dried manures, sometimes miscalled guanos.

Mixed or complete fertilizers. The mixed or complete fertilizer is composed of a combination of simples in such proportion as to give a

certain percentage of nitrogen, phosphoric acid, and potash. The mixed fertilizers are sold in this state under specific names or brands. These brands are so compounded by the manufacturer that they contain those plant foods in proportions suitable for certain crops and soils. Consequently we may have a mixed fertilizer containing, for example, a high percentage of phosphoric acid, a medium percentage of nitrogen, and a medium percentage of potash; or another, having a high percentage of nitrogen, a high percentage of phosphoric acid, and little or no potash.

Available plant foods. A plant food or element is considered "available" when it is in such form or combination that plants can immediately utilize it, or when it is in such form that, though not suited for immediate use, it gradually changes into the available condition during the growing season in which it is applied.

Unavailable plant foods. A plant food or element is "unavailable" when it is in such form or combination that plants cannot utilize it under any natural conditions, or when it becomes available so slowly under favorable conditions as not to furnish, during a single growing season, appreciable amounts of material that can be used by the growing crops.

The following description of the various plant foods and of the fertilizer materials that contain these elements will give a more definite knowledge regarding the composition and ingredients of various commercial fertilizers. All statements regarding the source of material and the specific kinds of fertilizers mixed to form complete fertilizers apply to conditions that exist at present in Oregon.

Nitrogen. (All too frequently AMMONIA is referred to in connection with fertilizers synonymously with nitrogen. To convert ammonia to nitrogen multiply by .823. To convert nitrogen to ammonia multiply by 1.216.) Nitrogen is probably the most commonly used and also the most expensive constituent of fertilizers. It may exist in the organic state, like the nitrogen of dried blood, or it may exist in the inorganic state, like the nitrogen of nitrate of soda. Other simples that contain nitrogen combined in the organic form are tankage, bone-meal, fish-meal, and the manures or guanos. Blood meal is the most concentrated of the organic, nitrogen-containing simples. A high-grade product should contain at least 13 percent nitrogen. The nitrogen content of the other organic materials varies greatly; the exact amount present may be ascertained by referring to Table II, which shows the chemical composition of brands sold in Oregon. The nitrogen combined in the inorganic forms as nitrate of soda and sulfate of ammonia should be present in quantities of about 15 and 20 percent respectively. Both of these forms, we note, have a very high percentage of nitrogen. The inorganic nitrogen of fertilizers is immediately available for plants, while the organic form is changed to the available condition when applied to the soil. Before assimilation by the plants, the nitrogen must be in a soluble or an available state. Nitrate of soda and sulfate of ammonia are readily soluble, while organic nitrogen when worked into the soil is changed by chemical and bacterial action to the available form.

Recent investigations have shown that there is an appreciable difference in the availability of the nitrogen of the various organic fertilizers. Materials having 50 percent or more of their nitrogen in a quickly avail-

able or active condition are dried blood, fish-meal, bone-meal, and tankage. Such materials as wool waste, leather scraps, feathers, etc., have most of their nitrogen in a very unavailable form and consequently should not be used unless acid-treated to render them more available.

Most of the nitrogen of pulverized sheep and cow manure also may be classified as material of low availability. The dried manures, however, are considered important fertilizers on account of the presence of small amounts of nitrogen in the nitrate form together with some available phosphorus and potassium and the value of the manure as humus-supplying material. The different brands of dried manure vary to a marked degree in quality. Some brands are very poor grade due to the presence of excess amounts of sand, straw, and other refuse, while other brands are high grade, being excrement only of domestic animals. The chemical analyses best show the quality of the manures although after some experience the grade may be determined by examination for straw, sand, and other refuse.

The relative agricultural values of the organic and the inorganic nitrogen depend largely upon the nature of the soil. If the soil is low in humus and organic compounds the organic nitrogen will probably be preferable and more profitable; on the other hand if there is sufficient or an abundance of organic matter present, the inorganic form will no doubt give as good or even better returns. The form in which nitrogen exists in a mixed fertilizer may be ascertained from the agent or manufacturer. This information may also be obtained by writing to the Chemistry department of the Oregon Agricultural Experiment Station.

Potash. All the potash guaranteed to be present in the commercial fertilizers sold in Oregon is in a soluble form and readily available to plants immediately after working well into the soil. It is represented by the chemical formula K_2O. The minimum amount actually present in a fertilizer is given on the label so that no difficulty should be experienced in judging the commercial value of any fertilizer from that standpoint. The simples used as a source of potash in mixed fertilizers are muriate of potash, sulfate of potash, and the dried manures.

The potassium of the pulverized manures is not all in the available form. The guaranteed amount stated on the label or tag, however, should be the form soluble in water. Most manures contain between 1.0 and 2.5 percent potassium soluble in water and therefore immediately available. Occasionally a very high grade manure will contain more than 2.5 percent water-soluble potassium, but the inspector's analysis should confirm it before such a guaranteed amount is accepted as correct.

Sulfur. Sulfur is one of the essential elements of plant growth. In some soils of the Northwest it is one of the limiting plant foods since certain soils are abnormally low in available sulfur. As a consequence many of our crops, especially the legumes, respond well to applications of sulfur either in the elemental or the combined form.

Sulfur is applied as a fertilizer either in the elemental form as Flowers of Sulfur or ground sulfur or chemically combined as calcium sulfate, sulfate of potash or sulfate of ammonia. Land-plaster or gypsum, if pure, is calcium sulfate containing water and known chemically as hydrated

calcium sulfate. Superphosphate likewise contains about 60.0 percent of hydrated calcium sulfate in addition to its phosphoric acid. This fact should be taken into consideration when buying phosphorus-containing fertilizers.

Phosphoric acid. To many users of commercial fertilizers this expression, like some others in fertilizer literature, is confusing. By it is meant an oxide of phosphorus, P_2O_5, phosphorus pentoxide. This oxide when dissolved in water produces phosphoric acid, H_3PO_4. Phosphoric acid forms with calcium a series of salts. The neutral tri-calcium phosphate, $Ca_3(PO_4)_2$, is the rock phosphate of the fertilizer trade and the source of the more soluble mono- and di-calcium phosphates that result from treatment of rock phosphate with sulfuric acid. The bone meals are likewise calcium salts of phosphoric acid. Thus neither phosphoric acid nor its anhydride, P_2O_5, are present in fertilizers as such. The phosphorus content of the calcium salts can be expressed conveniently, however, for purposes of comparison, as phosphorus pentoxide, just as the potassium content of K_2SO_4 and KCl for the same purpose, can be, and is, in the fertilizer trade expressed in the form of its oxide, K_2O. Long established custom is followed here in expressing analytical results.

Available phosphoric acid means phosphoric acid that is readily soluble in soil solutions and therefore is in condition for immediate use by growing plants. It is necessary to understand that available phosphoric acid consists of two fractions that differ one from the other in degree of solubility. The larger fraction is readily soluble in water, for which reason it is always referred to as "water-soluble" phosphoric acid. The smaller fraction is less soluble in water but is readily soluble in ammonium citrate of low concentration. Since the solvent effect of ammonium citrate on phosphoric acid under laboratory conditions is believed to be similar to that exerted by soil solutions, *citrate-soluble* phosphoric acid is always rated as available phosphoric acid. This smaller fraction of available phosphoric acid is also referred to in fertilizer literature as *reverted* phosphoric acid because water-soluble phorphoric acid when applied to the soil in part *reverts* to that form.

Insoluble phosphoric acid is that portion of the phosphorus content of fertilizers that is practically insoluble in water or ammonium citrate solution. Under the weathering agencies of the soil it slowly undergoes molecular decomposition yielding corresponding amounts of the forms that are soluble in soil solutions. The commercial value of insoluble phosphoric acid should be much lower than that of the water-soluble and citrate-soluble fractions.

The following simples are phosphorus-containing fertilizers: superphosphate, tankage, bone-meal, fish-meal, and the manures.

Superphosphate. Superphosphate is prepared from insoluble phosphates by treating them with sulfuric acid or by the pyrolytic method. The sulfuric acid treatment produces a mixture of water-soluble compounds of phosphoric acid and corresponding amounts of gypsum whose total phosphoric acid content is therefore less than that of the raw rock. The pyrolytic method produces, by distillation from mixtures of rock phosphate, silica, and coke, pure phosphoric acid which then is used in much the same manner as is sulfuric acid in treating finely ground rock phos-

phate. The resulting product is not only water-soluble but substantially richer in phosphoric acid than the raw rock. At present rock phosphate, which is a mineral deposit of phosphate of lime, is employed almost exclusively for the preparation of superphosphate.

The gypsum, or land-plaster, that forms a part of the mixture resulting from the treatment of mineral phosphate with sulfuric acid is not inert material. It is a valuable source of sulfur for fertilizing purposes. Recent investigations show that sulfur is a very essential element of plant food and particularly beneficial to the legumes. A high grade superphosphate made by sulfuric acid treatment of mineral phosphate should contain at least 16 percent of available phosphoric acid. The mixture will contain in addition about 60 percent of gypsum.

Bone-meal. Bone-meal contains besides the organic nitrogen mentioned above from 25 to 30 percent of phosphoric acid. Most of this phosphoric acid is combined in a manner similar to the mineral rock phosphate, but is considered more available owing to the organic matter that is also present. The presence of the organic or animal matter facilitates decomposition and the phosphoric acid becomes rapidly available for growing plants.

Tankage and fish-meal. In general both tankage and fish-meal are similar to bone-meal except that they contain only approximately one-half as much phosphoric acid. The availability is similar to the phosphoric acid in bone-meal.

Raw rock phosphate. Raw rock phosphate is a naturally occurring mineral and the source from which superphosphate or acid phosphate is chemically prepared. The rock phosphate is insoluble in water and very slowly available. On account of its slow availability it is necessary to use abnormally large amounts to give results comparable to those obtained with superphosphate.

Sheep manure. During the past two years, many complaints have been received relative to the quality of various brands of sheep manure. Samples submitted for examination have shown excessive amounts of sand, soil, or moisture.

The sheep manures are obtained from feeding corrals where they have accumulated over considerable periods of time. Some manures taken from old corrals may be practically worthless. Others may contain excessive amounts of sand, straw, and soil which reduce the quality of the manure. When the manure is removed from the corrals, most of it contains a high percentage of water. Analyses have shown many samples to contain more than thirty-five percent moisture.

In order to judge best the quality of a sheep manure, the chemical analyses on the tag should be carefully noted. The nitrogen content is perhaps the best indication of the quality of the manure. If the nitrogen is below 1.0 percent, a poor grade product, low in organic matter and high in sand or moisture, is indicated. On the other hand, a manure that contains 1.8 percent nitrogen is a very high grade product.

New fertilizer material. In recent years, several new fertilizers have been synthesized and others have been imported into this country from Europe. Not all of these materials have yet been offered on Oregon markets. A brief description of these fertilizers, however, is opportune.

Urea is an organic material containing about 46 percent nitrogen.

Calcium nitrate is a lime-nitrogen containing about 15 percent nitrogen and 28 percent lime.

Leunasaltpeter is ammonium sulfate-nitrate containing 6 percent of nitrate nitrogen and 18 percent of ammonia nitrogen.

Potassium ammonium nitrate contains about 27 percent potash, 7.5 percent nitrate nitrogen, and 7.5 percent ammonia nitrogen.

Synthetic nitrate is similar to the ordinary nitrate of soda and contains about 15 percent nitrogen.

Cyanamid, a domestic product, contains 20 percent or more nitrogen.

Calurea is a combination of Calcium Nitrate and Urea. It contains about 34 percent nitrogen of which one-fourth is in nitrate (inorganic) form and three-fourths in the organic form, Urea.

Nitrate of potash is a mixture of synthetic nitrogen and potash. It contains 12.3 percent nitrogen and 44 percent potash.

Diammon phos is a concentrated nitrogen phosphate that contains 21 percent nitrogen and 53.4 percent phosphoric acid.

Treble superphosphate and *double superphosphate* contain varying amounts of phosphoric acid. The maximum content is 46 percent phosphoric acid.

Nitrophoska. This synthetic fertilizer compound is marketed in several forms. They are designated No. 1, No. 2, No. 3, and No. 4. Nitrophoska No. 1 contains 15 percent nitrogen (1.5 percent in nitrate form and 13.5 percent in ammonia form), 30 percent phosphoric acid, and 15 percent potash (mostly muriate). The numbers differ one from the other in the content of nitrogen, phosphoric acid, and potash.

The high plant food content of these new fertilizer materials is indicative of the trend in modern fertilizer manufacture and usage toward the more concentrated products.

MATERIALS THAT SHOULD NOT BE A PART OF MIXED FERTILIZERS

Ground limestone, hydrated lime, burned lime, gypsum or landplaster, and ground raw rock phosphate should not be used in mixed fertilizers. All of these materials have their places either as soil amendments or as fertilizers, as the case may be, and can be used advantageously at times. Their cost, however, is so much lower than the simples from which the mixed fertilizers are made that when they are added as a component part they should be classed as "filler" to make weight. It is of course understood that the gypsum naturally present in superphosphate will necessarily be present in a mixed fertilizer when superphosphate is a component part of that fertilizer.

The State Fertilizer Law does not require manufacturers to declare on the label or tag the various materials from which mixed fertilizers are compounded, but it does require them to file a statement with the chemist of the Oregon Agricultural Experiment Station showing of what these materials consist. Any person interested may obtain full information regarding the exact material used in a specific mixed fertilizer by

writing to the Chemistry department, Oregon Agricultural Experiment Station. Consumers should insist on being shown the official label at the time of contract and should understand fully the statements regarding the quality of fertilizers purchased. If there is any doubt regarding the quality of the fertilizer as indicated by the statement on the label, explanations may be obtained by writing to the Chemistry department of the Agricultural Experiment Station.

THE RELATIVE COMMERCIAL VALUE PER TON

As previously stated, the commercial value of fertilizers is entirely distinct from the agricultural value; the two have no true relation whatever, and farmers should be warned against judging the producing power of a fertilizer by its selling price.

During the past two years the number of dealers offering fertilizers for sale has increased greatly. There are now on the market several very low grade brands which, although sold in accordance with the provisions of the fertilizer law, do not contain enough available plant food to warrant applying them to the soil. To avoid the purchase of practically worthless fertilizers and low grade material it is important to understand the meaning of the chemical analyses that, according to the law, must be declared on a tag or label attached to each sack.

Consumers of commercial fertilizers may avoid payment of inflated prices or excessive overhead charges by calculating for themselves the approximate commercial value of any brand on the market and comparing these prices with those of other brands produced by the same manufacturer or of brands of another manufacturer. The selling prices of commercial fertilizers are based upon the prevailing commercial values of the plant foods they contain. As fertilizers are sold on the basis of their plant-food content we may arrive at the commercial value of any fertilizer by multiplying the number of pounds per ton of each plant food in the fertilizer by its value per pound and adding the products.

For convenience it is customary to speak of a "unit" of plant food, such as a unit of potash or a unit of nitrogen. This means 20 pounds or one percent of a ton (2,000 lbs.). Thus a unit of nitrogen per ton means 20 pounds of nitrogen per ton; for example, a fertilizer having 6 percent nitrogen contains 6 units of nitrogen in each ton. The actual cost per unit or per pound may be calculated easily in those fertilizers that contain only one plant food. For example nitrate of soda contains 16 percent nitrogen or 16 units per ton. If the selling price is $66.00 per ton each unit would cost $4.12. The approximate price per unit and per pound of the various plant foods has been calculated from quotations of the fertilizer dealers of the state. These have been calculated from the lowest quotation on simples, or the basic fertilizer material from which mixed or complete fertilizers are prepared, and upon these prices the prices of the mixed fertilizer should depend. The price* per pound and per unit of plant foods, nitrogen, phosphoric acid, and potash in car-load lots is as follows:

*Prices quoted January 1, 1929.

TABLE I. PRICES OF PLANT FOODS PER POUND AND PER UNIT

	Price per pound	Price per unit
Nitrogen, N available	$0.200	$4.00
Phosphoric acid, P_2O_5 available	.082	1.64
Phosphoric acid, P_2O_5 unavailable	.036	.72
Potash, K_2O available	.046	.92

Since the above figures show the actual cost per pound and per unit of plant food we can calculate the number of pounds or units of plant food in a mixed fertilizer and estimate the actual cost per ton of that fertilizer. Take for instance a fertilizer composed of inorganic simples and guaranteed to contain the following plant foods:

Nitrogen, N total	4%
Phosphoric acid, P_2O_5 available	10%
Phosphoric acid, P_2O_5 unavailable	2%
Potash K_2O total	4%

Employing the data showing the price per pound and per unit given above we find:

POUND METHOD

4 × 20 =	80, number of pounds of N in a ton.	80 × $0.20 =	$16.00
10 × 20 =	200, number of pounds of P_2O_5 in a ton.	200 × .082 =	16.40
2 × 20 =	40, number of pounds of P_2O_5 in a ton.	40 × .036 =	1.44
4 × 20 =	80, number of pounds of K_2O in a ton.	80 × .046 =	3.68
	Total cost or commercial value per ton		$37.52

UNIT METHOD

Nitrogen	4 × $4.00 =	$16.00
Phosphoric acid, available	10 × 1.64 =	16.40
Phosphoric acid, unavailable	2 × .72 =	1.44
Potash	4 × .92 =	3.68
Total cost or commercial value per ton		$37.52

A few words of explanation will make this clear. As given, a fertilizer that contains 4 percent nitrogen has the equivalent of 4 pounds per hundred, and as there are 2,000 pounds in a ton, it would contain 20 times this amount, or 80 pounds. At $0.20 a pound this would cost $16.00. In like manner the cost of the phosphoric acid, available and unavailable, and of the potash may be calculated. The sum of these values will therefore give the cost per ton of the fertilizer in question.

By using the unit system, the cost per ton may be more easily calculated. It is only necessary to multiply the price per unit by the percentage of plant food and then add the products as indicated above. The calculation will be more easily understood when we consider that the unit amount, 20 pounds, is 1/100 of a ton, and that the percentage of plant food represents units per ton, so that it is only necessary to multiply the percentage of plant food in a fertilizer by the price per unit, quoted in Table I, to obtain the value of that fertilizer per ton. The sum total, therefore, of the cost of different plant foods contained in the mixed fertilizer gives the price of the fertilizer.

The commercial value obtained in the manner outlined above is not the actual selling price, but the approximate cost of the simples contained in mixed fertilizers. It will be understood that the manufacturer must charge an excess which is about $12.00 per ton to cover the cost

of mixing the fertilizer, handling, agents, and other overhead charges. Consequently, a fair price for a mixed commercial fertilizer should be not more than $12.00 above the amount found by calculation. In other words, the fertilizer exemplified above should cost not more than $37.52 + $12.00, or $49.52 a ton at the manufacturing plant in car-load lots.

If the farmer will make comparison of different brands of fertilizers, in the manner suggested above, he will be enabled to obtain the best product at the lowest prices. If he has time to spare, it would be even more profitable to purchase the necessary simples and prepare his own mixed fertilizers. For instance, if he desires to fertilize a piece of land with nitrogen and phosphoric acid but not with potash it will be necessary then to purchase only those materials or simples containing the plant foods desired; namely, superphosphate (for phosphoric acid) and nitrate of soda (for nitrogen); or if an organic combination is more suitable for the particular soil to be fertilized, he may purchase bone-meal (for nitrogen and phosphoric acid) and blood-meal (for nitrogen) to supply the necessary plant foods. Any other combination containing one or all of the important plant foods may be selected from the table showing the chemical composition of commercial fertilizers. This procedure and the advantages derived therefrom will be more fully appreciated when the calculations are made of the actual cost of the fertilizer ingredients and the quoted selling price of mixed fertilizers.

GRADES OF MIXED COMMERCIAL FERTILIZERS

If it is found advantageous to invest in a mixed or complete fertilizer, the highest grade materials should be purchased. It must be remembered that most low grade fertilizers contain sand or other inert filler upon which freight must be paid and time wasted in hauling from depot and applying to the soil. It is somewhat difficult to make an exact statement regarding a satisfactory division between high, medium, and low grade products. In general, however, it is understood that a brand containing a sum total of available nitrogen, phosphoric acid, and potash of 15 percent or above may be considered high grade; if between 12 percent and 15 percent it may be considered medium grade; and if under 12 percent it is low grade and should not be purchased, since it contains too high a percentage of inert filler. As an example, the following fertilizer may be classified as high grade:

Nitrogen, total	4%
Phosphoric acid, available	10%
Potash, total	4%
	18%

A total of 18 percent of plant food substance is indicative of a high grade fertilizer. The example below is one of a low grade fertilizer—it contains but 11 percent of active ingredients. To repeat, the modern trend in fertilizer manufacture and use is toward mixtures of even higher concentration of the plant food elements.

Nitrogen, total	2%
Phosphoric acid, available	7%
Potash	2%
	11%

Very often all grades of fertilizers are carried by manufacturers and the prices for the lower and the medium grades appear cheaper, but if their cost is estimated as suggested above it will be found that the cost for each pound or unit of plant food is higher than in the high-grade fertilizer. The agent or manufacturer may offer for sale both high and low grade fertilizers on the assumption that many buyers are attracted by and will purchase the apparently cheaper stuff. The price, however, is in part paid for inert filler. Furthermore, the charge of about $12.00 mentioned above for overhead and other expenses is equal for low and high grades. Since this overhead cost is proportioned on the basis of the plant foods contained in a fertilizer, we can readily see that it costs more per unit of plant food to place on the market a low-grade than a high-grade fertilizer. For example, a low-grade fertilizer containing only 10 units of plant food would cost $1.20 for each unit, while a high-grade fertilizer of 16 units would cost only $0.75 per unit. Furthermore, it is conceded by manufacturers that the purchase of high-grade fertilizers saves ⅜ or more on freight cost; that is, freight is charged on five tons for high grade instead of eight tons when the fertilizer is low grade. The additional tonnage is inert filler used in the low-grade material. Likewise, it means five trips to the warehouse for a high-grade fertilizer and eight trips for a low-grade to obtain equal amounts of plant food content; also only five bags are necessary for the high-grade while eight are necessary for the low-grade type. Thus the actual cost per unit of active ingredients of a mixed low-grade fertilizer is probably almost double the cost of the high-grade product.

RESULTS OF CHEMICAL ANALYSES

In Table II on pages 15 ff. are given detailed results of the chemical analyses of all brands of fertilizers sold in Oregon during the biennium 1927-1928. The different columns show the guaranteed amount 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 manufacturer, are given the results of chemical analyses made by the Chemistry department of the Oregon Agricultural Experiment Station on samples collected from different sources. The arrangement facilitates comparison of the guaranteed amount and the actual percentage of ingredients found by analysis.

In order to ascertain whether a certain brand is high, medium, or low grade, one should add together the percentages indicated in the columns marked "Total Nitrogen," "Total Phosphoric Acid," and "Water Soluble Potash," and compare the results with statements made on page 13. Comparative commercial values can be found by the method of calculation illustrated in Table I.

TABLE II. GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON DURING 1927-1928.

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen				Phosphoric acid			Potash	Sources of materials used in mixed fertilizers.
				Total N	Ammonia N	Organic N	Nitrate N	Total P_2O_5	Available P_2O_5	Insoluble P_2O_5	Water soluble K_2O	
				%	%	%	%	%	%	%	%	
Nitrate of Soda	Balfour Guthrie Co.	Portland. Ore.	Guar.	14.0	.....	.....	14.0	.....	.....	.....	.....	
			Found	14.8	.....	.....	14.8	.....	.....	.....	.....	
Nitrate of Soda	Swift & Co.	Portland. Ore.	Guar.	15.0	.....	.....	15.0	.....	.....	.....	.....	
			Found	15.2	.....	.....	15.2	.....	.....	.....	.....	
Nitrate of Soda	Marine Products Co.	Seattle. Wash.	Guar.	16.0	.....	.....	16.0	.....	.....	.....	.....	
			Found	15.1	.....	.....	15.1	.....	.....	.....	.....	
Ammonium Sulfate	Swift & Co.	Portland. Ore.	Guar.	20.6	20.6	.....	.....	.....	.....	.....	.....	
			Found	20.7	20.7	.....	.....	.....	.....	.....	.....	
Ammonium Sulfate	Ford Motor Co.	Detroit. Mich.	Guar.	20.8	20.8	.....	.....	.....	.....	.....	.....	
			Found	20.8	20.8	.....	.....	.....	.....	.....	.....	
Arcadian Ammonium Sulfate	The Barrett Co.	New York, N. Y.	Guar.	20.75	20.75	.....	.....	.....	.....	.....	.....	
			Found	20.8	20.8	.....	.....	.....	.....	.....	.....	
Sulfate of Ammonium Ordinary	The Barrett Co.	New York. N. Y.	Guar.	20.5	20.5	.....	.....	.....	.....	.....	.....	
			Found	20.7	20.7	.....	.....	.....	.....	.....	.....	
Merino Brand Tankage	Feeds & Fertilizers. Inc.	Portland. Ore.	Guar.	4.1	.....	4.1	.....	8.0	4.0	4.0	.....	
			Found	5.2	.....	5.2	.....	5.8	2.9	2.9	.....	
Gill's Tankage	Gill Bros. Seed Co.	Portland. Ore.	Guar.	5.76	.....	.....	.....	7.0	.....	.....	.....	
			Found	5.6	.....	.....	.....	5.0	.....	.....	.....	
Tankage	Oregon Grain Co.	Portland. Ore.	Guar.	4.0	.....	4.0	.....	8.0	3.5	4.5	.....	
			Found	4.4	.....	4.4	.....	9.3	4.7	4.6	.....	

TABLE II. (Continued.) GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON DURING 1927-1928.

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen				Phosphoric acid			Potash	Sources of materials used in mixed fertilizers.
				Total N	Ammonia N	Organic N	Nitrate N	Total P_2O_5	Available P_2O_5	Insoluble P_2O_5	Water soluble K_2O	
				%	%	%	%	%	%	%	%	
Merino Brand Bone Meal	Feeds & Fertilizers, Inc.	Portland, Ore.	Guar.	2.0	.....	2.0	.....	21.0	21.0	.....	.....	
			Found	0.9	.....	0.9	.....	31.1	15.6	15.5	.....	
Bone Meal	The Chas. H. Lilly Co.	Seattle, Wash.	Guar.	1.0	.....	1.0	.....	30.0	23.1	6.9	.....	
			Found	0.8	.....	0.8	.....	35.0	17.5	17.5	.....	
Bone Meal	Magnolia Fertilizer Co.	Seattle, Wash.	Guar.	1.0	.....	1.0	.....	30.0	20.0	10.0	.....	
			Found	1.0	.....	1.0	.....	35.3	17.7	17.6	.....	
Red Steer Bone Meal	Swift & Co.	Portland, Ore.	Guar.	2.1	.....	2.1	.....	24.0	12.0	12.0	.....	
			Found	2.2	.....	2.2	.....	31.2	15.6	15.6	.....	
Bone Meal	Mailliard & Schmiedell	Portland, Ore.	Guar.	0.98	.....	0.98	.....	31.1	13.4	17.7	.....	
			Found	0.80	.....	0.80	.....	34.4	17.2	17.2	.....	
Bone Meal	Marine Products Co.	Seattle, Wash.	Guar.	1.0	.....	.....	.....	28.0	14.0	14.0	.....	
			Found	0.7	.....	.....	.....	34.7	17.4	17.3	.....	
Sheep Guano	The Chas. H. Lilly Co.	Seattle, Wash.	Guar.	1.25	.....	.....	.....	1.0	.....	.....	1.04	
			Found	1.26	.....	.....	.....	1.2	.....	.....	1.05	
Merino Brand Sheep Manure	Feeds & Fertilizers, Inc.	Portland, Ore.	Guar.	1.5	.....	.....	.....	1.0	.....	.....	1.5	
			Found	1.3	.....	.....	.....	1.3	.....	.....	1.7	
Sheep Guano	Magnolia Fertilizer Co.	Seattle, Wash.	Guar.	1.5	.....	.....	.....	1.5	.....	.....	1.5	
			Found	1.6	.....	.....	.....	1.3	.....	.....	3.0	

Sheep Guano	Swift & Co.	North Portland, Ore.	Guar.	1.6				0.8			1.5
			Found	1.7				1.1			1.6
Sheep Guano	Portland Seed Co.	Portland, Ore.	Guar.	1.37				1.27			1.81
			Found	1.5				1.3			0.9
H. Q. Sheep Manure	Routledge Seed & Floral Co.	Portland, Ore.	Guar.	1.65				1.25			3.0
			Found	1.3				.70			2.9
Groz-it Sheep Manure	Pacific Manure & Fertilizer Co.	San Francisco, Cal.	Guar.	1.65				1.25			3.0
			Found	1.30				.70			2.9
Sheep Manure	Gill Bros. Seed Co.	Portland. Ore.	Guar.	1.64				1.25			2.0
			Found	1.44				1.04			1.8
Hermiston Sheep Manure	Hermiston Alfalfa Co.	Hermiston, Ore.	Guar.	1.30				1.00			1.5
			Found	1.78				1.18			2.97
Red Rooster Chicken Manure	Mailliard & Schmiedell	Portland. Ore.	Guar.	2.66				3.02			.78
			Found	2.5				2.6			1.00
Fish Fertilizer	Gill Bros. Seed Co.	Portland, Ore.	Guar.	8.24		8.24		6.0			
			Found	6.9		6.9		4.7			
Merino Brand Fish Fertilizer	Feeds & Fertilizers, Inc.	Portland, Ore.	Guar.	6.5		6.5		8.0	4.0	4.0	
			Found	6.9		6.9		7.5	3.8	3.7	
"Mococo" Superphosphate	Mountain Copper Co.	San Francisco, Cal.	Guar.					18.0	17.5	0.5	
			Found					19.2	19.2		
Superphosphate	Swift & Co.	Portland, Ore.	Guar.					18.0	17.5	0.5	
			Found					24.1	24.1		
Superphosphate	The Chas. H. Lilly Co.	Seattle, Wash.	Guar.					18.0	17.5	0.5	
			Found					19.3	19.3		
Superphosphate	Portland Seed Co.	Portland, Ore.	Guar.					18.0	17.5	0.5	
			Found					18.4	17.8	0.6	

TABLE II. (Continued.) GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON DURING 1927-1928.

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen: Total N	Nitrogen: Ammonia N	Nitrogen: Organic N	Nitrogen: Nitrate N	Phosphoric acid: Total P_2O_5	Phosphoric acid: Available P_2O_5	Phosphoric acid: Insoluble P_2O_5	Potash: Water soluble K_2O	Sources of materials used in mixed fertilizers.
				%	%	%	%	%	%	%	%	
Cyanamid	American Cyanamid Sales Co.	Azusa. Cal.	Guar.	21.0	.....	21.0	.....	.....	.....	.....	.....	
			Found	**20.6**	.....	**20.6**	.....	.....	.....	.....	.....	
Ammo-Phos 20-20 Grade	American Cyanamid Sales Co.	Azusa, Cal.	Guar.	16.0	16.0	.....	.....	20.0	20.0	.....	.....	
			Found	**17.1**	**17.1**	.....	.....	**24.0**	**24.0**	.....	.....	
Ammo-Phos 13-48 Grade	American Cyanamid Sales Co.	Azusa, Cal.	Guar.	10.25	10.25	.....	.....	48.0	47.0	1.0	.....	
			Found	.....	.....	.....	.....	.....	.....	.....	.....	
Muriate of Potash	Balfour Guthrie Co.	Portland, Ore.	Guar.	.....	.....	.....	.....	.....	.....	.....	50.0	
			Found	.....	.....	.....	.....	.....	.....	.....	**49.5**	
Muriate of Potash	Marine Products Co.	Seattle. Wash.	Guar.	.....	.....	.....	.....	.....	.....	.....	50.0	
			Found	.....	.....	.....	.....	.....	.....	.....	**51.1**	
Muriate of Potash	Swift & Co.	Portland, Ore.	Guar.	.....	.....	.....	.....	.....	.....	.....	50.0	
			Found	.....	.....	.....	.....	.....	.....	.....	**50.4**	
Sulfate of Potash	Balfour Guthrie Co.	Portland, Ore.	Guar.	.....	.....	.....	.....	.....	.....	.....	48.0	
			Found	.....	.....	.....	.....	.....	.....	.....	**49.3**	
Merino Brand Berry Special	Feeds & Fertilizers, Inc.	Portland. Ore.	Guar.	2.0	.....	.....	.....	10.0	10.0	.....	2.0	Nitrate of soda, tankage, superphosphate, steam bone, muriate of potash, sheep manure.
			Found	**2.5**	.....	.....	.....	**10.3**	.....	.....	**1.9**	
Merino Brand Harris Special	Feeds & Fertilizers, Inc.	Portland. Ore.	Guar.	1.0	.....	0.5	0.5	8.0	8.0	.....	10.0	Nitrate of soda, superphosphate, muriate of potash, sheep manure.
			Found	**1.2**	.....	**.5**	**.7**	**6.9**	.....	.....	**8.6**	

Merino Brand 3.3-7-6	Feeds & Fertilizers. Inc.	Portland, Ore.	Guar.	3.3	.....	.....	.....	7.0	7.0	.....	6.0	Sulfate of ammonia, tankage, superphosphate, muriate of potash, sheep manure.
			Found	2.8	.....	.....	.....	8.4	.....	.....	5.07	
Gill's Garden Grow	Gill Bros. Seed Co.	Portland. Ore.	Guar.	3.3	.....	.....	.....	10.0	.....	.....	2.3	
			Found	3.5	.....	.....	.....	9.8	.....	.....	7.8	
Morecrop "K"	The Chas. H. Lilly Co.	Seattle, Wash.	Guar.	3.0	.....	.....	.....	10.0	9.2	0.8	7.0	Superphosphate, cyanamid, sheep guano, tankage. sulfate of ammonia, muriate of potash. sulfate of potash, steam bone flour.
			Found	3.2	.....	.....	.....	9.9	7.0	2.9	6.1	
Morecrop "B"	The Chas. H. Lilly Co.	Seattle, Wash.	Guar.	2.0	.....	.....	.....	10.0	9.5	0.5	2.0	Sulfate of ammonia, sheep guano, superphosphate, cyanamid, steam bone flour, muriate of potash, tankage.
			Found	2.1	.....	.....	.....	11.0	7.4	3.6	2.7	
Morecrop "L"	The Chas. H. Lilly Co.	Seattle, Wash.	Guar.	5.0	.....	.....	.....	6.0	5.3	0.7	8.0	Sheep guano, superphosphate cyanamid, tankage, sulfate of ammonia, muriate of potash, sulfate of potash, steam bone, fish-meal.
			Found	5.3	4.6	.7	.....	6.4	4.1	2.3	8.0	
Lawn Morecrop	The Chas. H. Lilly Co.	Seattle. Wash.	Guar.	5.0	.....	.....	.....	1.0	.....	.....	1.0	Sulfate of ammonia, sheep guano, muriate of potash, superphosphate.
			Found	6.1	.....	.....	.....	1.3	.....	.....	1.3	
Pep Brand "C"	Marine Products Co.	Seattle, Wash.	Guar.	6.0	.....	.....	.....	10.0	.....	.....	4.0	Leunasaltpeter, bone, tankage, fish or whale meat, muriate of potash.
			Found	4.1	.....	.....	.....	16.9	.....	.....	.....	
Pep Brand "I"	Marine Products Co.	Seattle. Wash.	Guar.	1.0	.....	.....	.....	8.0	.....	.....	10.0	Tankage. superphosphate, bone, muriate of potash.
			Found	1.3	.....	.....	.....	8.2	.....	.....	10.2	
Pep Brand "U"	Marine Products Co.	Seattle, Wash.	Guar.	2.0	.....	.....	.....	10.0	.....	.....	4.0	Blood, bone, fish, tankage, sheep manure, superphosphate, muriate of potash.
			Found	1.9	.....	.....	.....	10.6	.....	.....	4.1	
Pep Brand "E"	Marine Products Co.	Seattle. Wash.	Guar.	3.0	.....	.....	.....	8.0	8.0	.....	6.0	Leunasaltpeter, blood, bone, tankage, fish, superphosphate, sheep manure, muriate of potash.
			Found	2.5	.....	.....	.....	12.5	.....	.....	6.3	

TABLE II. (Continued.) GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON DURING 1927-1928.

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen				Phosphoric acid			Potash	Sources of materials used in mixed fertilizers.
				Total N	Ammonia N	Organic N	Nitrate N	Total P_2O_5	Available P_2O_5	Insoluble P_2O_5	Water soluble K_2O	
				%	%	%	%	%	%	%	%	
Magnolia 2-10-2	Magnolia Fertilizer Co.	Seattle. Wash.	Guar	2.0	.25	1.50	.25	10.0	7.0	3.0	2.0	Cyanamid, nitrate of soda, sulfate of ammonia, leuna-saltpeter, tankage, sheep guano, superphosphate, muriate of potash.
			Found	2.4	.28	1.73	.39	11.9	7.2	4.7	2.6	
Magnolia 5-6-8	Magnolia Fertilizer Co.	Seattle. Wash.	Guar.	5.0	2.00	2.25	.75	6.0	4.0	2.0	8.0	Cyananid nitrate of soda, sulfate of ammonia. leuna saltpeter. tankage, bone, superphosphate. muriate of potash.
			Found	5.2	2.25	1.91	1.04	6.7	3.7	3.0	7.9	
"Oregon" Vegetable & Berry	Oregon Grain Co.	Portland. Ore.	Guar.	3.0	.....	1.2	1.8	8.0	6.4	1.6	6.0	Blood meal. fish meal. tankage, nitrate. guano, superphosphate. muriate of potash.
			Found	3.5	.....	2.0	1.5	8.9	7.4	1.5	6.6	
"Oregon" Fruit & Vegetable	Oregon Grain Co.	Portland. Ore.	Guar.	6.0	.....	2.4	3.6	10.0	7.9	2.1	4.0	Blood-meal, fish-meal. tankage. nitrate, superphosphate. muriate of potash.
			Found	5.2	.....	2.6	2.6	10.1	7.9	2.2	3.6	
"Oregon" Lawn Dressing	Oregon Grain Co.	Portland, Ore.	Guar.	4.0	.....	4.0	.....	7.0	3.6	3.4	2.0	Blood-meal, fish-meal. bone-meal. tankage, superphosphate. muriate of potash.
			Found	4.1	.....	4.1	.....	7.0	4.5	2.5	3.4	
Plantabbs	Plant Products Co.	Baltimore, Md.	Guar.	11.0	.....	.....	.....	17.0	15.0	.....	20.0	Ammonium phosphate, potassium nitrate.
			Found	.....	.....	.....	.....	.....	.....	.....	.....	
Diamond A—General Vegetable Fertilizer	Portland Seed Co.	Portland, Ore.	Guar.	2.0	1.33	0.67	.....	10.7	10.0	0.7	2.0	Sulfate of ammonia, superphosphate, muriate of potash, sheep guano.
			Found	2.3	1.4	0.9	.....	10.9	10.2	0.7	2.1	

Diamond B—Heavy Cropper Fertilizer	Portland Seed Co.	Portland, Ore.	Guar.	3.0	2.5	0.5	.....	7.7	7.0	0.7	10.0	Sulfate of ammonia, superphosphate, muriate of potash, sheep guano.
			Found	3.3	2.7	0.6	.....	7.9	6.9	1.0	10.0	
Diamond Fruit & Berry	Portland Seed Co.	Portland, Ore.	Guar.	4.0	2.67	1.33	.....	6.5	6.0	0.5	8.0	Sulfate of ammonia, superphosphate, muriate of potash, sheep guano.
			Found	3.9	3.5	0.4	.....	7.4	6.1	1.4	8.4	
Diamond Lawn & Garden Grower	Portland Seed Co.	Portland, Ore.	Guar.	4.0	2.67	1.33	.....	7.4	7.0	0.4	3.0	Sulfate of ammonia, superphosphate, muriate of potash, sheep guano.
			Found	4.3	3.5	0.8	.....	7.3	6.4	0.9	2.8	
Q. A. Marvel Fertilizer	Routledge Seed & Floral Co.	Portland, Ore.	Guar.	6.0	.....	.....	.....	9.0	8.0	1.0	5.0	
			Found	5.8	.....	.....	.....	10.4	7.1	3.3	5.3	
Orchard Dressing	Swift & Co.	North Portland, Ore.	Guar.	.....	.....	.....	.....	.....	.....	.....	.....	
			Found	8.19	.....	.....	.....	12.3	.....	.....	.....	
Swift's Lawn and Garden	Swift & Co.	North Portland, Ore.	Guar.	4.9	2.5	2.4	.....	10.0	10.0	.....	4.0	Sulfate of ammonia, superphosphate, muriate of potash.
			Found	4.3	3.0	1.3	.....	13.1	10.5	.....	4.63	
Tankage No. 1	Swift & Co.	North Portland, Ore.	Guar.	4.9	.....	4.9	.....	17.3	12.0	5.3	.....	Tankage, superphosphate, steam bone, blood.
			Found	5.1	.....	5.1	.....	14.4	.....	.....	.....	
Tankage No. 5	Swift & Co.	North Portland, Ore.	Guar.	4.1	.....	4.1	.....	14.7	8.0	6.7	.....	Tankage, superphosphate.
			Found	4.0	.....	4.0	.....	13.4	.....	.....	.....	
Red Steer Fish Fertilizer	Swift & Co.	North Portland, Ore.	Guar.	6.5	.....	6.5	.....	16.0	8.0	8.0	.....	Salmon meal, steam bone.
			Found	6.5	.....	6.5	.....	19.0	9.5	9.5	.....	
Red Steer "B"	Swift & Co.	North Portland, Ore.	Guar.	1.6	1.2	0.4	.....	13.0	12.0	1.0	3.0	Sulfate of ammonia, tankage, superphosphate, muriate of potash.
			Found	1.9	1.4	0.5	.....	13.2	12.1	1.1	5.4	
Red Steer "C"	Swift & Co.	North Portland, Ore.	Guar.	2.5	.....	0.6	1.9	10.6	10.0	0.6	4.0	Nitrate of soda, tankage, superphosphate, muriate of potash.
			Found	2.7	.....	0.7	2.0	11.6	9.6	2.0	3.9	
Red Steer "D"	Swift & Co.	North Portland, Ore.	Guar.	3.3	2.5	0.8	.....	7.7	7.0	0.7	6.0	Sulfate of ammonia, tankage, superphosphate, muriate of potash.
			Found	3.3	.....	0.7	2.6	8.6	7.1	1.5	8.5	
Red Steer "E"	Swift & Co.	North Portland, Ore.	Guar.	2.5	.....	0.6	1.9	10.6	10.0	0.6	10.0	Nitrate of soda, tankage, superphosphate, muriate of potash.
			Found	2.5	.....	0.5	2.0	11.9	9.7	2.2	8.8	

TABLE II. (Continued.) GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON DURING 1927-1928.

Name or brand	Manufacturer	Address	Guaranteed and found	Nitrogen: Total N	Nitrogen: Ammonia N	Nitrogen: Organic N	Nitrogen: Nitrate N	Phosphoric acid: Total P_2O_5	Phosphoric acid: Available P_2O_5	Phosphoric acid: Insoluble P_2O_5	Potash: Water soluble K_2O	Sources of materials used in mixed fertilizers.
				%	%	%	%	%	%	%	%	
Red Steer "Berry"	Swift & Co.	North Portland. Ore.	Guar.	4.9	3.7	1.2	.....	7.8	7.0	0.8	8.0	Sulfate of ammonia, tankage, superphosphate, muriate of potash.
			Found	4.1	1.2	1.9	.....	10.8	7.4	3.4	7.4	
Red Steer "Lettuce"	Swift & Co.	North Portland. Ore.	Guar.	2.5	1.0	1.5	.....	10.6	10.0	0.6	7.0	Sulfate of ammonia, tankage, superphosphate, muriate of potash.
			Found	2.6	2.1	0.5	.....	11.1	10.7	0.4	6.9	
Red Steer "Hop Dressing"	Swift & Co.	North Portland, Ore.	Guar.	9.0	8.2	0.8	.....	14.9	9.0	5.9	.....	Sulfate of ammonia, steam bone, superphosphate.
			Found	9.3	7.4	0.9	.....	15.2	9.9	5.3	.....	
Red Steer "Rose Lawn"	Swift & Co.	North Portland, Ore.	Guar.	4.9	3.4	1.5	.....	20.0	10.1	9.9	.....	Bone-meal, sulfate of ammonia.
			Found	4.5	3.1	1.4	.....	23.4	11.7	11.7	.....	
Red Steer Onion Fertilizer	Swift & Co.	North Portland, Ore.	Guar.	2.5	2.3	0.2	.....	6.5	5.0	1.5	26.0	Sulfate of ammonia, steam bone, muriate of potash.
			Found	3.1	2.2	0.9	.....	8.3	4.2	4.1	24.1	
Blood Meal	Swift & Co.	North Portland, Ore.	Guar.	13.2	.....	.....	.....	.....	.....	.....	.....	Dried blood.
			Found	13.0	.....	.....	.....	.....	.....	.....	.....	
Black Gas Sulfur	Western Sulfur Co.	San Francisco, Cal.	Guar.	Sulfur	.....	.....	90.0	.....	.....	.....	.....	
			Found	Sulfur	.....	.....	92.0	.....	.....	.....	.....	
Bac-Sul	Western Sulfur Co.	San Francisco, Cal.	Guar.	Sulfur	.....	.....	95.0	.....	.....	.....	.....	
			Found	Sulfur	.....	.....	94.0	.....	.....	.....	.....	
Stim-U-plant	Earps-Thomas Cultures Corp.	Long Island, N. Y.	Guar.	11.0	.....	.....	.....	12.0	.....	.....	15.0	Ammo-phos. muriate of potash.
			Found	.....	.....	.....	.....	.....	.....	.....	.....	

OREGON AGRICULTURAL LIME LAW

A separate law was enacted by the State Legislature in 1917 to regulate the sale of agricultural lime. This is called the State Agricultural Lime Law. Agricultural lime referred to in this law includes gypsum or land-plaster, ground limestone, oxide of lime, and hydrated lime.

Gypsum or land-plaster. Gypsum or land-plaster is sulfate of lime containing water of combination and is represented chemically by the formula $CaSO_4.2H_2O$. Sulfur is the most important plant food or fertilizing element in land-plaster, and in the light of recent investigations its importance as a limiting plant food is more generally recognized. The use of land-plaster in various parts of Oregon has been found very profitable, and noteworthy increases in crop production have been obtained, especially with the legumes. If it is found desirable and profitable to use gypsum, it may be purchased in a comparatively pure form at a very reasonable price.

There are on the market several brands of gypsum or land-plaster, and for the benefit of those interested in this material a table is given indicating the various brands sold in Oregon, together with the average chemical analysis of numerous samples collected from different sources during the past year.

Table III shows the actual amount of gypsum, $CaSO_4.2H_2O$, guaranteed by the manufacturer and found by official analysis, in each sample. The last column shows the amount of sulfur present calculated from the hydrated calcium sulfate $CaSO_4.2H_2O$ content.

TABLE III. GUARANTEED AND FOUND COMPOSITION OF DIFFERENT BRANDS OF LAND-PLASTER SOLD IN OREGON

Brand	Manufacturer	Address	Hydrated calcium sulfate Guaranteed	Hydrated calcium sulfate Found	Sulfur content
			%	%	%
Alabastite (Jumbo)	Jumbo Plaster and Cement Co.	Sigurd, Utah	99.5	96.6	17.9
Bumper Harvest	Standard Gypsum Co.	San Francisco, Cal.	93.0	94.6	17.5
Empire	Pacific Portland Cement Co.	San Francisco, Cal.	92.0	93.5	17.3
Nephi	Nephi Plaster and Mfg. Co.	Salt Lake City, Utah	92.0	93.5	17.3
Ben Franklin	United States Gypsum Co.	Chicago, Ill.	90.0	94.2	17.4

From Table III it will be observed that there is little variation in the calcium sulfate content of the various brands of gypsum sold in Oregon. All brands will probably be equally efficient provided equal amounts of $CaSO_4.2H_2O$ are applied to the soil. This means that a brand containing 90 percent gypsum must be applied in larger quantities proportionately than the brands containing 98 percent gypsum. Consequently, since $CaSO_4.2H_2O$ is the active ingredient, the selling price should be in proportion to the amount of that compound present. Thus a brand containing only 80 percent $CaSO_4.2H_2O$ should be proportionally cheaper than a brand containing 90 percent $CaSO_4.2H_2O$. In other words, if the 90 percent product costs $14.00 a ton the 80 percent material should cost only $12.50 a ton. The materials of which the inert

matter is composed should not be considered of any value from a land-plaster standpoint. On the other hand, they are harmless.

Limestone and hydrated lime. The use of limestone and hydrated lime for correcting soil acidity is quite generally known. Most of the soils of Western Oregon are more or less acid, and applications of limestone may be advantageously made. It has been found that some soils, although distinctly acid according to results obtained by our laboratory methods, do not respond to lime treatment. Any soil, however, that responds to lime treatment should receive applications of limestone or hydrated lime once in three or four years.

Most of the ground limestone used by farmers throughout the state is obtained from the State Lime Plant. During the past few years, however, several firms have taken out a permit to sell either limestone or hydrated lime. The names of the manufacturer and the guaranteed and found composition of their products are given in Table IV.

From the analyses presented in Table IV the comparative commercial value and quality of the different brands may be seen. The last column gives the neutralizing value calculated from the analyses and expressed in terms of calcium carbonate. The quality of the material and its value for correcting soil acidity or sourness is proportional to the neutralizing values stated. The cost, therefore, of these different brands should likewise be in proportion to their neutralizing value.

TABLE IV. GUARANTEED AND FOUND COMPOSITION OF DIFFERENT BRANDS OF LIME SOLD IN OREGON

Brand	Manufacturer	Address	Guaranteed and found.	Calcium carbonate.	Calcium hydrate.	Magnesium carbonate.	Neutralizing values as calcium carbonate.
				%	%	%	%
Limestone	Balfour Guthrie & Co.	Portland, Ore.	Guar.	90.0	.....	.....	90.0
			Found	85.8	.....	.....	85.8
Hydrated Lime	Idaho Lime Co.	Portland, Ore.	Guar.	.....	.....	.....	.....
			Found	.....	57.2	.....	124.5
Hydrated Lime	International Lime Co.	Sumas, Wash.	Guar.	3.2	86.8	.....	110.0
			Found	.....	.....	.....	.....
Agstone	Oregon-Idaho Lime Co.	Portland, Ore.	Guar.	55.4	.....	43.6	99.0
			Found	54.7	.....	40.5	106.0
Hydrated Lime	Orcas Lime Co.	Seattle, Wash.	Guar.	69.0	26.0	.....	103.0
			Found	70.2	26.3	.....	106.8
Hydrated Lime	Pacific Lime Co.		Guar.	.....	.....	.....	.....
			Found	.....	69.2	.....	128.0
Limestone	Pacific Portland Cement Co.	San Francisco, Cal.	Guar.	95.0	.....	.....	95.0
			Found	96.4	.....	.....	96.4
Fertiline	Spaulding Building Material Depot	Portland, Ore.	Guar.	.....	.....	.....	112.0
			Found	60.9	42.5	.....	128.3
Dolomite	Washington Brick Lime and Sewer Pipe Co.	Portland, Ore.	Guar.	.....	.....	.....	97.0
			Found	63.0	.....	40.5	103.5