PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF AGRICULTURE
(SOIL AND CROP DIVISION)

FERTILIZERS

BULLETIN No. 87

PRINTED BY
AUTHORITY OF THE LEGISLATIVE ASSEMBLY.

VICTORIA, B.C.:
Printed by WILLIAM H. CULLIN, Printer to the King's Most Excellent Majesty.
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DEPARTMENT OF AGRICULTURE,

VICTORIA, B.C., March 31st, 1921.

To His Honour WALTER CAMERON NICHOL,

Lieutenant-Governor of the Province of British Columbia.

MAY IT PLEASE YOUR HONOUR:

I have the honour to submit herewith for your consideration Bulletin No. 87, entitled "Fertilizers," which has been prepared by W. Newton, Chief Soil and Crop Instructor, under the direction of Dr. D. Warnock, Deputy Minister of Agriculture.

I have the honour to be,

Sir,

Your obedient servant,

E. D. BARROW,

Minister of Agriculture.

DEPARTMENT OF AGRICULTURE,

VICTORIA, B.C., March 31st, 1921.

Hon. E. D. Barrow, M.L.A.,

Minister of Agriculture, Victoria, B.C.

SIR,—I have the honour to submit herewith for your approval Bulletin No. 87, entitled "Fertilizers," which has been prepared by W. Newton, Chief Soil and Crop Instructor, of the Live Stock Branch of this Department.

I have the honour to be,

Sir,

Your obedient servant,

DAVID WARNOCK, O.B.E.,

Deputy Minister of Agriculture.

PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE
(LIVE STOCK BRANCH).

HON. E. D. BARROW, M.L.A.,
Minister of Agriculture.

DR. D. WARNOCK, O.B.E.,
Deputy Minister of Agriculture.

W. T. McDONALD, B.S.A., M.S.A.,
Live Stock Commissioner.

S. A. K. WHITE, V.S.,
Veterinary Inspector.

WM. NEWTON, B.S.A., M.Sc.,
Chief Soil and Crop Instructor.

J. R. TERRY,
Chief Poultry Instructor.

B. R. ILSLEY, V.S.,
Veterinary Inspector.

C. TICE, B.S.A.,
Soil and Crop Instructor.

GEO. C. HAY, B.S.A.,
District Agriculturist, Kamloops.

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Chief Veterinary Inspector.

W. W. ALTON, V.S.,
Veterinary Inspector.

D. B. McKAY, B.S.,
Veterinary Inspector.

W. T. BROOKES, V.S.,
Veterinary Inspector.

J. D. McDONALD, V.S.,
Veterinary Inspector.

M. SPARROW, V.S.,
Veterinary Inspector.

WM. J. BONAVIA,
Departmental Secretary.

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FERTILIZERS.

By W. Newton, B.S.A., M.Sc.

A CLEAR conception of the economic value of fertilizers is more important to-day than at any period through which agriculture has passed. In the Province of British Columbia the yields are beginning to decrease, due to the exhaustion of the stores of fertility in our virgin soils. Crop-production costs have increased; unless fair yields are obtained the cost of production will be greater than the value of the crop.

Specialized fruit districts have become established. Their future productiveness depends largely upon the intelligent use of fertilizers.

In the mixed-farming districts, when a carefully chosen rotation, including a clover or other legume crop, is followed, and where the grain and hay is fed on the farm and the manure properly cared for, it may not be necessary to use commercial fertilizers, but when the nature of the crop prevents rotation, and where very little farmyard manure is produced, commercial fertilizers may be required.

CHEMICAL ELEMENTS NEEDED BY PLANTS.

As far as we know, there are fifteen chemical elements required for normal plant-growth. There are only four that particularly interest the farmer, for the others are usually found in abundance in all soils. These four are nitrogen, phosphorus, potassium, and calcium. When we speak of plant-food we usually refer to these elements as nitrogen, phosphoric acid, potash, and lime.

AVAILABILITY OF PLANT-FOOD.

It may be surprising to know that most farm soils, even those that produce poor crops, are abundantly supplied with plant-food. When poor crops are obtained it means that the plant-food is not available. This fact serves to emphasize the necessity of paying special attention to the numerous factors that influence the availability of the plant-food in the soil.

AERATION AND DRAINAGE.

Foremost among these factors is the question of aeration and drainage. A free circulation of air is necessary to promote the development of soil organisms that assist in changing the locked-up fertility of the soil into a form available to plant-growth. Without adequate drainage the air cannot penetrate the soil. Besides favouring the development of soil organisms, the roots of practically all plants require free air to develop normally. Air has also a direct chemical effect that not only releases plant-food, but frequently oxidizes soil substances that are injurious or toxic to plant-growth.

INCREASING THE FEEDING AREA.

Some soils are so shallow that the crop-roots are confined to a thin surface strata. The limited area from which they obtain their food will frequently account for the poor returns.

MOISTURE-SUPPLY.

The moisture-supply must be sufficient at all times during the growth of the plant. The moisture in a saturated soil is not available to plants to the same extent as when a soil is properly drained. Increasing the depth, improving the texture, and the maintenance of an adequate humus or rotted vegetable-matter content all have a direct bearing upon the supply of moisture required for plant-growth.

FUNCTION OF PLANT-FOOD CONSTITUENTS.

To intelligently use fertilizers a knowledge of the functions of the plant-food materials added to the soil is necessary. The kind of fertilizer to use upon a given soil will depend upon the character of the soil and the crop it is proposed to raise. For example, it would be poor economy to fertilize heavily with nitrogen when clover is to be the crop, because of the ability of that plant to obtain its own supply of that element.

FUNCTION OF NITROGEN AS A FERTILIZER.

Nitrogen stimulates the growth of the vegetative parts. Truck-crops such as lettuce, celery, and cabbage are greatly improved by its use owing to the fact that it stimulates rapid growth.

With certain crops there is a danger of an overapplication. If too much nitrogen is applied to potatoes the growth of vine will be stimulated at the expense of tubers.

When the season is short and the grain-crops have a tendency not to ripen, the use of nitrogen may not be advisable. On the whole, this fertilizer tends to lengthen the growing season. When trees appear to be stunted nitrogen is frequently beneficial, in that it will induce a more luxuriant growth.

Clover, alfalfa, peas, beans, vetches, and other legumes are seldom benefited by using a nitrogen fertilizer, in that this group of plants can use the free nitrogen of the air. In farm practice inclusion of a legume at short intervals in the rotation will dispense with nitrogen fertilizers.

FUNCTION OF PHOSPHORIC ACID AS A FERTILIZER.

Phosphoric acid hastens the maturity of crops. It has a ripening effect and serves to hasten grain and fruit formation; it stimulates root-development in young plants. The proportion of grain to straw is usually higher with ample phosphoric acid. In a very general way grain-crops are heavy phosphoric-acid feeders. It is required to build up protein and consequently should be liberally supplied to the legume crops that are rich in protein.

FUNCTION OF POTASH.

Potash is essential to the formation of starch, sugar, and cellulose in plants. The flavour and colour of fruits is generally credited to potassium. Potatoes and sugar-beets in particular require an abundant supply of potash owing to the quantity of starch and sugar they contain. Experiments show that soils without sufficient potash do not produce as heavy grain-crops. This is probably due to the effect of potash in prolonging the growing season of grains. However, the growing season of all crops is not prolonged by the use of potash. With roots the reverse is found to be true.

FUNCTION OF CALCIUM OR LIME.

Calcium seems to impart hardness to the plant. It has been noticed that soils containing an abundant supply of lime usually produce well-nourished crops that are capable of standing unfavourable climatic conditions, such as drought or early frost. It has also a decided beneficial effect on the texture or physical condition of the soil. Lime acts as a liberator of plant-food, particularly potash, held in insoluble forms in the soil. It neutralizes soil-acidity, a condition that is not favourable to the normal development of a great many farm crops.

TYPE OF SOIL AND FERTILIZER REQUIREMENT.

On most soils and for most crops a judicious mixture of nitrogen, phosphoric acid, and potash will give the best results. Clays or clay loams if adequately supplied with lime may not require potash. Peat soils as a rule only require lime, phosphoric acid, and potash. The nitrogen content of peat soils is usually sufficient for satisfactory crop production.

THE FINANCIAL STANDPOINT.

Viewed from the financial standpoint, the whole problem of the use of artificial fertilizers is simply one of profit or loss. Regardless of the needs of the soil or its ability to produce crops, if the use of fertilizers will increase the net profit from the crop after the cost of the fertilizer and the labour is deducted it is a profitable investment. Every farmer must determine for himself the point where the cost of a fertilizer application is greater than the value of the increased yields. Fruit and truck farmers that expend a large amount of labour on small areas find it profitable to fertilize heavily. As a rule the higher the acre value of the crop the greater is the amount that can be profitably expended on fertilizers.

PLANT-FOOD REMOVED BY CROPS.

The amount of plant-food removed by crops is indicative to a degree of their fertilizer requirements. The following table may be of some assistance:—

Crop.	Gross Weight.	Nitrogen.	Phosphoric Acid.	Potash.	Lime.
	Lb.	Lb.	Lb.	Lb.	Lb.
Wheat, 20 bu.	1,200	25	12½	7	1
Straw	2,000	10	7½	28	7
Totals	.....	35	20	35	8
Barley, 40 bu.	1,920	28	15	8	1
Straw	3,000	12	5	30	8
Totals	.....	40	20	38	9
Oats, 50 bu.	1,600	38	12	10	1½
Straw	3,000	15	6	35	9½
Totals	.....	53	18	45	11
Corn, 65 bu.	2,200	40	18	15	1
Stalks	6,000	45	14	80	20
Totals	.....	85	32	95	21
Peas, 30 bu.	1,800	..	18	22	4
Straw	3,500	..	7	38	71
Totals	.....	..	25	60	75
Flax, 15 bu.	900	39	15	8	3
Straw	1,800	15	3	19	13
Totals	.....	54	18	27	16
Meadow-hay	2,000	30	20	45	12
Red clover	4,000	..	28	66	75
Potatoes, 300 bu.	13,000	80	40	150	50
Mangels, 10 tons	20,000	75	35	150	30

FARM MANURES.

Farm manure is the oldest and one of the most important of our fertilizers. The value is better understood than formerly. The benefit to be derived from its use is threefold: First, it supplies plant-food; second, it maintains the humus or rotted vegetable-matter content of soils; third, it inoculates the soil with beneficial organisms that assist in the release of plant-food.

The quality of the manure depends upon a number of factors, the kind of animal, the quality of the feed, and the amount and kind of the bedding that is used being the most important. The manure of mature animals fed heavily on concentrates is usually the richest in plant-food. Bedding, besides affecting the composition of the manure, makes it more sanitary and easy to handle. Frequently the liquid parts of farm manures contain over half the nitrogen and potash. Unless the liquid parts are saved by means of a liquid-manure tank or by using plently of absorbent bedding a great deal of the value will be lost. Straw is the standard bedding. Dried peat has a very high absorbent power, and since it quite readily decomposes in the soil it is quite valuable for this purpose. Dried leaves and sawdust are used, but are much inferior to straw or peat because they decompose very slowly in the soil. On heavy clay soils their use may prove beneficial.

THE CARE OF STABLE MANURE.

Practically every farmer appreciates the value of the stable manures, but not all farmers appreciate the losses that occur through their methods of handling.

It is so difficult to prevent large losses that it is usually advisable to apply the manure direct from the stable to the soil. This practice is not always possible; hence the treatment of manure is important.

LEACHING.

When the manure-heap is exposed to the washing of rain and the solutions allowed to wash away the value of the manure decreases. We have already noted that the greater part of the nitrogen and potash is frequently found in the liquid parts. Furthermore, the nitrogen in the urine is largely in the form of urea, a compound that is readily changed into volatile substance, ammonium carbonate.

FERMENTATION.

There are two distinct types of fermentation that occur in manure-heaps. The first type is caused by organisms that require free air and the second by organisms that do not require free air. The first form of fermentation, that caused by organisms that require free air, is undesirable. It is responsible for large losses of nitrogen. The nitrogen in the manure is converted into a volatile form by such organisms and it escapes as a gas. To prevent this undesirable fermentation air must be excluded from as much of the manure-pile as possible. This can be done by keeping the pile as compact as possible, and since dry manure ferments more readily than wet manure it is desirable to keep the manure-pile damp.

The other form of fermentation which takes place in the absence of free air is desirable, in that it is helpful in increasing the availability of the plant-food.

STORING MANURE UNDER COVER.

To prevent loss storing manure under cover is advisable. Some farmers use covered sheds where the stock are allowed to exercise and the manure is kept compact by the tramping of the animals.

PRESERVATIVES.

By adding moist gypsum (land-plaster) to manure much loss of nitrogen due to the evolution of ammonium gas is avoided. Superphosphate and ground rock phosphate are sometimes used to good advantage.

VALUE OF FARM MANURES.

It has already been noted that the value of farm manures depends not only upon the plant food they contain, but because they maintain the humus or rotted vegetable matter of soils and introduce organisms that assist in the release of plant-food.

The following table will assist in determining the plant-food values of farm manures:—

Kind of Manure.	Nitrogen.	Phosphoric Acid.	Potash.
	Per Cent.	Per Cent.	Per Cent.
Cattle (solid fresh excrement)	0.29	0.17	0.10
Cattle (fresh urine)	0.58	...	0.49
Hen-manure (fresh)	1.63	1.54	0.85
Horse (solid fresh excrement)	0.44	0.17	0.35
Horse (fresh urine)	1.55	...	1.50
Sheep (solid fresh excrement)	0.55	0.31	0.15
Sheep (fresh urine)	1.95	0.01	2.26
Stable manure (mixed)	0.50	0.30	0.60
Swine (solid fresh excrement)	0.60	0.41	0.13
Swine (fresh urine)	0.43	0.07	0.83

NITROGEN MANURES.

The following table is a list of the commonest nitrogen manures found on the market:—

Materials.	Nitrogen.	Phosphoric Acid.	Potash.
	Per Cent.	Per Cent.	Per Cent.
1. Cotton-seed meal	6.58	2.80	1.50
2. Linseed-meal	5.30	1.60	1.25
3. Castor pomace	5.50	1.80	1.00
4. Rape-meal	5.00	1.60	...
5. Red blood	13.50	...	...
6. Black blood	12.00	...	...
7. Tankage	6.58–7.41	3–5.5	...
8. Concentrated tankage	10–12	...	...
9. Azotin (fish or meat meal)	13.00	...	...
10. Steamed horn and hoof meal	12–15	...	...
11. Dried ground fish	8.50	9.00	...
12. King crab	10.00	...	...
13. Guano	4–12	5–20	...
14. Ammonium sulphate	20.00	...	...
15. Nitrate of soda	15.30	...	...
16. Calcium nitrate	13.00	...	...
17. Calcium cyanide	16.20	...	...

The first four fertilizers are vegetable products. On account of their value as food for live stock they are not frequently sold as fertilizers.

From the fifth to the thirteenth are animal by-products. The chief characteristic of the group is that the nitrogen content is very variable. In purchasing the precaution should be taken of securing a guaranteed analysis. Their value should be based upon the pounds of nitrogen they contain. The nitrogen in groups 1 and 2 is not so available as the nitrogen in the group of chemical fertilizers. For this reason they should be used when a nitrogen-supply is desired throughout the season. Dried fish-meal is frequently quite rich in phosphoric acid. The content of phosphoric acid varies, depending upon the quantity of bone ground up in its manufacture. If the bone content is low the phosphoric-acid content is low. In the purchase both elements must be considered in estimating the cost.

The guanos also vary greatly in both nitrogen and phosphoric acid. It is largely a question as to where the guano has been collected that determines its analysis. A guarantee is a safeguard to the purchaser.

Of the chemical fertilizers, ammonium sulphate and nitrate of soda are the two commonest on the market. Ammonium sulphate is considered the best to apply to deep-rooted plants and the nitrate of soda to shallow-rooted plants. Unless the soil to which they are applied contains a high lime content the frequent use of ammonium sulphate will make a soil acid.

Nitrate of soda should never be mixed with acid phosphate before applying to the soil. A chemical action takes place if this is done that results in a considerable loss of nitrogen. It is preferable to apply the acid phosphate six or seven weeks before the date of planting and the nitrate of soda not more than a week before planting.

All the chemical nitrogen fertilizers are readily available; consequently they should be applied in small quantities shortly before they are required by the plants, otherwise the nitrogen in the form of nitrates will dissolve and leach away.

Calcium nitrate and calcium cyanamide are as valuable as the first mentioned if their value is based upon the percentage of nitrogen they contain. Calcium cyanamide should be applied shortly before seeding, for it is considered to have a slightly toxic action on vegetable-growth. More recently claims have been made that the toxic materials contained in the fertilizer have been successfully removed.

Nitrogen is an important element to consider in the study of fertilizers. Nitrogen usually costs about three times as much as phosphoric acid. This fact serves to emphasize the necessity of maintaining the nitrogen-supply in soils by the use of clover, alfalfa, and other legumes rather than by the application of nitrogen in the form of a commercial fertilizer.

PHOSPHATIC MANURES.

A number of materials are used as a source of phosphoric acid. The principal sources are listed in the following table:—

(*a.*) RAW PHOSPHATES.

	Phosphoric Acid. Per Cent.	Nitrogen. Per Cent.
1. Raw bone-meal	19–25	2–4
2. Steamed bone-meal	17.5–29	5–4.5
3. Bone-black	30	
4. Bone-ash	30–39	
5. Bone-tankage	11.5–20	4–6
6. Dried ground fish	6–16	4–11
7. Phosphatic guanos	11–42	
8. Basic slag	11–13	
9. Ground rock phosphate	25–40	

(*b.*) SUPERPHOSPHATES.

	Total Phosphoric Acid. Per Cent.	Available Phosphoric Acid. Per Cent.
1. Acid phosphate	14–18	12–16
2. Dissolved bone-black	16.5–17.5	12.5–16.5
3. Double superphosphate	48	43

RAW PHOSPHATES.

The organic phosphatic manures, the first seven in the above table, are very variable in composition.

Raw bone-meal is a finely ground product derived from raw bones. It carries considerable organic matter in the form of fats. This fatty organic matter tends to make the fertilizer very slowly available as plant-food. The phosphoric acid in steamed bone-meal is more available than bone-meal, for in the manufacturing process the fats are extracted. Grinding does not affect the composition but finely ground material is more available than coarser samples.

Bone-black, a by-product of sugar-refineries consist of bones that have been heated and distilled until all the organic or volatile matter has passed off. The product is then ground to a coarse consistency. It is sold as fertilizer when it has served its usefulness in the process of clarifying syrups.

Bone-ash that is sold as a fertilizer consists of burnt bones.

Bone-tankage consists of refuse from slaughter-houses.

Basic slag, a by-product of iron-smelters, is known by several names, as iron phosphate, Thomas phosphate, odourless phosphate, and phosphatic slag. The phosphoric acid in basic slag is often rated as valuable as the phosphoric acid in bone-meal. The composition is variable, depending upon the composition of the iron ore. The lime content of this material adds to the value on acid soils.

The phosphoric acid in ground rock phosphate is the least available of the raw phosphates. (Section (*a*) of the above table.) The composition and the fineness of the material determines its value.

Availability of the Raw Phosphates.—The raw phosphates are slowly available as plant-food and practically insoluble in water. The phosphoric acid is not entirely used the first year, so the maximum returns cannot be expected immediately. For quick-growing crops the raw phosphates are not always desirable.

SUPERPHOSPHATES.

Many of the raw phosphates are treated with sulphuric acid to render the phosphoric acid more available. The commonest of these is the acid phosphate or superphosphate of lime. The composition is variable, depending upon the phosphate ore from which it is manufactured and upon the process of manufacture.

There seems to be a great deal of confusion among farmers as to what contributes available phosphoric acid. Chemists usually class the phosphoric acid soluble in water as "soluble," and the phosphoric acid soluble in citrate acid as "reverted." The sum of the two is the "available phosphoric acid." For all practical purposes the farmer in purchasing superphosphate need only to consider the percentage of available phosphoric acid.

Dissolved bone-black is manufactured by treating bone-black with sulphuric acid.

The double superphosphates are not frequently found in the market in this country. It is manufactured by treating high-grade phosphate rich with sulphuric and phosphoric acid in solution.

The phosphatic manures as a whole are very variable in composition. Their value should be based on a guaranteed analysis. Owing to the acid nature of the superphosphates they should not be applied to sour soils. Liming should precede an application of superphosphate. When immediate returns are expected the superphosphates are superior to the raw phosphates.

POTASH MANURES.

Until the discovery of the potash-mines in Germany in 1860 wood-ash was the chief source of this constituent as a fertilizer. Until the recent European conflict practically all the potash salts used as fertilizers throughout the world came from the German mines. The war stimulated the development of other supplies. It would be difficult to say whether the supplies from the newly developed sources are to become permanent.

The following table includes the principal potash fertilizers:—

	Actual Potash. Per Cent.
1. Kainit	12.5
2. Sylvinit	12–15
3. Muriate of potash	50
4. Sulphate of potash	50
5. Double sulphate of potash and magnesium	26
6. Potassium magnesium carbonate	20–25
7. Wood-ashes	5–6
8. Kelp or seaweed (dried sample)	12
,, ,, (ash)	20–30

Kainit is a crude yellowish-red salt containing about 12.5 per cent. of actual potash which is largely in the form of sulphate. Along with it are large quantities of common salt and small percentages of chloride and sulphate of magnesia.

Sylvinit.—This salt when ground is much more red in colour than kainit. It is sometimes sold by fertilizer-manufacturers under the name of kainit. It consists chiefly of chlorides, being principally composed of sodium chloride and potassium chloride.

Muriate of Potash.—Muriate of potash or potassium chloride is more generally used than any of the other salts. It varies somewhat in composition, according to the method of manufacture, but the product most commonly met with contains about 50 per cent. of actual potash. The principal impurities are common salt and certain insoluble matters which are not injurious. All the potash is immediately available.

Sulphate of Potash.—This is a yellow, dry, almost powdery substance. It is sold from 90 to 95 per cent. pure and therefore contains an equivalent of from 48 to 51 per cent. of actual potash. It is more expensive than muriate, but is more adapted for certain crops, such as tobacco and potatoes, crops injured by excessive chlorides.

Double Sulphate of Potash and Magnesia.—This product is somewhat similar to high-grade sulphate of potash in its effect on crops. It usually contains 26 per cent. actual potash.

Potassium Magnesium Carbonate.—This is a dry white manufactured product and is an excellent source of potash for crops injured by chlorides. It contains 20 to 25 per cent. actual potash. It is not sold extensively.

Wood-ashes.—The potash in wood-ashes is in the form of carbonate, which is very desirable for all plants. Good unleached ashes should contain 5 to 6 per cent. of potash. Leached ashes or ashes that have been exposed to the weather usually have lost all but one-half of 1 per cent. of their potash. But they contain some phosphoric acid and 25 to 50 per cent. of the whole material is carbonate of lime. This phosphoric acid and lime remain unchanged by weathering and leaching.

Seaweed.—The practice of using seaweed as a fertilizer is very old. During the war greater attention was paid to the value of this material owing to the scarcity of other potash fertilizers. In the fresh state the Pacific Coast seaweed contains almost as much nitrogen and more potash than farmyard manure. The analysis of dried samples proved to contain over 12 per cent. potash. Seaweed ash samples contained as high as 30 per cent. actual potash. Its value, applied either in the fresh, dried, or burnt condition, proved it to be a valuable potash fertilizer. It readily decomposes in most soils.

LIME.

Lime should be classed as a soil-stimulant rather than a fertilizer, for there are few soils that do not contain sufficient lime to supply the needs of a crop as a plant-food. The action of lime is usually not so immediate as that of a true fertilizer. It is only when soil needs lime badly and where a liberal application is given that the effect may be immediate and striking. The immediate effect of liming is more frequently seen in the case of alfalfa and clover fields than with other crops.

Although a plant-food, the primary purpose of liming is to neutralize soil-acidity. Certain crops require more lime than they are able to secure from a soil which is acid. But perhaps the most important benefit of lime is that by neutralizing the soil-acidity it stimulates favourable forms of soil organisms that increase the crop-producing power of soils.

Lime improves the texture of clay soils, an important consideration in their management.

Burnt lime, and to a lesser degree ground limestone rock, has an effect of increasing the available supply of plant-food, particularly potash in soils.

WHEN AND HOW TO APPLY LIME.

Although there are a few crops that prefer a slightly acid soil, for the most part a soil that is neutral or slightly alkali is more favourable for crop production. Soil-acidity tests are made to determine whether lime is required. The litmus is the most common test for this purpose. If a good quality blue litmus-paper is secured from a druggist and a strip pressed against the moist surface of the soil under test, the paper will turn pink, either completely pink or pink in spots, if the soil is acid. The rapidity with which the paper turns pink is a rough guide as to the degree of acidity. A little experience may be necessary in knowing just what shade is required to indicate acidity, as the paper will lose its blue colour even in a neutral soil and turn purplish in colour, which may be mistaken for the proper pink.

The hydrochloric-acid test to determine the lime content of soils is made as follows: Take 1 or 2 oz. of hydrochloric acid (muriatic acid) and dilute with equal parts water. A handful of soil, preferably wet and worked into a mud-ball should be tested by adding the hydrochloric acid. If unmistakable and distinct bubbling takes place the soil almost invariably contains sufficient lime. If no bubbling occurs lime is required. The amount of bubbling as a rule varies directly with the lime content of the soil.

FORMS OF LIME AND THEIR COMPARATIVE VALUES.

Quick or burnt lime, water-slaked or hydrated lime, and ground limestone rock are the three forms chiefly used for agricultural purposes. The kind of lime to use should be determined largely upon the basis of the amount of active lime (calcium oxide) one can buy for the dollar. In order to determine this it should be remembered that approximately 2,000 lb. of finely ground limestone or old air-slaked lime is required to equal 1,100 lb. of burnt lime or 1,500 of fresh water-slaked lime. With a delivered price on each, one can figure the cheapest form when hauled and spread. On soils that are lacking in vegetable matter the use of ground limestone is recommended. The burnt lime or fresh water-slaked lime causes a too rapid decay of vegetable matter. On peaty soils the latter forms are superior. On such soils there is a surplus of vegetable matter. Any treatment that will encourage the decay of the vegetable matter will release plant-food and is therefore beneficial.

GUARANTEES.

To aid the purchaser of fertilizers the Dominion Government has enacted a law whereby it is made illegal for any manufacturer or manufacturer's agent to offer for sale any fertilizer without giving a guarantee of the amount of plant-food constituents contained therein. The purchaser will do well to remember that, no matter how complex the guarantee may be, the valuation should be on the three items: (1) Nitrogen; (2) available phosphoric acid; (3) potash. This fact is recognized in fertilizer formulas written as 3–7–9. The meaning is that it contains 3 per cent. nitrogen, 7 per cent. phosphoric acid, and 9 per cent. potash.

CALCULATION OF THE VALUE OF FERTILIZERS.

Every farmer should be able to calculate the true market value of the fertilizer he purchases. The preference on the part of many to purchase mixed fertilizers is not to be discouraged, providing the price is in proportion to its various constituents if these were purchased singly. The manufacturers have facilities for mixing that the average farmer does not possess. A nominal charge is always allowed for mixing.

METHOD OF CALCULATING THE VALUE PER POUND OF ACTUAL PLANT-FOOD.

In the case of purely chemical fertilizers the value of a fertilizer depends upon the amount of nitrogen phosphoric acid and potash present.

Nitrate of soda contains 15 per cent. nitrogen. One ton contains 15 per cent. of 2,000 lb. or 15/100 of 2,000 = 300 lb. If the commercial value of nitrate of soda is $90 per ton, 300 lb. of actual nitrogen costs $90.

One pound of actual nitrogen would therefore cost 1/300 of $90=30 cents.

Similarly, superphosphate contains 16 per cent. available phosphoric acid.

One ton contains 16 per cent. of 2,000 lb. or 16/100 of 2,000=320 lb.

If the commercial value is $32 per ton, 320 lb. of available phosphoric acid costs $32.

One pound of available phosphoric acid therefore costs 1/320 of $32=10 cents.

Similarly, muriate of potash contains 50 per cent. actual potash.

One ton contains 50 per cent. of 2,000 lb. or 50/100 of 2,000=1000 lb.

If the commercial value of muriate of potash is $150 per ton, 1,000 lb. of actual potash costs $150.

One pound of actual potash would therefore cost 1/1000 of $150=15 cents.

A mixed fertilizer is guaranteed as a 4–9–5 fertilizer. A ton would contain the following amounts of plant-food:—

Nitrogen, 4 per cent.; therefore 1 ton contains 4/100 × 2,000 = 80 lb.

Available phosphoric acid, 9 per cent.; therefore 1 ton contains 9/100 × 2,000 = 180 lb.

Potash, 5 per cent.; therefore 1 ton contains 5/100 × 2,000 = 100 lb.

A ton of mixed fertilizer guaranteed to contain 4 per cent. nitrogen, 9 per cent. phosphoric acid, and 5 per cent. potash consists of 80 lb. actual nitrogen, 180 lb. actual available phosphoric acid, and 100 lb. actual potash.

Having calculated the value per pound of these three plant-foods when purchased singly, it is not difficult to estimate whether it is more economical to buy a mixed fertilizer.

The value of a 4–9–5 fertilizer based on the commercial values of the nitrate of soda, superphosphate, and muriate of potash quoted above would be:—

80 lb. nitrogen at 30c.	$24 00
180 „ phosphoric acid at 10c.	18 00
100 „ potash at 15c.	15 00
Total	$57 00

Added to this is the manufacturer's charges for mixing.

No fertilizer contains 100 per cent. plant-food; therefore purchasing by the ton without calculating the number of pounds of actual plant-food contained in each ton is not a safe practice.

On soils that are deficient in humus or rotted vegetable matter the organic fertilizers have a value in access of their actual plant-food content owing to their effect in improving the physical condition of the soil.

MIXING FERTILIZERS.

The operation of home-mixing must be thoroughly done or the result may prove unsatisfactory. Select a clean dry floor, preferably of concrete, and dump the fertilizers in their required proportions in a heap. After thoroughly mixing with a shovel the whole should be passed through a ⅛-inch mesh screen. If the bulk to be applied to an acre is less than half a ton the quantity should be increased by adding fine dry sand or earth.

Some fertilizers cannot be mixed on account of unfavourable chemical action. To avoid trouble do not mix the following:—

(1.) Lime, wood-ashes, or basic slag with any fertilizer containing ammonia, such as ammonium sulphate, farmyard manure, or organic manure.

(2.) Lime, wood-ashes, or calcium cyanamide with any fertilizer containing soluble phosphate, such as superphosphate or dissolved bones.

(3.) Nitrate of soda with superphosphate or dissolved bones, except for immediate application, and under no circumstances if the superphosphate or bones be not in a fine dry condition.

(4.) When muriate of potash and other potash salts are mixed with superphosphate a hard cement-like mass is likely to form if the mixture is not spread immediately. This can be avoided by adding a quantity of dry sand, sawdust, peat, or other material.

MISCELLANEOUS FERTILIZER MATERIALS.

Gypsum.—Gypsum, land-plaster, or sulphate of calcium acts more as a soil-stimulant than a direct fertilizer. Its value from an agricultural standpoint is similar in some respects to lime, in that it improves the mechanical condition of clay soils and tends to make the potash content of soils more available. Gypsum will not correct soil-acidity and therefore cannot be used to take the place of lime for such a purpose. It does not hasten the decay of vegetable matter in soils to the same extent as lime. The value of gypsum to lessen the toxic properties of black alkali in soils has long been recognized.

Sulphur.—That gypsum, calcium sulphate, is of value as a plant-food owing to its sulphur content has long been a debated question. The consensus of opinions appears to be that most soils contain enough sulphur as a plant-food. In humid districts the amount of sulphur added to the soil dissolved in the rain-water is in itself sufficient. It is probable, however, that indirectly sulphur has a beneficial effect when applied to some crops. The most apparent results from sulphur have been secured when it is applied to alfalfa and clover. Flowers of sulphur are used, but the sulphur has to be converted in the soil into a sulphate form before it is of value to the crop. For this reason an application in the fall is preferable to a spring application. Gypsum or calcium sulphate may be applied in the spring to better advantage.

Common Salt.—Common salt, or sodium chloride, has been used for many years in the older countries. It supplies no essential ingredient of plant-growth. The value as a fertilizer is probably due to its action in the soil of setting free more important constituents.

FERTILIZER FORMULAE FOR CROPS.

	Nitrogen.	Phosphoric Acid.	Potash.	Lb. to Acre.
	Per Cent.	Per Cent.	Per Cent.	
Wheat	4	7	3	300 to 600
Barley	5	7	3	250 to 600
Rye	4	6	9	300 to 600
Oats	4	5	9	300 to 800
Buckwheat	4	7	9	400 to 800
Corn	3	7	6	500 to 1,000
Tobacco	5	5	8	1,000 to 2,000
Potatoes	5	6	8	500 to 1,500
Clovers and legumes	1	7	9	400 to 800
Rape	3	4	4	300 to 600
Roots	5	5	7	400 to 800
Asparagus and rhubarb	4	6	7	400 to 800
Beans and peas	1	7	8	400 to 800
Lettuce	5	5	8	900 to 1,500
Cabbage and Cauliflower	5	6	8	800 to 2,000
Cucumbers	5	5	7	500 to 1,500
Celery	5	5	9	1,100 to 1,500
Tomatoes	5	5	7	500 to 1,000
Onions	5	5	10	500 to 1,000
Sweet corn	4	8	10	500 to 1,000
Strawberries	3	9	12	500 to 800
Fruit-trees	2	8	11	400 to 700
Blackberries	2	5	8	500 to 800
Raspberries	3	6	9	500 to 800
Loganberries	3	6	9	500 to 800

Example.—Formula selected: Strawberries 3–9–12.

Quantity to be used: 500 lb.

Amount of actual nitrogen to be supplied: 3 per cent. of 500 = 15 lb.

Amount of actual phosphoric acid: 9 per cent. of 500 = 45 lb.

Amount of actual potash to be supplied: 12 per cent. of 500 = 60 lb.

If the composition of fertilizers used to supply the three plant foods are:—

Nitrate of soda, 15 per cent. nitrogen;
Superphosphate, 16 per cent. available phosphoric acid;
Muriate of potash, 52 per cent. actual potash,—

15 lb. nitrogen will be supplied by 100 lb. nitrate of soda.

45 „ phosphoric acid supplied by 45/16×100 = 280 lb. superphosphate.

60 „ potash supplied by 60/52×100 = 115 lb. muriate of potash.

The fertilizer formulæ for the crops given are compiled for average conditions. On heavy soils well supplied with lime the proportion of the potash may be decreased. On soils that have an excess of vegetable matter the nitrogen proportion may be decreased. If clovers or other legumes are included at short intervals in a crop-rotation the amount of nitrogen that is necessary to apply may be materially decreased.

The commercial value of fertilizers varies from year to year. This variation must be considered when a fertilizer formula for any crop is selected. For example, the present price of potash is so high that it would probably be wise to reduce the amount of potash in the formulæ listed until the price returns to normal.

Soil conditions are so variable in the Province of British Columbia that it would be unwise to lay down any hard-and-fast formula. Every farmer should attempt to determine the fertilizer formula that suits his particular soil and crop needs. This may be done by selecting a uniform field and applying different fertilizers and fertilizer mixtures in a manner that the comparative yields resulting therefrom can be easily determined.

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