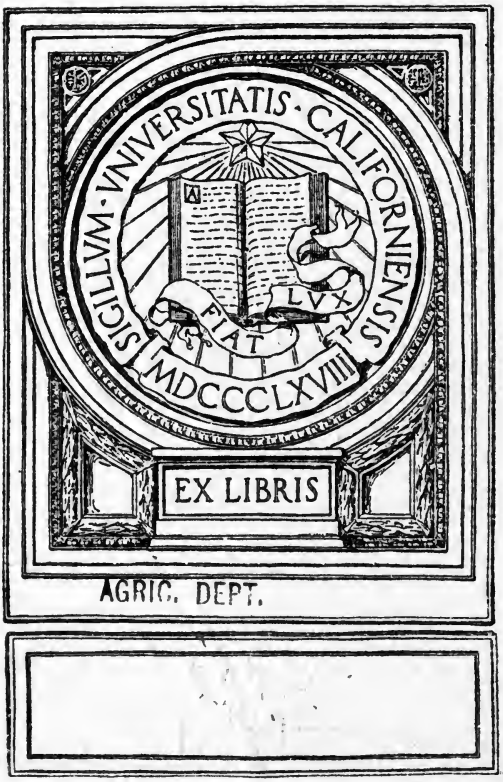
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Fertilizing Field and Garden.

. . BY . .

F. E. H. W. KRICHAUFF, J.P.,

Cor. Mem. R.H.S.,

Chairman of Central Agricultural Bureau of South Australia.

Adelaide:

PRINTED BY VARDON AND PRITCHARD, GRESHAM STREET.

1901.

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INDEX.

PREFACE.

The Mylor Branch asked the Central Agricultural Bureau of S.A. in September, 1895, to have a list prepared showing the Commercial fertilisers in general use; the different cereals, fodder crops, vegetables, and fruit trees to which each can be judiciously and economically applied; those manures which can be mixed with advantage, and especially those which should not be mixed together, and in March, 1896, a similar motion passed at Stockport Branch. The last part is answered thus. Do not apply at the same time, or unless some weeks intervene, superphosphate with Thomas phosphate, lime, or nitrate of soda. In this respect an interesting experiment was made at the County Council farm in Lancashire in 1899. 1½ cwt. of nitrate of soda gave an increase of 11 cwt. of hay over unmanured plots. With 132 lbs. sulphate of ammonia (an equivalent to 1½ cwt. of nitrate of soda) the increase over unmanured plots was 7½ cwt. Where, on other plots, 2 cwt. of superphosphate was added to the 132 lb. of sulphate of ammonia, 11¼ cwt. of hay were cut, but where 2 cwt. superphosphate were added to 1½ cwt. of nitrate of soda, the superphosphate became insoluble, and no more was harvested than with nitrate of soda alone. If 2 cwt. of Thomas phosphate had been used with 1½ cwt. of nitrate of soda, the result would, in accordance with many other experiments, have been a pretty large increase. Do not apply Thomas phosphate with superphosphate or sulphate of ammonia. Lists of the fertilisers appear in the reports of the Inspector of Fertilisers, but what to apply, and the payable quantity to different plants here cultivated, I have attempted to answer herein. I give on page 6 a price-list of manures and present prices of cereals, &c., to enable farmers to see in what case it pays to use fertilisers. What pays in France or Germany with lower prices for most fertilisers, and frequently higher prices for produce may not pay here. I have collected the more important results which members of the Branches of the Bureau have published since its establishment in 1888, thus showing what have been the cultivated plants in certain districts grown either successfully or not, and also results from using fertilisers in other parts of Australia, Europe, and America. For, as was said in the "New England Farmer": "The science of Agriculture is, in a great degree, founded on experience. It is, therefore, of consequence that every farmer should know what has been done, and what is doing, by others engaged in the same occupation." In this way I think you can only get into the current of thoughts and facts, and observations obtain only their real value, if they become common property through being published. I have added to the results recorded by our Branches, the rainfall in brackets, which in ever so many cases explains why a crop was poor although manured, for moisture in the soil is the most important factor in the growth of crops, and no amount of manuring and good cultivation can make up for the want of it. Some manures, however, like bone meal and Thomas phosphate, do very frequently show

better results in our dry climate in the second, and even later years, especially where the crops to which they were applied are shortlived, unless buried some time before the seed is sown. With kainit this is absolutely necessary in any case. And is it not an advantage to have your hands freed from the necessity to manure at the time you have to put in your crop?

While I am giving prominence to commercial manures, as they only are obtainable in sufficient quantities, I do not by any means wish farmers and gardeners to neglect stable dung, green manuring, liming, and marling, or other fertilisers, such as human excreta, blood, flesh, fish, vegetable refuse, seaweed, soot, ashes, &c., if these can be had at low rates, and yet answer their purpose. They are very good alternatives to prevent—as Professor Gerard, of Lyons, says—the soil from getting hard, and more or less impermeable from using some potassic and other commercial fertilisers.

F. E. H. W. KRICHAUFF.

Norwood, March, 1901.

The following prices have ruled for cereals at Port Adelaide after harvest in 1900-1, and in the other States the difference was not material:

Wheat, 2/7 to 2/9.
Barley, for malting, 3/3 to 3/8; Cape, 2/3.
Oats, dun or Algerian, 1/8 to 1/11; white, 2/ to 2/8.
Hay, 25/ to 35/.
Inland prices are lower the more distant from a shipping port.

Manures have been sold at Adelaide, to which must be added cost of cartage to farms:

Kainit, 4/6 per cwt.
Nitrate of soda, 12/ per cwt.
Thomas phosphate, 4/6 per cwt.
Muriate of potash, 15/ per cwt.
Sulphate of potash, 18/ per cwt.
Superphosphate, 6/ per cwt.
Bonedust, £5/15/ per ton, on trucks Port Adelaide.
Mineral superphosphate, 36-38 per cent., 87/6 per ton, on trucks Port Adelaide.
Bonemeal, 11/ to 12/6 per cwt.
Guano superphosphate, £4 per ton, on trucks Port Adelaide.
Kangaroo guano, about £3 per ton, on trucks Port Adelaide.
Peruvian guano, £12 per ton, on trucks Port Adelaide (Ohlendorff's dissolved).
Thomas phosphate, 67/6 per ton, on trucks Port Adelaide.
Nitrate of soda, £10/10/ per ton, on trucks Port Adelaide.
Sulphate of ammonia, £13/10/ per ton, on trucks Port Adelaide.
Kainit, £4 per ton, on trucks Port Adelaide.
Sulphate of potash, £14/5/ per ton, on trucks Port Adelaide.
Muriate of potash, £13/15/ per ton, on trucks Port Adelaide.
Blood manure, £8 to £9 per ton, on trucks Port Adelaide.

Fertilizing Field and Garden.

SOME GUIDING LINES FOR MANURING.

"Theory has during the last decennia acted as pioneer to practice, and by degrees the distrust has been somewhat less against innovations. Not that every proposal, invention, or manure should be swallowed without due enquiry and critical reflection; but the prejudices of our old practical farmers against everything new must be more and more wiped away as a reciprocity between theory and practice is absolutely necessary to rational progress." This I found amongst notes, which I am in the habit of making, whether copied, or my own, I cannot say.

It is, however, an undertaking to successfully teach even the most intelligent the complex and wonderful phenomena which our greatest scientists have laid bare, but I hope this treatise may lead to personal investigation and independent experiments. With these our young, and many more of the old, farmers may become convinced that their old ways can be superseded by something better.

Should afterwards anything hereafter stated prove to be incorrect, do not blame me too much. With the best intentions, it is impossible to know everything, or to foresee all contingencies. We have all to learn, and you will at least acknowledge that my principal object, to stimulate thought, can to some extent be attained.

Professor Maercker's remarks on mixing of commercial manures may find here a place, as not quite agreeing in what I shortly stated in the preface: "You may mix nitrate of soda with potash salts, superphosphate, Thomas phosphate, and no harm will be done. Sulphate of ammonia and guano you may mix with potash salts and superphosphate, but never with Thomas phosphate, for that is alkaline, and the lime in it does not combine harmoniously with ammonia; it drives it off. Superphosphate and Thomas phosphate must not be mixed, because the lime in the latter renders the soluble phosphoric acid in the superphosphate insoluble. The mass becomes heated, insoluble phosphoric acid is formed, and thereby the plants will be deprived of just that which should have been supplied to them in the superphosphate for their first growth. Thomas phosphate may be mixed with potash salts without any chemical change taking place; but lime, silicic acid, and alkalies form cement. In the Thomas phosphate you have lime and silicic acid; alkalies you have in potash salts. By mixing them a kind of cement is formed, which after eight or ten hours becomes hard.

having, indeed, the same constituents, but it is difficult to broadcast, and only enough should be mixed for the day's requirements."

We have sufficient proof that we need not fear to apply certain substances to the soil in almost any quantity. These contain plant food, but not altogether in a form at once soluble. Time is required for a large portion to be absorbed first by the soil and they are frequently utilised only by a subsequent crop. Such manurial substances are: Blood manure, green manure, tankage, &c., and perhaps farmyard dung, not quite fresh, or not applied direct to cereals. It is different with many commercial fertilisers, such as potash salts, superphosphate, sulphate of ammonia, and nitrate of soda. These act more or less quickly, and seem to require more frequent applications than others, such as Thomas phosphate and bonemeal, which it is known are stored up in the soil, and not at once dissolved. They (Thomas phospate and bonemeal) suffer no deterioration in the soil and remain always active, a reliable and profitable investment. It is also quite certain that excessive quantities of the first-named chemical fertilisers not only do not increase the crop sufficiently to make it a paying crop; it is actually observed that at times the crop is greater where smaller quantities had been applied (see farther on). Professor Maercker states as a fact that the percentage of sugar in beets is lower if you use an excess of nitrogen. Again, if the entire dressing of nitrate of soda is applied at one time we have to reckon with formidable enemies to plant nutriment in the form of bacilli that live on nitrates, which they decompose into the form of gaseous nitrogen. If nitrate of soda is applied to a green crop it must be quite dry, or the leaves will be injured. Where the soil is either too wet or too dry you cannot expect maximum crops; in fact, in extreme cases the fertilisers will not act at all, or easily soluble salts may, with little moisture in the soil, act injuriously.

Then, again, in ever so many cases manures are applied at the wrong time, or not sufficient time has been allowed for slower-acting manures, or too great quantities of highly concentrated fertilisers come into close contact with the seeds and roots. Yet the pickling of wheat with superphosphate in a tube—when a few pounds will stick to the seed—does not seem to be sufficient to do any harm nor much good either. The more soluble the smaller should be the quantities used in *dry* districts with the *drill*. Broadcasting is a different thing, and my own leaning, supported by a few intelligent farmers, is to broadcast larger quantities of fertilisers, and more so in dry districts. I base my opinion on the following: Fertilisers broadcasted do not force on the young plants at first like those where the manure is drilled in with the seed. Afterwards when the roots spread the manure-drilled plants do not find so much plant food to sustain them away from the drill, and this is important at the time of flowering and the formation of the grain. Mr. A. H. Ward, of Boston, U.S., says that the germinating seeds and the plants exert and keep up an electric action to obtain plant food; but to what distances is at least undetermined as yet. I believe more in contact; a transfer of remote

substances to the roots seems to me unlikely, although the roots search for food and grow towards it. Most farmers find it, however, necessary to force crops by drilling them with manure, causing for the time too luxurious consumption of plant-food against later needs, and why? They say the weeds have in that case no chance! But surely the seeds of weeds should be made to grow before, and the seed-bed fairly free from these robbers.

The question how much of the different manures should be used per acre is a matter that can only be answered subsequently under the headings of the different cultivated plants. It depends also on the soil and whether in good heart or not. In default of an analysis, which may still be misleading as regards the at once soluble constituents, a knowledge of the general physical qualities of soils is useful. A limy soil is generally rich in phosphoric acid and poor in potash; with clay it is probably the reverse. Sandy soils require nearly always all three plant foods in a larger or lesser degree. Where the soil contains much potash it is desirable to use gypsum to make it fit for absorption by the plants. But I may say here that much as regards phosphatic manures, which are undoubtedly needed in large quantities, that the preference generally given to superphosphates over other phosphatic manures is more the natural consequence of being best and longer known. Others, if applied at the proper time and to certain soils, have proved to be as good, cheaper, and more lasting. Dr. Bernard Dyer, F.C.S., F.L.S., in his 160th thousand of "Some Points in Artificial Manuring," says: "Is it better to use raw or undissolved phosphatic manures, such as bones, phosphatic Peruvian guano, and Thomas phosphate? Or is it better to use acid manures, like dissolved bones and superphosphate? This is a question which for some years has occupied a great deal of attention, and has been the subject of a great many experiments. At one time it was generally supposed both by farmers and agricultural chemists that dissolved manures, like superphosphates, were invariably to be preferred. Of late years, however, both here and abroad—especially abroad—it has been recognised that on some soils and for some purposes raw or undissolved phosphatic manures answer quite as well. Indeed, careful comparative experiments, of which I have myself conducted some, have shown that sometimes undissolved, or non-acid, manures give better results. How, then, are we to decide in any given case? Speaking broadly, and with some reservations, I would lay down the rule that for all crops, when the soil possesses a fairly abundant quantity of lime, superphosphate, or some similar dissolved manure, is probably the most economical and efficacious, while on soils decidedly deficient in lime I would recommend bonemeal, raw phosphatic guano, or Thomas phosphate. This last fertiliser is not a new nostrum of which you need be suspicious. In 1894 already 59,500 tons were used in England and Scotland, against 4,500 tons in 1887. On light Norfolk soils potash has shown to produce marvellous results on root crops, grain crops, and clovers. On much of the Lincolnshire heath land it acts

almost magically." I have come to the conclusion that, except in too dry districts, an early and medium dressing of superphosphate, although containing sulphuric acid, may be fairly safe to use, and give a good profit in an average season; but another phosphatic fertiliser, Thomas phosphate, can be used without fear in larger quantities, even in dry districts, and any surplus is stored for future corps. A dry September or October frequently injures here crops by excessive evaporation of too luxurious crops caused by water soluble phosphoric acid; they are thus unable to fully support the winter growth and the sulphuric acid in such fertiliser must greatly add to the injury. This occurs chiefly if the crop is in bloom, with several days of hot winds. I find also that such a good farmer as Mr. W. Correll, of Minlaton, Yorke Peninsula, had noticed that crops manured with superphosphates containing an excess of sulphuric acid were more liable to be scorched by hot winds than those grown with fertilisers not so soluble. And the Caltowie Bureau agrees with this view. Against the damage of crops by blighting after a long dry spell, when hot winds occur exceptionally early, while the wheat is in bloom, must be set that fertilisers accelerate ripening, and thus give the distinct advantages of escaping later hot winds that are more frequent and of higher temperature. The Premier of South Australia, Hon. F. W. Holder, stated lately also that several Northern farmers had complained to him that larger doses of superphosphate had seriously damaged their crops. The quantities used I could not ascertain. Mr. Holder now says, in a letter dated February 18, 1901, addressed to me: "I noticed the blighting over considerable areas always on the land with a northern or north-eastern aspect where the drill had been used. The appearance was as if the wheat had been grown upon an old sheep camp. The farmers remarked that the hot winds then experienced had not been so severe, as they had often known the wheat plant to stand without injury before, but the wheat plant appeared to have been specially susceptible this year, and they assured me it was because of an over-use of some fertiliser." Some Branch Bureaus who enquired into this matter could not find any instance of serious injury to crops through which Mr. Holder had passed.

I may here insert what M. Toulouse Camille, Laureat of Agriculture, says, as applied to France, in his text-book for teachers on the employment of chemical manures: "Thomas phosphate at an equal expense will always give better results for all cultures and all soils. It presents over the very soluble superphosphate an enormous advantage, if used for perennial plants. Containing also lime and magnesia, lands poor in lime receive besides from 15 to 22 per cent. of phosphoric acid; also from 45 to 50 per cent. of lime. And as regards the growth of cereals, he says that Thomas phosphate gives more rigidity to the straw and resistance to rust, while the grain is larger and richer in gluten. Potash salts give surprising results in soils rich in lime and poor in potash." In our wetter districts dressings should be

limited only by what leaves a profit from the first and subsequent crops.

The physical qualities of the soil naturally are of the greatest importance for the action of fertilisers, and so much is certain that the more favorable the conditions of growth are as regards these and moisture, the greater may also be the quantity of commercial manures suitable for the particular crop wth a view of obtaining the largest crop and net profit. In some cases, even in our climate, losses of plant food may occur where the soil cannot absorb it, or the permeability to water is very great in sandy and gravelly soils resting upon a percolating subsoil, and there it is advisable to use manures that slowly decompose, as farmyard dung, green manuring, blood manure, or fertilisers like bonemeal and Thomas phosphate. Where the water sinks too quickly even these might be given in smaller doses from time to time, so as not to lose plant food. In naked fallow there is comparatively more danger of losing it in such soils after heavy rains, but they are better not fallowed.

I find that last year, up to May 31, 219,000 tons of the Star Brand alone of Thomas phosphate, irrespective of other brands and superphosphates, were used for agricultural purposes in Germany, as against 138,000 tons in the same period of the previous year. There was altogether a yearly consumption of 300,000 tons of phosphoric acid in one form or another. In Europe in 1899, 1,800,000 tons of Thomas phosphate and 975,000 tons of superphosphates were used, against 107,688 tons of potash in the form of 80 per cent. muriate of potash, 90 per cent. sulphate of potash, and of sylvinit and kainit. Although the sale of potash for agricultural purposes was constantly increasing, the quantity used in 1895 having been seventeen times greater than in 1880, Professor Dr. Wagner has last year clearly shown that the proportion of three of phosphoric acid to one of potash is for very large districts in Germany (and probably also here) entirely wrong. If the highest returns are expected, considerably larger quantities of potash are necessary. He thinks that 200 lb. of phosphoric acid require 268 lb. of potash, instead of as present only 66 lb. of potash. If the larger quantity of potash is not given the supply of it in the soil is drawn upon, so long as it lasts. Under any circumstances, "it exists chiefly in insoluble compounds in the soil," as stated by Professor Wright, of Glasgow, and the plants may find only a thousandth part of 1 per cent. soluble, where we find 3 per cent. or 4 per cent. in the soil. They have, therefore, to search for it, and cannot consume it quickly and easily enough in proportion to the phosphoric acid and nitrogen supplied. It is also not quite correct to say that only sandy and moor land require potash, and that clay and strong loam contain a sufficient supply. It is the exception, not the rule. Professor Wright and C. M. Aikman say in "Potash Manuring: Its Value to British Agriculture": "In whatever form the potash is absorbed it has been, at any rate, proved beyond doubt to be an absolutely necessary ingredient for the growth of all crops." Frequently, however, the wrong potash manure is being used for clayey soils, for kainit contains too

much common salt, except it is the "new kainit of 40 per cent. potash" now produced at Stassfurt (which is not exported to Australia), or else muriate or sulphate of potash, 8 lb. of muriate being equal to 10 lb. of the 40 per cent. new kali. Nitrogenous manures, as nitrate of soda and sulphate of ammonia, are also applied to German soil in surprisingly large quantities. It is, perhaps, not always quite understood why nitrate of soda acts so quickly. It contains as nitrogen, nitric acid, which represents, ready-made, the form which nitrogenous materials must assume before plants can make use of them as plant food. Other nitrogenous manures must first undergo a change, and cannot act with such rapidity. 976,592 bags of nitrate of soda were delivered in 1899 into Atlantic ports of the United States, mostly from the West Coast of South America. England, France, Belgium, Holland, and the United States use enormous quantities of commercial manures of all kinds, and for all crops. South Australia has lately imported much larger quantities, which will be mainly used for cereal crops; but mistakes are frequently made. The proper balance between the application of the three main plant foods not being kept, the result is certain to be disappointing after any of the constituents naturally stored in the soil have been used up. Larger returns from well-directed manuring, but smaller areas, is the advice that I hope will be followed shortly, and that the net income will be all the larger. Every acre not used for grain-growing is a clear gain for your cattle.

Whether it pays to purchase commercial manures is the question often raised, and it is a reasonable question. Another question is whether the use of commercial manures does not eventually exhaust the soil. It should not be asked by persons who admit that these manures are plant food, not merely stimulants, which do abstract the plant food from insoluble compounds they find in the soil, unless you give only one manure, not nitrogenous, potassic, and phosphatic manures together in such quantities as the soil requires. But to manure conscious of what you are aiming at is up to the present in Australia only an exception. We must seek the information elsewhere, with a few facts from our best farmers; and, as nothing convinces more than ocular demonstration, where the enquirer cannot himself see the results of experiments, I have found it useful to reproduce photographs with them. In Germany the number of leaflets dealing with special cultures is very great, and they, together with personal visits to the thousands of farms using commercial manures in an intelligent manner, and in ever-increasing quantities, have resulted in the conviction of thousands upon thousands of farmers and gardeners, that they cannot any longer dispense with their use if they hope to get payable crops.

From the foregoing it must become apparent that most of our farmers have yet much to learn. Experience is good; experiments are better. The former may be obtained at great mistakes and losses; the latter can be carried out at a trifling cost; and by them you may lay the foundation to know how to improve your farm or garden, and of future wealth. A few turns of the drill with one

fertiliser, a few turns without one, then again with a larger quantity of the fertiliser, and in turn in the same manner with the other fertilisers, and finally with two mixed you will quickly and cheaply learn what your soil wants. Maximum crops at the smallest cost only pay to-day, and rational application of manures is, therefore, imperative, and gives us the only chance of contending with low prices. Many farmers having had good crops with phosphatic manures say they require no other, but they should consider that nitrogen and potash has been drawn from the soil, and it stands to reason that sooner or later the soluble supply of these plant-foods must give out, and the crops get poor again.

The remarks made by Messrs. Proebsting and Arnold in "l'Epuisement en Potasse Sols Belges" for 1901 will before long be here quite worthy of consideration, that the constantly increasing use of phosphoric acid becomes there already in a good measure unproductive through want of potash. The loss through the inefficient use of potash represents for Belgium already fantastic sums, for nitrogen and phosphoric acid alone are exhausting the soil of potash, and impoverish the cultivated land yearly by a net deficit of 77,366,000 lb. of potash, after allowing for the potash in farmyard dung, urine, and last year's quantity of potassic manures used by Belgian farmers.

GENERAL REMARKS ON GROWING CEREALS.

It is doubtless correct that in our more arid portions of the North, the subsoil is of more importance than the mostly shallow worked surface soil. Unless you can irrigate you must fallow early, and utilise the winter rains by making the subsoil your reservoir for the next crop. But to retain the benefit of the moisture thus stored in the subsoil, you must mulch the surface as well as if you had irrigated, that is, have a layer of loose, well-tilled soil, three inches deep, for cereals, which will prevent too rapid evaporation to a great extent. The fact that weeds make their appearance on fallow long after all rain has ceased, while lands not stirred and sun-cracked are quite bare, shows that moisture has been conserved and is raised to the loose, tilled surface. But, of course, very shallow ploughing, especially in clay loams, year after year, may form a ploughsole, that prevents the roots from penetrating deeper; they are, in that case, subject to the injurious effect of the hot, dry surface-soil and air. I do not think that by going gradually a little deeper, the surface soil will be poisoned for the next season's crop very often by "raw" subsoil, and a somewhat deeper mould, having been exposed to our powerful solar heat, is of very great advantage. According to experiments made in California with a similar climate by Professors Hilgard and Loughridge, the difference of moisture kept in cultivated and uncultivated land up to 6 ft. depth is 244 tons per acre; but even the first foot is 42 tons in favor of cultivated ground. The hygroscopic moisture absorbed from the atmosphere varies according to the texture of the soil. In sandy soils there is usually found 2 to 3 per cent. present; in loamy,

4 to 5 per cent.; and in heavy clays, from 8 to 10 per cent. Mr. W. Lehmann, of Murray Bridge (13.90 in.) read a very good paper on "How to Grow Good Crops with Commercial Fertilisers in Dry Districts (from 12 to 14 in.)" He also recommends early fallow to a depth of 4 to 7 in., and, whereas sandy soils grow the finest crops of wheat with artificial manures, he maintains that we should prepare all soils to closely resemble sandy soils by fallowing about 5 in. deep and subsoiling another 7 in., where such can be done fairly easily, and thus conserve more moisture. Mr. Jos. Correll, of Minlaton (Y.P.), in his very practical paper read at the Congress of 1898, has come to the same conclusion after he had subsoiled some land. Mr. Lehmann also suggests to give to the subsoil a certain quantity of slow-acting manure, as Thomas phosphate, guano, guano super, or bonedust. To drill in commercial manures to a depth of 2 to 4 in. gives the grain for a time a luxuriant growth, which cannot afterwards be maintained in all cases unless fed from the subsoil.

Professor Dr. P. Wagner states that generally cereals require manures containing all three plant foods, only that barley and rye require less nitrogen than oats and wheat. As normal doses (for Germany), within which you may select them for cereals, in accordance with the state of the soil, he recommends per acre:

	Nitrogen.	Phosphoric Acid.	Potash.
Low manuring ...	12 lbs.	24 lbs.	24 lbs.
Medium ...	20 lbs.	40 lbs.	40 lbs.
High	48 lbs.	64 lbs.	80 lbs.

12 lb. of nitrogen are found in about 75 lb. of nitrate of soda, or in a little less of sulphate of ammonia; 24 lb. of phosphoric acid in about 130 lb. of Thomas phosphate, or in somewhat less superphosphate; 24 lb. of potash in 180 lb. of kainit, or in about 40 lb. of muriate or sulphate of potash.

These will be found large quantities for South Australia, if it comes to high manuring; but it must not be forgotten that Thomas phosphate, which Wagner had in view, has, as well as all the potash manures, a large residual value. Dr. Aitken concluded from experiments made by him from 1887 to 1893 that sulphate of potash had a tangible residual value for five years and muriate of potash for four years. The quantity applied to a cereal crop may, therefore, be larger than required, but is available for future years. Our clay soils generally do not seem to require any manuring with potash as yet, but it is quite different with sandy soils.

WHEAT.

A few words on the tillage of wheat from a lecture by Professor Maercker may be useful, especially for exposed positions: "For wheat the land should not be too finely pulverised; it prefers a certain quantity of clods in the soil, which keeps off the wind, which often plays mischief in the spring during long, anxious periods of drought, when the young plants find shelter in the clods." He also said: "A dressing of nitrate of soda for wheat is absolutely necessary, except after lucerne broken up, or another leguminous, that

is, a nitrogen-gathering crop. After a nitrogen-consuming crop, on the other hand, an intensive and reasonable full application of nitrate of soda is remunerative. One hundredweight of it, applied in two doses, early, and when beginning to form stems, will produce 3 to 4 cwt. more of wheat and the corresponding straw. Fine loam and clay soils, rich in humus, contain naturally so large an admixture of potash, and in so soluble a condition that in their case manuring with potash would be useless. On lighter soils the case is altogether different. We are not overdoing sandy soils if we dress them with 12 to 18 cwt. of kainit per acre; but manuring with kainit has very unpleasant collateral effects, as it promotes clods in the soil and incrustation." Other potash salts are, therefore, preferable.

Farmyard dung should not be used in a fresh state at all events. In Europe the risk of using it—and especially where rusty straw has been used, has long been recognised. There, it is thought, that the combination of acids contained in commercial manures contributes to the destruction of the resting spores of the rust fungus, and tend to weaken, or even destroy, the rust altogether. The fresh dung is also likely to produce rank, soft straw, which seems much more inclined to propagate rust. But if farmyard dung is used to a previous crop, then with the assistance of commercial manures, good crops can be obtained in South Australia, in some districts with a better rainfall, even splendid crops. The late Professor Frank expresses the opinion that, while nitrate of soda may be favorable to the development of rust, Thomas phosphate has distinctly the contrary effect. Kainit and other potash salts are also named by others as protecting wheat against rust and other diseases. Frank also mentions the "Eppstein" wheat, according to all farmers, as the wheat which best resists rust. (I forwarded a sample of it to Professor Lowrie, Mr. Roediger, of Gawler River, and Mr. Jos. Correll, of Minlaton, who think it too late a wheat.)

As our wheat crops are by far the most important, and may oblige many farmers, impoverished by a cycle of dry seasons, to curtail the quantity of manures they might wish to purchase, it is my first duty to ask them to make some experiments of a simple but practical nature. I do not favor analyses of soil as their guide. They are deceiving. Much of the plant food found by the analyst, and recorded, is frequently not at once available; but the farmer himself should try on a small scale, of one-tenth of an acre, one plot with potash alone, one with a phosphatic manure alone, others with nitrogenous manures, such as sulphate of ammonia, nitrate of soda, and some ammoniacal Peruvian or other guanos. Dr. Lawes pronounces Peruvian guano one of the best artificial manures for wheat, if 2 to 3 cwt. per acre are sown broadcast. And Voelker, agreeing with him, said that 2½ cwt. per acre should increase the wheat crop by 12 bushels of grain and 8 cwt. of straw, provided the brand has a guaranteed analysis to contain from 14 to 16 per cent. of ammonia. If the percentage is much less, sometimes only 6 per cent., such results cannot be obtained. Many guanos are only rich in phosphates. If the

farmer notices any increase in the crop of any plots over an unmanured plot it shows him that the soil is benefitted by such manure. In other plots he may combine the above two manures of potash and nitrogen and either of them with a phosphatic manure; also give a complete manure of all the three plant foods. In thus ascertaining whether his soil is rich enough in one or other of the plant foods, he can afterwards save considerable sums. Unfortunately our farmers are either not inclined to make exact experiments, or the want of labor, or necessary hurry at harvest time makes it for them very difficult to carry them through. It will, in such cases, be at least an advantage if they let the drill make for them the experiments. After they have drilled in any grain and manure, they then let the drill run on without manure for some turn-abouts, and then resume manuring with the same or other manure. In most cases they will have thus an ocular demonstration of the value of the manure, which should be added to by separate reaping and thrashing of at least a small average sample in a bag. Meanwhile, it being hitherto almost taken for granted that our arable soil in Australia requires for wheat only phosphoric acid, and before the farmer has convinced himself that nitrogenous, or potassic manures, or both, are required, he may as well manure for his main crop with phosphoric acid alone; but try light, medium, and heavy dressings of the different phosphatic manures. The majority of our farmers give at present the preference to superphosphates, others to Thomas phosphates. As regards the latter it should not be forgotten that, while it does not act so quickly, it does not merely benefit the first crop; no, many subsequent crops, frequently up to seven, unless you apply too small a quantity. In connection with the prominent part which phosphoric acid takes in the growth of plants, says Dr. Meyer: "A large quantity of available phosphoric acid quickens and strengthens the growth while young, and increases afterwards the whole green bulk of the plant, ripens any grain. seed, or fruit earlier, increases the value of fodder plants, and is the first condition to enable leguminous plants to collect nitrogen from the atmosphere. Without a sufficient quantity of phosphoric acid the proper development of the organs for the propagation, especially also the pollen of the cereals, &c., is not conceivable." And Professors Wagner and Maercker hold similar opinions.

The use of phosphatic manures has quickly increased in South Australia, and, although quite double last season's quantity has probably been imported, there will be many farmers disappointed who have not given their orders very early. Fairly good results have also been recorded at different times in our "Journal of Agriculture," so long as we only compare them with the very poor crops grown upon unmanured land But in good seasons, such as we now hope for, larger returns should yet follow with larger doses of manure. We should not be content with present results, of which much has been made. They should all the more induce us to sow no crop without manure, and also to try the two hitherto neglected plant foods in

conjunction with phosphoric acid. When even the poor white sand which I saw in the Hundred of Ramsay, Yorke's Peninsula, gave a fair crop of wheat with only 80 lb. of superphosphate per acre, as applied by Mr. C. Smith, what may we not expect? Plants cannot shift quarters to collect food that may be at even only a little distance away, like animals; so you must bring their food to them, and plenty of it, not merely an apology of a complete feeding.

After saying so much on the use of phosphates, I wish to at least call attention to some paragraphs from Dr. Benjamin H. Paul, F.C.S. in his "Dictionary of Chemistry," that, in regard to cereals, nitrogen is generally the minimum constituent of a soil, and that, therefore, the removal of this element is the main cause of the exhaustion produced by the exportation of these crops, and that the value of a manure can, other circumstances being equal, be determined by the amount of nitrogen it contains. A wheat crop, consisting of 25 bushels and 3,000 lb. of straw, contains 46 lb. of nitrogen, equivalent to 55.7 lb. of ammonia. The falling-off in fertility of wheat fields appears, therefore, to be mainly due to the abstraction of nitrogen. When dressed with an ammoniacal guano these soils should, and, I believe, do, yield again increased crops. The ammonia restores the equilibrium, rendering previous unavailable mineral constituents in the soil active. But Lawes and Gilbert also say that of mineral constituents phosphoric acid (in the form of superphosphate of lime) is by far the most effective manure; but, when this manure (or any other phosphatic manure) is used alone, the immediately available nitrogen in the soil is rapidly exhausted. Really large crops can be obtained only when the soil contains, in addition to ash constituents or mineral salts, a due proportion of nitrogenous food. We must not in any case forget Baron von Liebig's "law of minimum," which means that if one of the nutritive substances, be it potash nitrogen, phosphoric acid, lime (to some extent also the less important salts as magnesium and others), are not present in sufficient quantities, the result, so far as a crop is concerned, will be almost the same as if all were deficient. To revive the productive power we must restore the equilibrium, and add as a special manure the substance which was not present in the soil. But, while we may supply the soil with all needed plant food, we are impotent even by adding fertilisers to counteract to any very marked degree unfavorable weather conditions—here mostly drought. This was in another place most clearly shown at the central and sub-stations of the Ohio Experiment Station (U.S.) during 1895 and 1896, when the wheat crop on the thin land suffered severely from winter killing, followed by spring drought, the average, notwithstanding fertilisers, being very low, while unfertilised blocks fell in 1895 to 3 bushels per acre, and for 1896 to 1 bushel. On the heavy clay the wheat was completely destroyed, with but little wheat even on that fertilised. The harvests of 1897, however, showed a handsome profit on the fertilisers in every case, except where nitrogen and potash were used singly, or with these two only, in combination.

Most remarkable was the continuous cultivation of wheat on the same land on the farm of the University at Columbus. The crop was also totally destroyed in 1896, but in 1897 the land, which had been sown with wheat for nine years in succession, without having received any fertiliser, yielded 39 bushels of wheat per acre. This shows how favorable a season 1897 was. The clay land at the Ohio Station reached also 40 and more bushels per acre. As regards the fertilisers used phosphoric acid has given more than twice as great a value of total increase as that obtained from either potash or nitrogen and a 50 per cent. greater increase than that obtained from potash and nitrogen combined, although the phosphoric acid had been used in smaller quantity than either potash or nitrogen. Potash added to phosphoric acid showed about an increase equal to the sum of that obtained from the two used separately; but the increase was much greater from phosphoric acid and nitrogen combined than that from these two used separately. With potash added to the last combination, we have a complete manure, and an aggregate increase more than two and a half times as great as that produced by the phosphoric acid used alone. Phosphoric acid, potash, and nitrogen, all three-produced the greatest increase of crop. The Director of the Ohio Station then states that for wheat the proportion of nitrogen may closely approximate that of phosphoric acid, and he recommends slaughter-house tankage, although a less effective carrier of nitrogen than nitrate of soda. He thinks it the most economical source of nitrogen when due allowance is made for the phosphoric acid carried by the tankage. At all events, the large quantities of nitrate of soda (from 5 to 7 cwt.), used with either superphosphate or Thomas phosphate and muriate of potash, swallowed the whole of the good crop. With tankage a good profit was made.

Director Bühl, of Lorraine, had a similar result with nitrate of soda, combined with either potassic or phosphatic manures, unless he used all three fertilisers in the proportion of only 256 lb. of nitrate of soda, with 480 lb. of Thomas phosphate and 108 lb. of muriate of potash, when his crop of wheat sold for £4/6/5, and the manure costing £2/3/5; the profit was £2/3/ per acre.

Professor Wagner also made a number of experiments with wheat in pots containing 36 lb. of soil to verify results obtained in the fields of the late lamented Schultz-Lupitz, and plates explain themselves sufficiently, viz., that wheat requires also potash, besides a full supply of phosphoric acid and nitrogen.

Experiments in Germany on a mild loam in good heart by Mr. Leesch, of Wolgast:

Without manure	25 cwt. grain, 34 cwt. straw per acre.	
With 3 cwt. kainit, 3 cwt. Thomas phosphate, 2 cwt. nitrate of soda, 8 cwt. lime,	30·20 " "	42·20 " " " "
		Profit, £0 17 2.

The nitrate was given on 15th May (here perhaps September) the others before winter.

Experiments made by Mr. Fastenrath, in Alsace:

Unmanured	8·80 cwt. grain, 27 cwt. straw per acre.	
6 cwt. Thomas phosphate, 1·3 cwt. muriate potash, 3·2 cwt. nitrate of soda,	15 " " 48 " " "	Profit, £2 9 4.

The nitrate increased the crop of straw.

Experiments by Mr. Graefe, of the Agricultural Station at Saxe-Weimar in 1898:

	Grain.	Straw (in lbs.)
Unmanured	960 ...	2,273 per acre.
320 lbs. kainit	1,651 ...	2,889 "
320 lbs. Thomas phosphate ...	1,651 ...	2,851 "
320 lbs. Thomas phosphate, 320 lbs. kainit	2,016 ...	3,081 "
320 lbs. Thomas phosphate, 320 lbs. kainit ... ..., 156 lbs. nitrate of soda	2,582 ...	4,088 "
156 lbs. nitrate of soda ...	1,912 ...	3,168 "

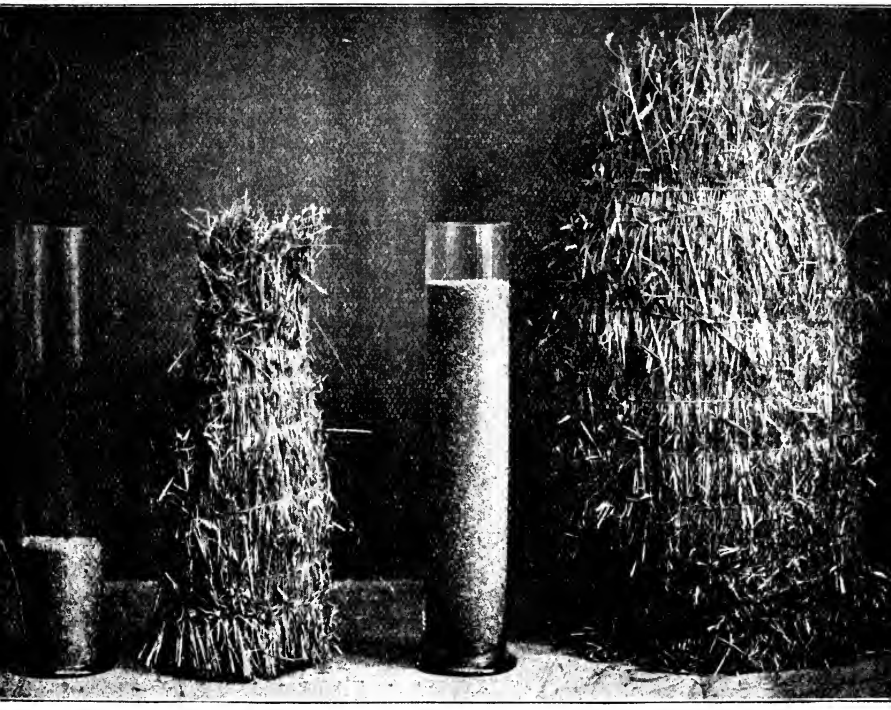


PLATE I.

Experiments by Mr. R. Freytag, of Roitz, per acre on second-class loam :

Unmanured	9·60	cwt. grain,	28·80	cwt. straw.
8 cwt. Thomas phosphate, 4 cwt. kainit, 2 cwt. nitrate of soda,	28·80	" "	52·40	" "

Experiments by Mr. R. Freytag, Roitz, 1898. Photo. $\frac{1}{80}$th acre, second-class loam (see Plate I.) :

Manured per acre with :	Result per acre :
8 cwt. Thomas phosphate 4 cwt. kainit	16.80 cwt. of wheat 28.80 cwt. of straw
4 cwt. kainit ... ... 2 cwt. nitrate of soda ... 8 cwt. Thomas phosphate	28.80 cwt. of wheat 52.40 cwt. of straw

PLATE II.

R. Freytag, of Roitz.—Standing wheat (see Plate II.) :

Unmanured	9.60 cwt. of wheat 21.60 cwt. of straw
8 cwt. Thomas phosphate per acre 2 cwt. kainit ... ... " 2 cwt. nitrate of soda ... "	28.80 cwt. of wheat 92.80 cwt. of straw

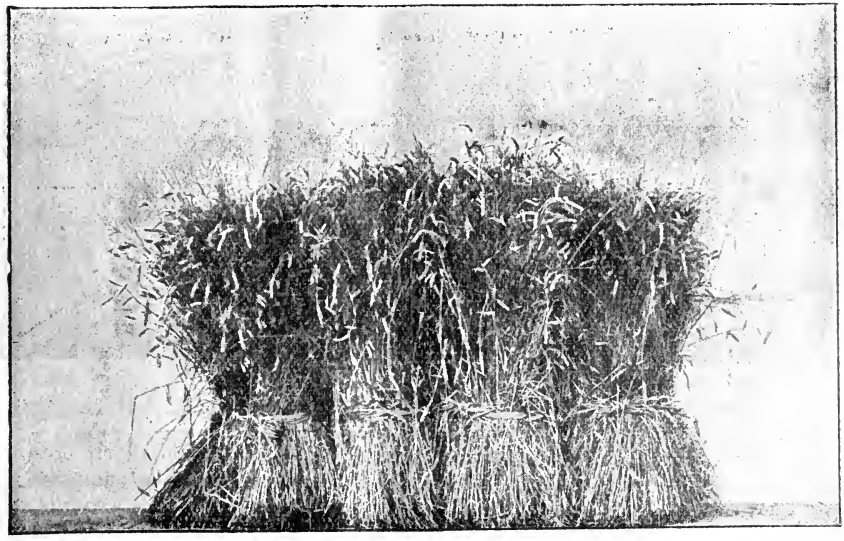


PLATE III.

Jacob Keller's experiments at Ernsthofen (Hesse). Photo. from $\frac{1}{40}$th of an acre. No manure. (See Plate III.)

Result per acre { 1,216 lbs. of wheat
2,920 lbs. of straw

Photo. from $\frac{1}{40}$th of an acre. (See Plate IIIA.)

Complete manuring per acre { 121 lbs. of muriate of potash
80 lbs. of superphosphate
160 lbs. of nitrate of soda

Result per acre ... ... { 1,952 lbs. of wheat
5,072 lbs. of straw

Profit, £3 7s. 6d.

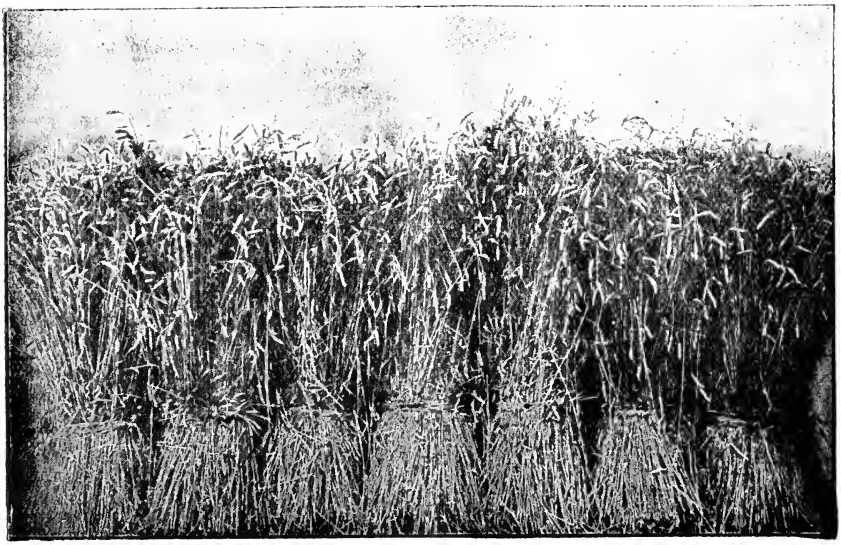


PLATE IIIa.

Mr. J. Keller, of Ernsthofen, made on sandy loam experiments with winter wheat, in each case on three plots, using a complete manure of potash, phosphoric acid, and nitrate of soda, and also leaving out one of them, using only two manures together. All were given as a top-dressing on March 2. The average of each three plots was as follows, calculated at per acre (see plate III and IIIa.):

	Straw.	Grain.	Profit.
No manure	29.2 cwt.	12.1 cwt.	—
Complete manure	50.8 cwt.	19.2 cwt.	£3/7/6
Manure without potash	43.5 cwt.	13.8 cwt.	£0/13/2
Manure without phosphoric acid ...	43.1 cwt.	16.2 cwt.	£1/13/8
Manure without nitrogen	42.4 cwt.	19.6 cwt.	£1/16/8

The field had been heavily manured with stable dung the previous year for potatoes, and contained quite sufficient nitrogen to give 19 cwt. of grain per acre, whether the nitrate of soda was applied or not. Only straw was much less without nitrogenous manure. While phosphoric acid was much required, as can be seen, potash was much more so, the profit sinking, without potash, by £2/14/6 per acre.

Professor H. Boiret recommends the usefulness of phosphoric acid to give the straw of cereals more rigidity, early ripening, and heavier grain. In a French essay received just now I find a most interesting plate, showing plants of "Golden Drop" wheat, how they appear without manure, with farm dung, without Thomas phosphate, without lime, without potash, without nitrogen, and with a com-

plete manure. It shows plainly you will obtain nothing from nothing, and without manure no payable harvest. The following results of manuring wheat with Thomas phosphate are also therein mentioned. M. Billiard, of Montiers, harvested without manure from an acre 1,520 lb., and manured with 800 lb. of Thomas phosphate 2,560 lb., which represented a profit of about £5/12/ per acre. MM. Munier and Marsal, of Badonvillers, had only 496 lb. without manure and 1,472 lb. with 800 lb. of Thomas phosphate, netting £5/8/. M. J. Borey, of Trevey, had 1,240 lb. without manure and 4,960 with 800 lb. of Thomas phosphate, netting £5/4/. M. G. Cornec, of Trevoacoc, had 656 lb. without manure and 1.367 lb. with 344 lb. of Thomas phosphate. M. Riomet, of Villeneuve sur Fere, had from "Mars" wheat 688 lb. without fertilisers and 1,760 lb. with 360 lb. of Thomas phosphate. M. Lallio, of Foulun, had with dung alone 616 lb., and with dung and Thomas phosphate 1,648 lb. M. Jacques, of Heillecourt, had, without fertilisers, 1,076 lb.; with 480 lb. an acre, 1,520 lb., and manured with 800 lb. of Thomas phosphate and 80 lb. nitrate of soda, 2,252 lb.; and on adding to the latter 160 lb. of muriate of potash, 2,976 lb. A good formula for medium manuring for wheat in France would be per acre 8 cwt. of Thomas phosphate, 80 lb. of muriate of potash, and 80 lb. of nitrate of soda.

Mr. John Woolley, of Skimblecott Farm, Montgomeryshire, has produced the "Big Wheat Crop" of 77 bushels per acre in 1896. His farm consists of 346 acres, half of which he leaves in pasture. Yet he made liberal purchases of bonemeal and superphosphate years ago, and now uses annually from 40 to 60 tons of Thomas phosphate, and says: "A good phosphatic heart is the foundation of all profitable agriculture."

I may here mention that probably the biggest return from one bag of wheat was reaped in 1898 by Mr. Pfitzner on a river flat of the Murray, above Morgan (about 9.24 in.), without any fertiliser, viz., 90 bags. The land was never cropped before. This year he has again, on a similar flat, as good a crop.

In many parts of Tasmania one manuring is expected to last for three crops, viz., potatoes, wheat, and oats. Elsewhere the farmer fallows, as at Spring Bay, Clarence, and Woodsdale, and is satisfied with 12 to 15 bushels per acre in a dry season like 1899-0. In Flowerdale they use 4 cwt. of bonedust or Thomas phosphate for potatoes and expect 20 bushels of wheat as the next crop; in East Mersey up to 26 bushels. H. Young had at Longford best results, viz., 23 bushels, with 1 to 1¼ cwt. Sydney bonedust, or with Thomas phosphate; and G. Gill 22 bushels from 1¼ cwt. Huon guano. The average per acre for 1898-9 was 27 bushels; for 1899-0, 17.12 bushels, on respectively 85,287 and 64,328 acres.

Before recording some of the trials with fertilisers in South Australia, I give Professor Lowrie's recommendations, viz., generally phosphatic manures alone in lots of about 2 cwt. per acre of bonedust, bone or mineral superphosphate, Thomas phosphate, and phosphatic

guano. Where nitrogen is deficient from 1½ to 1¾ cwt. of superphosphate. with ½ to ¾ cwt. of sulphate of ammonia; or 2 cwt. of Thomas phosphate, and ½ to ¾ cwt. of nitrate of soda; or 1½ to 2 cwt. of bonedust and either of the above quantities of sulphate of ammonia or nitrate of soda should be used. Some land may require 2 tons per acre of quicklime, and light lands 3 cwt. of wood ashes or 1½ cwt. of kainit. This year's crop of wheat up to 32 bushels of wheat with 19 in. of rain proves how correct Professor Lowrie has judged his soil. That heavier dressings of phosphates at all events gave better results, not only as regards crops, but also profits with a fair rainfall, is sufficiently shown by the experiments made at our Roseworthy College Farm, and by not a few farmers. Even with the high prices paid for such manures, to which the cost of cartage must be added, and with the low price of wheat, 1 cwt. of a phosphatic manure secured in 1899 against 6 bushels 21 lb. without manure, 14 bushels 48 lb., and a net profit of 16/9, and 2 cwt. gave 18 bushels 53 lb. and a net profit of £1/2/10 at Roseworthy. Profits, of course, would be less where the land is already in very good heart as regards phosphates, and where perhaps nitrogen and potash is wanting and not supplied to utilise any extra quantity of phosphoric acid. In 1897 2 cwt. yielded at Roseworthy 22 bushels, and in 1900 30 bushels 16 lb. The unmanured block produced 10 bushels 10 lb., and 1 cwt. produced only 3 bushels 14 lb. more.

Against Professor Lowrie's opinion I will mention that of Mr. A. N. Pearson, the Victorian Chemist of Agriculture, who thinks that Mr. Telford's experiments, made at St. Arnaud, and another set at Jeparit, in dry districts of the State of Victoria, prove 20 lb. of concentrated superphosphate on one-twenty-fifth part of an acre to be for those districts as best paying for wheat, and that the dipping of grain in a tub containing superphosphate had also given favorable results, although only a few pounds stuck to the grain. This latter plan, however, has certainly not found many followers.

Dr. Howell, the Agricultural Expert for Victoria, himself convinced of the value of commercial manures, is now arranging again for hundreds of experiments in Victoria to show that phosphoric acid, and next to it, nitrogen, is wanted, which latter might be obtained from leguminous crops. Experiments containing potash are, however, also to be made.

The experiments made at the Clare Agricultural School gave on land not manured at the rate of 11.1 and 15 bushels per acre; with 120 lb. of each muriate of potash and nitrate of soda, 19 bushels; and with an addition of 400 lb. of Thomas phosphate, 26 bushels and 26 bushels 6 lb.; 400 lb. of Thomas phosphate and 120 lb. of muriate of potash gave 20 bushels; and 400 lb. of Thomas phosphate and 120 lb. of nitrate of soda, 25 bushels 3 lb. (rainfall 24.30 in.).

Some of the members of the Nantawarra (15½ in.) Agricultural Bureau recorded interesting results for a dry year. Mr. Jas. Kelly had at Mount Templeton on stiff clay land, with 80 lb. English superphosphate, 11 bushels; with 90 lb. bonedust, 7¼ bushels; with

60 lb. bonedust and 30 lb. English superphosphate, 12 bushels; 35 lb. of King's Early Solid Straw wheat drilled with 100 lb. of Thomas phosphate, 17¼ bushels; and he believed Thomas phosphate would pay for their heavy soil. Mr. A. Robinson agreed that it gave better results on dry than on marly land. Mr. Ratten had from Purple Straw, with 112 lb. Kangaroo Island guano, 9 bushels; with 112 lb. colonial bonedust, also 9 bushels; with 75 lb. superphosphate per acre, 16 bushels. Others also recommended drilling with 100 lb. superphosphate, and Mr. Frost broadcasting apparently with 120 lb., although Mr. Nicholls found a crop manured with Thomas phosphate was far better than one with English superphosphate. Both fields had been badly affected with take-all the last time they had been cropped.

Mr. A. Jarrett, of Maitland (19.80 in.), Yorke Peninsula, had taken seven crops from his land before drilling in Thomas phosphate, and reaped 24 and 28 bushels per acre. Mr. E. Kains, of Balaclava (15.94 in.), reported well on Thomas phosphate, much against his expectation on rubbishy limestone land, and also as regards after-effects. Mr. T. Corlett, of Yorketown (18.08) reported that a plot of wheat manured with Thomas phosphate yielded four times as much than an adjacent unmanured plot; and Mr. Domaschenz had quite doubled his crop. Mr. A. Bairstow, of Narridy (16.78), applied 5 cwt. bonedust per acre, and to another field Thomas phosphate (how much ?), and reaped 3 bushels 20 lb. more than from the former. Mr. P. Anderson had no drill, and broadcasted in 1895 on 20 yards square 15 lb. of Thomas phosphate, which yielded double as much straw and four times as much wheat as the land alongside; and in 1896 the patch showed very distinctly that the manure was not all taken out by the crop of 1895. Professor Lowrie also stated in a lecture at the eighth annual Congress that Thomas phosphate giving 3 to 4 bushels less than different superphosphates would no doubt show to advantage in the next crop. It was applied, however, also with profit to the crop then reaped, though the year was exceptionally dry, the rainfall being only about 14 in. Mr. Jos. Correll, of Minlaton (17.62 in.), remarked once that superphosphate and Thomas phosphate, sown side by side, yielded equally well. He also gave in 1900 to his wheat 100 lb. of Thomas phosphate, and to other fields from 73 to 93 lb. of Lawes superphosphate per acre, and mixed with the latter 7 lb. of Thomas phosphate (Bilston's) to counteract any injurious effect from an excess of sulphuric acid the superphosphate might contain. There was no difference visible in the two crops; but the fertilisers ought to have been given at different times. Mr. W. Correll tabled wheat plants manured with Thomas phosphate, also with it and sulphate of potash, and with mineral super. The plant which received potash was much more robust than the others. Where potash and super. had been applied there was apparently no benefit from the potash. He thought the potash made the phosphoric acid in the Thomas phosphate more readily available.

On the experimental plot near Millicent (29 in.) a block was sown with wheat and one with barley. Half a hundredweight of superphosphate, costing 3/, was drilled with the seed. Result, 36 bushels of barley and 20 bushels of wheat; and this in a neighbourhood where cereals are not generally grown with much success. Mr. Shannon, of Kapunda (19.65 in.), had used 1 cwt. of English superphosphate on a piece of land that would not even grow grass without manure, and reaped 23 bushels of wheat per acre; while Mr. Woithe, near Point Pass (about 16 in.), had as good a crop with Thomas phosphate. Mr. M. Rankine, of Strathalbyn (18.91 in.), reported on his experiments with 5 and 7 lb. of sulphate of ammonia and 50 lb. superphosphate, and others with 5 lb. of potash, 4 lb. of ammonia, and 35 lb. of superphosphate, and with 7 lb. of potash and 50 lb. of superphosphate; that the best results were from the plot receiving the most potash, and he believed similar land in the district required potash. The returns were in every case quite satisfactory.

Mr. A. M. Dawkins, of Gawler River (18.90) reported that King's Early wheat, manured with 1 cwt. guano super, yielded 21 bushels per acre, against 12 bushels from unmanured crop. Bonedust was praised by some members of the Gawler River Bureau, but Mr. Badcock and Mr. Badman got double the crop with Thomas phosphate against unmanured land. Mr. Kluske, of Eudunda (with 16.96 in.), manured for Purple Wheat on fallow land with 95 lb. bonedust and 250 lb. sheep manure, and reaped 15 bushels. Mr. A. W. Morrison, of Brinkworth (with 15 in.), used 60 lb. of superphosphate per acre on 50 acres, and reaped 16 bushels per acre, against 4 bushels where not manured. Mr. Stribling, of Stockport, had 17 bushels per acre on 22 acres manured with 1 cwt. of Thomas phosphate; and Mr. Godfrey reaped 19 bushels from Early Para per acre from 16 acres, and 23 bushels per acre from 33 acres of Dart's Imperial, and stated that Thomas phosphate pays well on poor red land. A farmer at our Congress of 1899 also stated that five crops of wheat were grown in twelve years on the same land manured only with some phosphatic fertilisers, and the average of the crops was 20 bushels. This being a good crop for South Australia, the soil must have contained sufficient nitrogen and potash made available by fallowing to act with the phosphates. It does, however, not preclude the great probability that complete manuring might have given still better crops.

Mr. C. Lewis, of Cherry Gardens, in our hills, with a larger rainfall (certainly over 30 in.), reported that he obtained 24 bushels of wheat per acre from land nearly worn out when applying 3 cwt. of Thomas phosphate per acre. Without manure it would not produce more than 8 bushels. Mr. Langberg, of Lucindale (with 22½ in. of rain), had seen no improvement in his wheat crop after using 2 cwt. of bonedust. Mr. Mudge, of Pine Forest, applied ½ cwt. of Thomas phosphate to half an acre of poor sandy soil, on which wheat

had failed for some years, and he had 12 bushels per acre. Without manure his crop was 2 bushels per acre.

Mr. Chittleborough at Neuarparr (about 20 in.) harvested from new land for some years 8 bushels per acre; afterwards only 4. When using Naracoorte guano he had with 2 cwt. per acre 12 bushels, with 3 cwt. 18 bushels. At Boothby (13.75 in.) Messrs. Sims and Robinson stated that where Thomas phosphate was drilled in the year before, the crops, though sown some weeks later, showed much more growth than those alongside; and Mr. Mills said that, although he did not derive any benefit from manuring with Thomas phosphate in the dry season of 1896 for onions, the wheat and cabbages planted in 1897 on the plot were far stronger than those on adjoining land, and last season's manuring was most marked. Mr. Turnbull, of Boothby, thought the Star phosphate most suitable in the sand and stony ridges of the district. At Port Lincoln (with 20 in.), Mr. J. D. Bruce reaped 18 bushels per acre where he had used 2 cwt. of Island guano at 35/ a ton, against 9 bushels where not manured. At Lipson (13.60) the local guano was not successful. At Bordertown (with 21 in.), Mr. G. Mills used on 5 acres 42 lb. of seed and 56 lb. of Thomas phosphate per acre, with a yield of 10 bushels. Where he used 52 lb. of seed and 65 lb. of Thomas phosphate the yield was 12 bushels; 52 lb. of seed and 80 lb. of Thomas phospahte increased the yield to 17 bushels upon worn-out soil. Mr. W. Correll, of Minlaton (with 17.62 in.), had with 20 lb. of sulphate of potash mixed with Thomas phosphate 5 bushels more than with phosphate alone. To show that a clay soil generally rich in potash (and so in this case) can still derive benefit from potash manures, I would refer to the experiments made in pots, without and with 12 grains of potash, by Professor Wright, of Glasgow, which show the same advantage as the potash applied to sandy soil, which contained but little of it. Too much depends in South Australia on the wheat crops, and the general opinion amongst farmers being that phosphatic manures may be used alone, and give them a good return year after year, I think that I must raise a warning voice again, and state that the continued use of phosphates alone takes all nitrogen and potash from the soil, and the effect will be the same as cropping without manure—exhaustion of the soil.

It is very pleasing to read the many good reports of the crops for 1900-1. Even in the hilly parts of the Far North of South Australia there have been crops up to 20 bushels per acre where commercial fertilisers had been used. So had Mr. J. McColl, of Quorn, 22 bushels from Dart's Imperial; and Mr. A. F. Noll 20 bushels from Purple Straw with phosphatic manures.

I will not conclude without mentioning the great advantage sheep are to our wheatgrowers. Sheep will turn what now goes to waste in wild oats and weeds into wool and mutton if you divide even a small farm of 300 acres into four paddocks, where the rainfall is fairly good. Only one of them should be cropped, and the others changed about for feeding perhaps 100 ewes; or where the feed is very good.

and some turnips and mangolds can be grown, more for the purpose of growing lambs. If one of the, say, 75-acre paddocks has been grazed three years by sheep the land will be cleaned, and will require, after an early fallow, but comparatively little commercial manures, chiefly phosphates. It is quite certain that the farmer will reap more grain from one field than he had formerly from two of them, and saved probably the wages of a laborer and half the seed.

OATS

is altogether, perhaps, too much neglected in Australia. New Zealand can place a better article on the market, and generally at a low price. There are, however, localities with a good rainfall where oats should pay at least as well as wheat. Last harvest showed again a falling-off in the acreage by 5,594 acres with oats, it having been only 20,229 acres, yielding 218,331 bushels, or 35,671 bushels less than the year before.

Results in South Australia have been sometimes fairly good. Mr. J. Riddoch, at Lucindale (22.57 in.), put in every other year 2 cwt. of bonedust on 5 acres, and reaped 20 bushels per acre of Algerian oats; but when he applied 2 cwt. every year he had 40 bushels. Mr. Frost reaped at Nantawarra (15½ in.) from 40 lb. of Champion oats, with 80 lb. of English superphosphate, 24 bushels, with parts badly damaged by hot winds. This agrees entirely with what I stated at our Congress in September, 1898, that in a long period of drought, or after a hot wind, superphosphate may act injuriously on account of the sulphuric acid contained in it. In Thomas phosphate we have no sulphuric acid, and it is not necessary to make the phosphoric acid soluble for plant food; the acids in the roots of the plants coming in contact with the Thomas phosphate will prepare it for plant food. Much, however, not coming so in contact will remain dormant for one or more years; and Mr. Correll's remark that Thomas phosphate always has given him good returns, and that sometimes the second crop is as good, or better, than the first, is quite in accordance with the experience of scientists and practical farmers.

In Tasmania 40 bushels of oats have been harvested without manure in Ringarooma and Flowerdale; but only from 18 to 25 bushels at Ellendale, Wordsdale, and elsewhere. With 4 cwt. of bonedust or phosphates put in for the next crop of potatoes 33 bushels were reaped at East Mersey.

At Neuarparr (about 20 in.), Mr. Chittleborough used 1 cwt. (mixed wet with oats) of Naracoorte guano, and had 26 bushels of oats (Algerian) upon impoverished land, where his neighbors reaped 4 bushels. Thomas phosphate was, however, making great progress in the locality. It seemed equal to guano or bonedust, and started the grain two weeks before not-manured grain. Mr. Chittleborough uses 56 lb. of Thomas phosphate, which he mixes with the wet grain, whereby he requires much less manure, and it proves beneficial where a farmer cannot afford to purchase or hire a seed and manure drill, and the sowing can yet be done in one act. At Port Elliot (20½ in.)

3 cwt. of Kangaroo Island guano broadcasted in May, June, and July with the oats, the yield was 25 per cent. better than the unmanured. Hot winds reduced the grain crop by one-third. Cost of manure, about 7/ per acre. At the Tatiara (21.13 in.) and Yankalilla (28.14 in.) commercial manures, chiefly bonedust and phosphates, have been given, and the results are stated to have been 30 to 33 per cent. better than where no manure was spread; but there are no quantities given.

Mr. Joseph Correll's father, of Minlaton (17.62 in.), once had 50 bushels of Cape oats per acre off a small paddock, which he subsoiled, without the application of manure. This can be accounted for by the ability of the oats to avail itself of plant food, and more moisture in the subsoil. If not subsoiled, Professor Wagner says nothing but "fall manuring" will give a profitable crop. If nitrogen is omitted, the profit falls off considerably, sometimes a loss is incurred, and in omitting phosphoric acid and potash it is the same. The average of seven fields of oats changed from 1,280 lb. to 2,400 lb. per acre when fully manured. Professor Wagner's recommendation is to use per acre 1½ cwt. of nitrate of soda, 4½ cwt. of Thomas phosphate, and 1¼ cwt. of sulphate of potash per acre, or double the quantity to see which will pay best, and omitting one of the above in three other plots. The nitrate should not be given before sowing, and one-half later on.

Wagner reports the following experiments:—Mr. Jacob Keller, of Ernsthofen, had an average from each two plots of one ar (10 = ¼ acre)—and by me calculated at per acre—with the following manures, of which kainit and Thomas phosphate was given on the 18th of January, and the nitrate of soda, half on the 14th of April, and the other on the 18th of May. The land was a loamy, humose, silicious soil. The two plots that received a complete manure received 494 lb. of kainit, and the same of Thomas phosphate, and 325 lb. of nitrate of soda, and the return was 17 cwt. 22 lb. of grain and 23 cwt. 25 lb. of straw per acre more than from the unmanured plots. Without the kainit the excess was 15 cwt. 28 lb. of grain and 17 cwt. 22 lb. of straw; without the phosphoric acid, 12 cwt. 70 lb. of grain and 15 cwt. of straw; and without the nitrogen, only 6 cwt. of grain and 6 cwt. 25 lb. of straw per acre. The profit per acre of the land receiving the complete manure was £5 above the unmanured; without the kainit, £4/6/; without the Thomas phosphate, £3/8/; and without the nitrate of soda, £1/10/. (See plates IV. and IVA. The complete manuring had subdued almost entirely the wild mustard, which was more or less in evidence on the other plots. Other experiments with oats were made at Neuhof by Director Weitzel, of the Agricultural School at Langen, Agricultural Teacher Ruths and the owner (Mr. Simon). Kainit and Thomas phosphate were given on the 5th of March, half of the nitrate of soda on the 23rd of March, and the other half on the 6th day of May. The soil was not uniform, but poor, and here and there clay in the sand. With three plots for each experiment

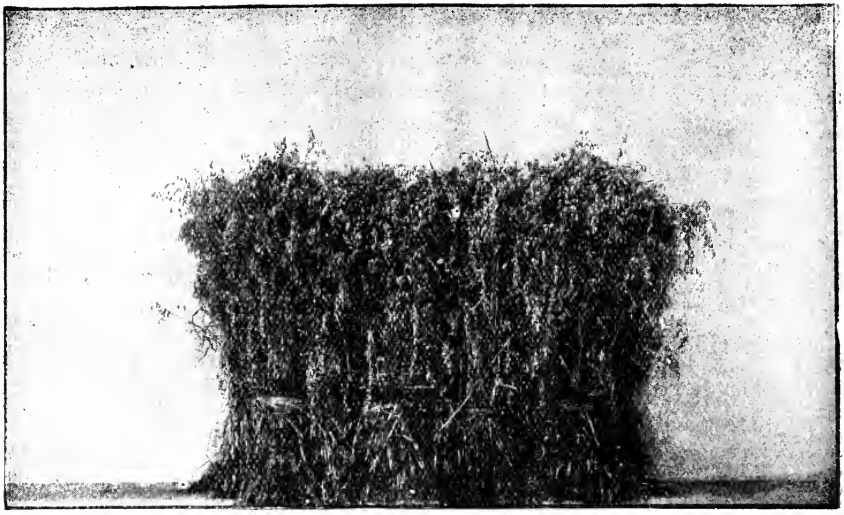


PLATE IV.

Jacob Keller's Experiments. Photo. from $\frac{1}{40}$th of an acre. Without manure.

Result per acre { 1,520 lbs. of oats
2,816 lbs. of straw

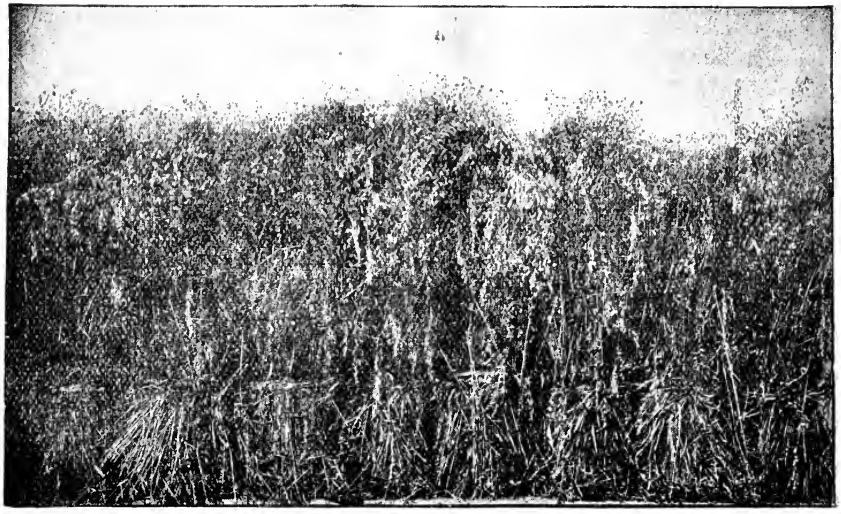
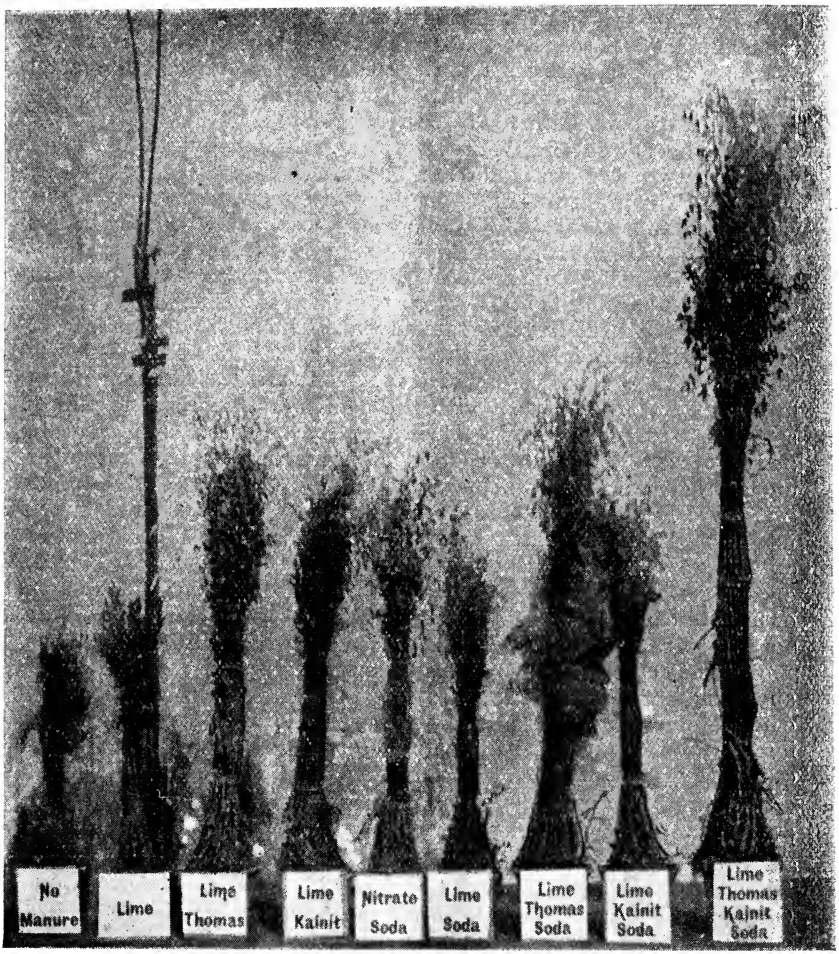


PLATE IVA. Photo. from $\frac{1}{40}$th of an acre.

Manured per acre with { 480 lbs. of kainit
480 lbs. of Thomas phosphate
320 lbs. of nitrate of soda

Result per acre { 3,240 lbs. of oats
5,160 lbs. of straw



1 2 3 4 5 6 7 8 9

PLATE V. Average samples of 9 plots of oats taken in 1897.

No 1. Unmanured
2. Per acre, 16 cwt. of lime
3. " 16 cwt. of lime and 6 cwt. Thomas phosphate
4. " 16 cwt. of lime and 8 cwt. kainit
5. " 132 lbs. of nitrate of soda
6. " 16 cwt. of lime and 132 lbs. of nitrate of soda
7. " 16 cwt. of lime, 6 cwt. Thomas phosphate, and 332 lbs. nitrate of soda
8. " 16 cwt. of lime, 8 cwt. of kainit, and 132 lbs. nitrate of soda.
9. " 16 cwt. of lime, 10 cwt. Thomas phosphate, 6 cwt. of kainit, and 132 lbs. nitrate of soda

these are, however, quite reliable results. The only difference in the manuring was that 250 lb. of nitrate of soda was given instead of 325 lb. The results were, from the complete manuring, 15 cwt. 80 lb. of grain and 25 cwt. 90 lb. of straw more than from the unmanured; without kainit, 11½ cwt. of grain and 16 cwt. of straw; without phosphoric acid, 11 cwt. 80 lb. of grain and 19 cwt. of straw; without nitrogen, 4 cwt. and 80 lb. of grain and 6 cwt. 85 lb. of straw per acre. The profit was £5/2/ per acre with the complete manure; without kainit, £3/8/; without Thomas phosphate, £3/15/; without nitrate of soda, £1/2/10. Other experiments with oats were made by Mayor Heddaeus, at Wolfskehlen, where he used in each case at the rate of 494 lb. of kainit and of Thomas phosphate, together with respectively 250 lb. and 325 lb. of nitrate of soda. The former manures were given on the 5th of March, the nitrate (in two doses) on the 9th day of April and the 4th day of May. The soil was medium heavy loam. The larger return with the additional 75 lb. of nitrate of soda was very marked, viz., 11 cwt. 70 lb., against 8 cwt. of grain and 23 cwt. 40 lb., against 13 cwt. 20 lb. of straw per acre above the unmanured plots. Without any nitrate only 1 cwt. 80 lb. more grain was harvested, and the same quantity of straw, as from the unmanured plots; without kainit, 4 cwt. 40 lb. more of grain and 11 cwt. 20 lb. of straw; without phosphoric acid, 7 cwt. 25 lb. of grain and 22 cwt. 60 lb. of straw were obtained. The profit with 325 lb. of nitrate of soda was £3/0/3 per acre; with 250 lb., £1/12/3; with none, a loss of 7/3. Without kainit the profit was 10/10; without phosphoric acid, £1/17/8. The soil contained much phosphoric acid and little potash, and still less nitrogen. It shows that to manure oats merely with potassic and phosphatic manures seems hardly to improve the crop over unmanured land. Nitrogen also is required to give a full crop. (See plate V.).

On a wet, sandy soil the Agricultural School at Zwischenahn, in Oldenburg, applied 4 cwt. Thomas phosphate, 4 cwt. 80 lb. kainit, and 1 cwt. 20 lb. nitrate of soda. Unmanured, the crop was only 2 cwt. 80 lb. per acre, against 11 cwt. 20 lb., and the profit £2/19/5. On dry, good, sandy soil the difference and profit was much less. Mr. Hellwig, of Torsholt, manured with the same quantities of fertilisers, and harvested from good sandy soil, unmanured, 9 cwt. 60 lb., against 19 cwt. 20 lb., making a profit of £3/1/6. With twenty loads of dung his crop was only 2 cwt. better than the unmanured.

Experiments made at the Agricultural College of Dookie, Victoria, must have been made on land in very good heart, as the plot without manure gave 35 bushels per acre; with 1 cwt. of Thomas phosphate, 39½ bushels; and with 1 cwt. sulphate ammonia and ½ cwt muriate of potash added to 1 cwt. of superphosphate, 59 bushels. This showed how good a complete manure acted, probably the potash in particular, for Professors C. M. Aikman and R. P. Wright, of Glasgow, say that a crop of 60 bushels and 3,175 lb. of straw require 22 lb. of phosphoric acid, 5½ lb. of nitrogen, and 62 lb. of potash. The great quantity of potash required may be the reason that our crops are not

heavy. Their experiments seem also to indicate this where they used 80 lb. of superphosphate and 40 lb. nitrate of soda, and the crop was 13½ bushels less than where 60 lb. of sulphate or muriate of potash was also given, and the potash ripened the crop earlier. Mr. R. W. E. MacIvor, in his "Chemistry of Agriculture," says also that 45 bushels of oats are likely to impoverish the land by about 193 lb. of mineral substances, amongst which are 18.9 lb. of phosphoric acid, 94.1 lb. of silica, 11.8 lb. of lime, 38.1 lb. of potash, and as the straw contains 139.4 lb. of the mineral substances, the grain only 53.6 lb., the straw should be returned or burnt on the land, an advice not likely to be adopted.

The average from forty-eight farms in British Columbia was 63 bushels per acre, and James Gilmore took his oath that his crop of 32 acres of oats averaged 154 bushels per acre, but the report gives no particulars as to manuring.

From France I can give a number of experiments. M. Dumonte, of Croisseroux, had, with 480 lb. of Thomas phosphate, 13 bushels 35 lb. more than without any manure; with 80 lb. of nitrate of soda added to the 480 lb. Thomas phosphate, 24 bushels more; and with the further addition of 160 lb. of muriate of potash, 48½ bushels more of oats per acre. As the unmanured plot gave 31 bushels the land was in fairly fertile state. M. Lecuyer, of Plomelin, had 1,392 lb. of oats, without manure, per acre; with 480 lb. of Thomas phosphate, 1,856 lb.; with 480 lb. of Thomas phosphate and 168 lb. of muriate of potash, 1,992 lb.; with the further addition of 30 lb. of nitrate of soda, 2,320 lb. The land was in still better heart. M. Magnieu, of Oisilly, reaped, without manure, 1,296 lb. of oats per acre, and manured with 320 lb. of Thomas phosphate 1,760 lb.

BARLEY.

It consumes within a few weeks after appearance above the ground quite one-half of the plant food it requires, and it should therefore be applied early. Professor Dr. Wagner says in vol. 100 of the Thaer Library that barley will at first grow very luxuriant if manured with superphosphate. The nitrogen is thus quickly consumed, the crops stop growing, the leaves get yellowish, and the grain thin and ripe before the proper time. He demands "full manuring" for barley. The average of five fields of barley increased over partially manured land from 1,520 lb. to 2,160 lb. per acre. Last year a very successful experiment was made by H. Mueller, of Unterliederbach. He had an unmanured plot, another manured per half acre with 2 cwt. of superphosphate, 1½ cwt. kainit of 40 per cent., equal to about 120 lb. of muriate of potash and ¾ cwt. of nitrate of soda, and a third plot with 4½ cwt. of Thomas phosphate, and the same quantity of potash and nitrate as on the second plot. The cost was equal for superphosphate and Thomas phosphate, the profits on grain and straw were £2/0/10 per acre from plot 2, and £5/1/4 from plot 3. The unmanured crop

yielded 20 cwt., the second plot 29 cwt., and the third 36 cwt., with corresponding increase in straw.

Barley, if rich in nitrogen, is not so good for the brewer, although you cannot expect any fair crop without a nitrogenous manure. If too rich it is suitable only for feeding. For brewing it should be evenly light yellow, thin-skinned, and easily germinating, and rich in starch. The climate near the sea is favorable. A cool temperature, with many showers, farther inland also. A deep, humose loam, which contains lime, is somewhat loose, and not too wet or cold, is the best soil, which must be free from weeds, and not manured with fresh dung. Dr. Aitken reports that the weight and the quantity of the grain was much improved by potash. While from a plot manured with nitrate of soda and superphosphate 16 per cent. was classed as light grain out of a total yield of 1,706 lb., the remaining 1,510 lb. (28½ bushels) weighed only 50 lb. per bushel. When sulphate of potash was added to the above manures the crop yielded 2,761 lb., of which 3½ per cent. was light grain, while the remaining 48.9 bushels consisted of grain weighing 54½ lb. per bushel. It is interesting that Dr. Aitken made four years earlier experiments, apparently on the same ground, which was a clay soil, and it contained at that time as much potash as the crop of barley required. Even a somewhat larger crop could then be grown with nitrate of soda and phosphoric acid alone. Four years later the two plots, receiving only potash yielded 50 per cent. more grain.

M. Monestier, of Montbrun, received, without manure, 1,360 lbs. of barley per acre; with 480 lbs. of Thomas phosphate, 1,920 lbs.; with 480 lbs. of Thomas phosphate and 80 lbs. of nitrate of soda, 2,240 lbs.; with 480 lbs. of Thomas phosphate, 80 lbs. of nitrate of soda, and 160 lbs. of muriate of potash, 2,640 lbs.

In his average of nineteen experiments Professor Emmerling, of Kiel, did not mention the quantities of manures used; but made some remarks. The steamed bonemeal gives up in the first year generally but little of its phosphoric acid, but more of its nitrogen. Kainit with superphosphate or Thomas phosphate gave favorable results on sandy or moor land, not in some of the good loam of Eastern Holstein, where the soil contains sufficient potash. Paul Heddaeus, of Wolfskehlen, experimented with manures for barley on a loamy soil. As complete manure he used 4 cwt. 80 lb. of kainit, and also of Thomas phosphate, with 160 lb. of nitrate of soda per acre; but he had also three plots with only 80 lb. of nitrate of soda. Kainit and phosphate were given on the 5th of March; the nitrate, one-half, on the 9th of April; the other half on the 4th day of May. The average of each three plots was as follows, viz.: 1, without manure, 15 cwt. 28 lb. of barley; 2, with full, complete manure, 22 cwt. 40 lb.; 3, with only 80 lb. nitrate of soda, 18 cwt. 32 lb.; 4, without potash, 18 cwt. 50 lb.; 5, without phosphoric acid, 18 cwt. 50 lb.; 6, without nitrogen, 15 cwt. 60 lb. The cost of the manure for 2 was £1/15/, against a gain of £3/12/ per acre; for 3, £1/7/, against £1/18/4; for 4, £1/6/9, against £1/19/9;

for 5, £1/4/4/, against £1/18/9; for 6, 19/4, against 2/4, or, in the last case, a loss of 17/, which shows that the soil was very poor as regards nitrogen. An experiment to compare nitrate of soda and Peruvian guano was favorable to the latter, as the quality of the barley was somewhat better, especially as regards starch. Experiments giving farmyard dung to barley did not result favorably. Barley being but a short time in growing, experiments made on clay soil by Councillor Hoppenstedt, of Hanover, showed that quick-acting fertilisers were the best to use. The effect of different quantities of potash with 32 lb. of nitrogen and 48 lb. of phosphoric acid per acre on an average of three plots in every case was as follows, viz.: Where beans, with superphosphate and kainit; wheat, with stable dung; turnips, with nitrogen and phosphoric acid had been previously grown, the unmanured plots averaged 1,603 lb. of barley; without kainit, 2,240 lb.; with 320 lb. of kainit, 2,201 lb.; with 480 lb. kainit, 2,307 lb.; with 640 lb. kainit, 2,405 lb. Another quicker-acting potash salt would probably have given far better results.

Mr. F. Novara's experiment with lime on a humose, sandy soil after a crop of mangolds was 703 lb. per acre without manure, and 1,187 lb. with 3,700 lb. of lime, or £1/5/ profit, without calculating the straw.

Barley is not to any extent cultivated in South Australia. In 1900 the crop was only 188,917 bushels from 15,767 acres, being 1,195 acres less than the year before. It is grown more for feeding than malting purposes. The brewers are not in favor of locally-grown barley. My remarks on manuring should improve the sample.

Mr. S. Schinckel, of Naracoorte (22.34 in.), manured with bone-dust, and had a heavy crop. Mr. W. Klenke, of Hartley (16 in.), sowed three acres with 1 bushel each, and reaped 31½ bags of barley, giving 1 cwt. of colonial superphosphate to one-half and 2 cwt. of English superphosphate to the other. The Colonial proved the best. Mr. D. G. Stribling, of Stockport (16.41 in.), manured 22 acres with 1 cwt. Thomas phosphate per acre, and the yield was 100 bags. Mr. Faulkner, of Stansbury (17¼ in.), reaped 30 bushels of malting barley with 80 lb. per acre of a phosphatic manure, and Mr. Cudmore 42 bushels of malting barley.

Mr. Jas. O'Shanaghan had dressed an acre with 2 cwt. bone-dust, and had 50 bushels of Cape barley at Port Lincoln (20 in.). At Riverton (20.36 in.) 60 acres were put in with the drill and farmyard dung, and only 4 bags per acre was the result. At Strathalbyn (18.91 in.) 32 acres were sown, one half manured with phosphatic manure, and returned 32 bushels per acre, while the unmanured part yielded nothing. Mr. A. Kinch tells me that at Cygnet River, in Kangaroo Island (30 in. or more), he reaped 375 bags of barley from 23 acres. The land was new, from which 150 big trees had been grubbed, and no manure applied. At other times he had never more than 30 to 40 bushels per acre. Mr.

Thomas Willson, of Hog Bay (K.I.), wrote in June, 1900, to me, saying that three persons had applied phosphatic manures in 1899 to small areas, and speak highly of its effect, so that now considerable quantities are being used. Mr. Dorward, of Port Lincoln (20 in.), used 2 cwt. of kainit for Scotch malting barley, and reaped 25 bushels, or from 6 to 8 bushels more than without it. Mr. J. Brock, of Tanunda (21.56 in.), used 3 cwt. of Peruvian guano per acre at £13 per ton, which resulted in 33 bushels 44 lb., against 8½ bushels of poor quality from unmanured land. He had still better results from phosphatic manures at £4/10/ per ton. Other guano gave him 38 bushels 48 lb. per acre, against 18 bushels on land not so treated. Mr. R. Puckridge, of Warrow (under 20 in. ?) showed splendid sample of Cape, Chevalier, Duckbill, and Scotch malting barley, averaging 24 bushels.

The average estimated yield on 5,693 acres of barley in 1898/9 was in Tasmania 32.36 bushels per acre; in 1899-0, on 7,606 acres, only 18.76 bushels in consequence of the dry season.

In conclusion, I may state that the average yield of 17 varieties of two-rowed and 19 of six-rowed barley grown on 16 farms in British Columbia was 52½ bushels per acre, and the average weight 57 lb. per bushel; but what fertilisers had been used is not stated.

MAIZE.

The Adelaide Sewage Farm records from 25 to 30 tons of green feed per acre, but although somewhat neglected in South Australia, it gives very good returns in the more north-easterly parts of Australia. Commercial fertilisers are sometimes used there; but I must fall back chiefly on the experiments made at Hawkesbury Agricultural College (N.S.W.), the United States, and Germany. Those made by the Horticultural Society of North Carolina are recorded in the form of photographs, without giving actual results as to the crops. A normal manuring with potash, phosphoric acid, and nitrogen increased the crop manifold over unmanured plots, and where lime was added, still more. Green manuring in place of nitrogenous manure was less successful. Where a double quantity of phosphoric acid was given to all others normal the result was very good; but where potash was doubled, and the other manures normal, the crop of cobs was much less. Where the nitrogen was doubled the crop was better than from all other plots, except where potash, phosphoric acid, and nitrogen were applied in three times the normal doses. In the last case, however, it is doubtful whether such quantities of commercial manures gave a payable result. The normal quantity of the manures used were 50 lb. of potash, 50 lb. of phosphoric acid, 20 lb. of nitrogen, 2,000 lb. of slaked lime; and for green manuring, cow peas. This would require per acre about 99 lb. of muriate of potash, or 103 lb. of sulphate of potash, 325 lb. of superphosphate or Thomas phosphate, and 125 lb. of nitrate of soda. Professor Wagner manured maize in pots with phosphoric acid and potash, and had

only half as strong plants compared with those that had received 3g. of nitrate of soda. With 6g. the difference was still greater.

Maize does not send its roots deep, and requires, therefore, much plant food near the surface. Farmyard dung and liquid manure are very good. If intended for green fodder the large varieties require per acre for a crop of 32,000 lb. 60 lb. of nitrogen, 32 lb. of phosphoric acid, and 118 lb. of potash, and for a crop of 64,000 lb. twice the before-mentioned quantities. The smaller varieties require for 16,000 lb. only 30 lb. of nitrogen, 16 lb. of phosphoric acid, and 59 lb. of potash. To cultivate maize for grain 48 lb. of nitrogen, 22 lb. of phosphoric acid, and 56 lb. of potash are withdrawn at a medium crop of 2,000 lb. of grain and 2,760 lb. of straw, &c. Twice the quantity of grain, with, however, proportionately less straw, require 96 lb. of nitrogen, but somewhat less than twice the quantity of phosphoric acid and potash as used for the medium crop.

If your farmyard dung contains 48 lb. of nitrogen, 14½ lb. of phosphoric acid, and 32 lb. of potash per manured acre, you will have to supplement for heavy crops with commercial manures; and, except nitrate of soda, they should be given long before the sowing as regards muriate of potash and Thomas phosphate. If the soil does not contain sufficient lime it is necessary to supply it, so as to obtain the full benefit from the manures.

Experiments made at Amherst, Mass., U.S., with maize for fodder upon the same plots four years following each other show that the soil required much potash, but not so much phosphoric acid. Results of dried fodder per acre:—

Manure.	1st Year.	2nd Year.	3rd Year.	4th Year.	Average.
No manure	2680	2240	1185	1033	1784
Without potash ...	3136	2777	2150	1344	2351
" phosph. acid	4301	3452	6451	5520	4931
" nitrogen ...	2509	2285	6553	6038	4346
Complete fertiliser...	7571	8019	8422	6603	7653

Experiments made at the Kentucky Agricultural Station from 1889 to 1894 on the same land, and also at Lexington, in Kentucky, U.S., resulted in loss where a superphosphate or nitrate of soda, or both together, were applied. Sulphate of potash alone gave always a good return and profit, and in most instances, when added to the other plant foods, also a profit. The crops did almost, without exception, decline from year to year, and in 1894, the fifth crop in some instances was less than one-half compared with that obtained in 1889. In the Western States generally from 35 to 80 bushels are harvested per acre:—

Manure per Acre.	Grain in 1889.	Profit in 1889.	Average of 5 yrs.
Unmanured...	2,184 lbs.	—	2,072 lbs.
Complete fertiliser	4,929 "	+£1 11 0	3,786 "
Superphosphate and nitrate of soda	2,121 "	−£1 11 3	1,927 "
143 lbs. sulphate of potash...	4,972 "	+£3 6 7	3,537 "
143 lbs. sulphate of potash 143 lbs. nitrate of soda ...	5,054 "	+£2 16 3	3,920 "
286 lbs. superphosphate ... 143 lbs. sulphate of potash	4,617 "	+£2 5 0	3,383 "

Dr. G. Smets, of Liege, records as the middle of two experiments made by him that without phosphoric acid he had 70.10 gr.; with ½ gr. of phosphoric acid in Thomas phosphate, 585.10 gr.; with ½ gr. of it in superphosphate, 659.75 gr. of maize; but he adds that the value of a manure cannot be compared immediately after its action the first year, irrespective of the difference in price. Dr. Petermann has, with his careful researches, found that he obtained the same increase in crops with both phosphoric acid manures, provided the Thomas phosphate was flour-like fine. In Dr. Smet's latest work on "L'Acide Phosphorique" he mentions that those plants which with difficulty absorb the phosphoric acid in the first stage of the growth—like turnips, beets, and maize—are better to be supported with some superphosphate, but to give this and Thomas phosphate not at the same time.

In the pamphlet by M. Toulouse Camille, written for French teachers of primary schools on commercial manures, he recommends for maize per acre 400 lb. of Thomas phosphate, 120 lb. of muriate of potash, and from 80 to 120 lb. of nitrate of soda.

At the Hawkesbury Experimental Farm in New South Wales a large number of experiments with maize have been made in 1893, 4, and 5. A crop of wheaten hay was in all cases taken off, then ploughed, harrowed, and disced, and brought to a fine tilth. Drills were 4 ft. 6 in. apart, and the seed dropped by hand 16 in. apart. In the first five experiments a mixture of 300 lb. kainit, 200 lb. superphosphate, and 200 lb. sulphate of ammonia was spread over the drills at the rate of 580 lb. per acre. The seeds were soaked into a solution of copper sulphate. Yellow Hogea maize was always used. Eight seeds to a set proved to be too many, as cobs were small. Seeds in the drills 9 in. apart gave a larger yield, with, however, also smaller cobs than where the distance was greater. The importance of clean cultivation was shown by other experiments, the average of two years of uncultivated plots having been 38 bushels 31 lb.; of one cultivation, 42 bushels 55 lb.; of two cultivations, 44 bushels 43 lb.; of three cultivations, 55 bushels 31 lb.; and of four cultivations, 56 bushels 37 lb. Cultivation did not require hilling. Seeds from the middle

of the cob yielded better than from the top, but those from the butt-end gave the largest crop per acre except in 1897. Experiments made with other manures at an equal money value of 30/ per acre compared with no manure are of value where the brands are better known than in South Australia. In ten instances there was a loss, in 21 a gain of from 16/6 to £4/0/3 per acre. All the Colonial Sugar Company's different compounds gave a profit, No. 4 being the best, with a profit of £2/16/3, the yield being 63 bushels 20 lb., against the unmanured acre with 28 bushels 50 lb. In 1897 Nos. 6 and 7 proved to be still better than No. 4. The varieties of white maize gave very good yields, both in cobs and leaf, when manured with 490 lb. per acre of bonedust, blood manure, and kainit mixed in equal quantities. Thomas phosphate applied singly (costing 30/) yielded 3 tons 11 cwt. 94 lb. cut for the silo pits. A mixture of 2 cwt. blood manure, 2½ cwt. bonedust, and 2 cwt kainit yielded 3 tons 9 cwt. 75 lb., and another of 1 cwt. sulphate of ammonia, ½ cwt. of sulphate of potash, 1 cwt. superphosphate and 1 cwt. bonedust gave the best returns, viz., 5 tons 1 cwt. 109 lb. of green feed, but at a somewhat greater expense.

The Under-Secretary of Agriculture of Queensland informs me that the manuring of maize is practically non-existent in Queensland except in isolated cases.

In South Australia fine cobs were grown by Mr. F. Gray, of Riverton (20.36 in.); Messrs. Fisher, of Renmark (11.43 in.); Mr. A. B. Robin, of Nuriootpa (about 21 in.); and Mr. Blackwell, of Naracoorte (22.34 in.). The late J. E. Brown harvested from 5 acres at Bundaleer Forest (about 14 in.), from 40 to 45 bushels per acre. Mr. Hutchens and Mr. W. F. Hughes, of Woodside (31.14 in.), made fine ensilage from cut maize. Mr. Westerman-Smith, of Golden Grove (about 24 in.), grew maize and sorghum better on rich, light soil, and even on pure sand than on stiff flats. Horse-hoeing improves the crop much. He sows in October, feeds with maize till February, when sorghum gets ready, which will last until April and May. Millicent Bureau (29.02 in.) states also that maize will grow on the peaty land in sheltered places, but not on the open black flats; and Mr. W. Brooks, of Hartley (about 16 in.), sows maize on the furrow, works it down well and puts an iron roller over it; then sows lucerne on it, which thereby obtains shelter. Mr. Giles, of Mount Pleasant (27.59 in.) sows in November with bonedust on well-cultivated clayey flats, and provides for one month food for about twenty head of cattle. Mr H. C. Schmidt, of Tanunda (30.56 in.), had 4 ft. high maize on the 5th of December, sown in October. Mr. E. W. Tucker, of Finniss (17.29 in.), showed Szeckler maize, having as many as ten cobs growing on one stalk, and the grain was much larger than the imported. On the swampy lands there he could cut from 50 to 70 tons of green feed. Mr. W. H. Hughes, of Aldgate (30 in.), had Horse-tooth maize 7 ft. and Ninety Days' maize 6 ft. high in loamy soil, enriched by bonedust; and Mr. C. Arndt had the Ninety Days' maize 10 ft. high, stooling and cobbing well on a river flat. Mr.

C. Ricks, of Cherry Gardens (over 30 in.), had another crop of Cobbett's Corn after cutting it. Mr. T. Searle, of Millicent (29.02 in.), estimated that maize sown in October should yield at the rate of 90 bushels. When he fed his cows with maize the value of their milk was increased as from 5½ to 9. Mr. T. Carter, of Clare (24.30 in.) sows 60 lb.; and Mr. D. Hanna, of Gumeracha (33.04 in.), 2 bushels broadcast, 20 lb. with the drill. Mr. A. Steinwedel, of Balaklava (15.94 in.), manures with good compost or superphosphate, and makes the distances between the rows a 9-tine scarifier, with the two end tines only down.

HAY AND PASTURE.—There can be no doubt that in Australia pasture lands have been almost everywhere robbed of a great portion of the natural nitrogen, phosphoric acid, and potash. From 1893 to 1899 inclusive the export of wool is said to have been 2,111,863,834 lb., containing as much nitrogen as in 456,200 tons of nitrate of soda, as much potash as is found in 11,320 tons of muriate of potash, or 45,256 tons of kainit, which latter is contained in the grease of the wool and near its roots. During the above years 46,088,677 sheep and 1,009,187 lambs have been exported, or nitrogen equal to 298,341 tons of nitrate of soda, and the phosphate of lime in the above animals was equal to about 141,034 tons of Thomas phosphate. Such being the case, our farmers, at all events should follow the example of Mr. Schickert, of the Schniftenberg Farm, described by me in our "Journal" of December, 1898, to apply phosphoric acid and potash manures in large quantities to enable them to keep twice the number of cattle and horses, or else sheep. Mr Schickert's farm was quite exhausted by former tenants, full of weeds, and the land itself, 960 ft. above the sea, was by nature poor of humus, one-half stony or sandy, the other a tough clay. Now it has become the place for pilgrimage of hundreds of the most intelligent farmers. By the application of potash and phosphates the number of pea-flowering plants will rapidly increase, and draw nitrogen from the air, which in turn nourishes the grasses and other herbs. Mr. Cameron, the agricultural editor of the "Dundee Advertiser," said at an agricultural dinner on 4th January, 1900: "By and by lighter stocking would have to be practised. . . . But the keeping of cattle was almost out of the question. Artificial means should be taken to restore the balance of phosphates and potash so plentifully taken off the land in the framework of animals, and in wool. There was no more generally useful phosphatic top-dressing than Thomas phosphate, which ought to be applied at the fall of the year, and that application could be very advantageously followed in early winter by a good dressing of potash, the cheapest source of which was kainit."

According to Professor Wright, potash salts alone, whether in the form of kainit or muriate, give a considerable increase of crop (of grass hay), and when due allowance is made for succeeding crops, and the increased development of leguminous herbage springing up on the land, the use of these manures is distinctly profitable

Experiments were made at Cleghorn and ten other farms in 1893 and 1894 on clay loams, and the average per acre of air-dried hay was with 2 cwt. of muriate of potash 27 cwt. 2 qrs.; with 2 cwt. of muriate and 2 cwt. of superphosphate it was only one quarter more; but if 1 cwt. of nitrate of soda was added, 38 cwt. The use of so much nitrate of soda is, however, not advisable, as the other herbage and grasses may be too much stimulated at the expense of clover (see Plate VI.) At Cleghorn itself the crops were respectively 36 cwt., 42 cwt., and 46 cwt., or 6, 12, and 16 cwt. of hay over the unmanured plots, so that the total profit per acre was £1/13/, £2/4/, and £3/19/, calculated at £3 per ton. At Rothamsted as soon as potash was withheld from any plot of permanent pasture the produce declined, and in the period of fourteen years, from 1862 to 1875, it gave only three-fourths of the amount of total produce recorded from the potash-manured plot. From 1876 to 1892 the potash plot still further increased its lead by 50 per cent. more produce. No other mineral substance supplied as manure—neither lime, nor phosphoric acid, nor any other—exercised such an influence on the yield of hay as potash. Leguminous plants flourished, and the grasses became denser.

PLATE VI.

Experiment on the Feldberge (810 metres above the sea), without a nitrogenous manure.

Un-manured.
Average of 5 years,
1,056 lbs. per acre.

Manured with
Thomas Phosphate, 4 cwt.
Kainit, 4 cwt. Lime, 10 cwt.
Average of 5 years.
3,320 lbs. per acre.

Dr. G. Smets says in his "Phosphoorzuur in den Landbouw" that in experimenting with superphosphate and Thomas phosphate he had on moist pastures from Thomas phosphate in three years 5,852 lb. more per acre, and from superphosphate 3,692 lb. more than from unmanured land. On very dry pastures he had from Thomas phosphate 5,836 lb. more per acre, and from superphosphate 5,128 lb, more than from unmanured land. He recommends

480 to 800 lb. of Thomas phosphate per acre, and 320 to 480 lb. of kainit the first year, and 160 to 320 lb. of Thomas phosphate and 240 to 430 lb. of kainit afterwards.

Professor Dr. Wm. Somerville, of Cambridge, said in "The Land Magazine":—"In the great majority of cases the character of grass land can be far more cheaply and quickly improved, without breaking it up (re-seeding), through the agency of manures, composts, drainage, &c." At the Northumberland County Farm the percentage of white clover is only 0.3 on the untreated ground, whereas it is 15.6 on the plot which received 5 cwt. per acre of Thomas phosphate less than two years ago.

Mr. D. Hall, The Farm, Cark-in-Cartmel, after six experiments with Thomas phosphate alone and with Thomas phosphate and sulphate of potash came to the conclusion that on calcareous soil 3 cwt. of Thomas phosphate and 1 cwt. of sulphate of potash should be applied per acre, and not one manure only.

At the County Council Farm in Lancashire 4 cwt. of Thomas phosphate and 117 lb. of muriate of potash was better than sulphate of potash for clover hay.

Messrs. J. A. Murray, B.Sc., and T. H. Middleton, B.Sc., Lecturers at University College of Wales, Aberystwyth, report on the relative merits of superphosphate and Thomas phosphate, either alone or with potash and nitrate of soda, that the results were almost exactly equal. Nitrate of soda was a little better and cheaper than sulphate of ammonia. The comparative value was 115 to 110.

Professor Middleton, in his last annual report on experiments conducted by the teaching staff of the Aberystwyth College, sums up the results of the manuring of pasturing lands as follows:—"On examining the effects produced by two seasons' use of the manures on the crops of this year, we find that in no case has nitrate of soda done much for the crop, and that over the whole twelve plots it has slightly decreased the crop (of clover.—Ed.) Superphosphate has on the average increased the crop, whether used alone or with other manures. It has done so most markedly when combined with kainit. When so used the profit exceeded 100 per cent. Kainit has produced about twice as much increase as superphosphate. It is clear that the land requires potash manures, and that it will pay well for them. On the average of twelve plots the profits from the outlay of 6/ for kainit amounted to about 200 per cent., and in favorable cases rose to more than 300 per cent. In a favorable season a mixture of 4 cwt. kainit and 4 cwt. superphosphate has yielded a profit of 200 per cent., and the following mixture of manures is likely to yield a profit of at least 100 per cent. in ordinary seasons. Two hundredweight Thomas phosphate applied in autumn, 1 cwt. superphosphate applied in spring, and 1 cwt. kainit in spring (?).

Professor Wagner says that where on a meadow at Bayersreich, greatly in want of phosphoric acid and potash, in October, 1889, 6 cwt. 40 lb. of Thomas phosphate and 4 cwt. 80 lb. of kainit per

acre were applied, and only kainit given in the next eight years, the crop was in 1890 better by nearly 6 cwt. of hay over the not manured portion, in 1891 by 18 cwt. 40 lb., in 1892 by 20 cwt. 80 lb., in 1893 (a very dry year) by 11 cwt. 60 lb., in 1894 by 23 cwt. 60 lb., in 1895 by 10 cwt. 40 lb., in 1896 by 8 cwt. 40 lb., and in 1897 by 11 cwt. 20 lb., in 1898 by 4 cwt. 40 lb. So you cannot form any conclusions from a single year. It is clear that the Thomas phosphate acted well for nine years, and potash was much required. At another meadow 31 lb. of hay were cut from 1 ar (10 ar $\frac{1}{4}$ of acre) without manure; but a similar plot, which had received 12 lb. of Thomas phosphate and some kainit cut 121 lb. Meadows at Upper Seehof, also destitute of phosphoric acid, yielded in 1894, without manure, 17.2 cwt. per acre; but with 480 lb. of Thomas phosphate, given in autumn 1893 on another portion, 24.8 cwt. In 1895 the results were 20.8 cwt. without manure, and with another 480 lb. of Thomas phosphate, given in autumn 1894, 71.6 cwt. of hay. At Lower Seehof, still more destitute of phosphoric acid, the unmanured portion yielded in 1894 only 6 cwt. of hay per acre; but where 480 lb. of Thomas phosphate was given in autumn, 1893, 18 cwt. In 1895 the unmanured part yielded 11.6 cwt.; but another 480 lb. of Thomas phosphate gave 58.8 cwt. (See plates VII. and VIIA.) (Professor Wagner adds that of course, provision for potash had to be made.

Photos. of Hay, from 150 square yards, at Ernsthofen. (See Plates VII. and VIIA).

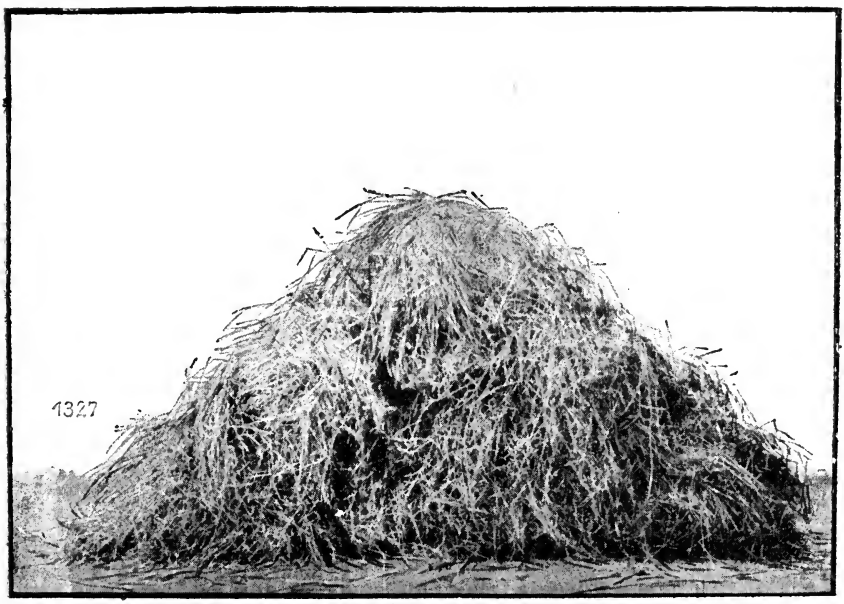


PLATE VII. No manure, 4,480 lb. per acre.

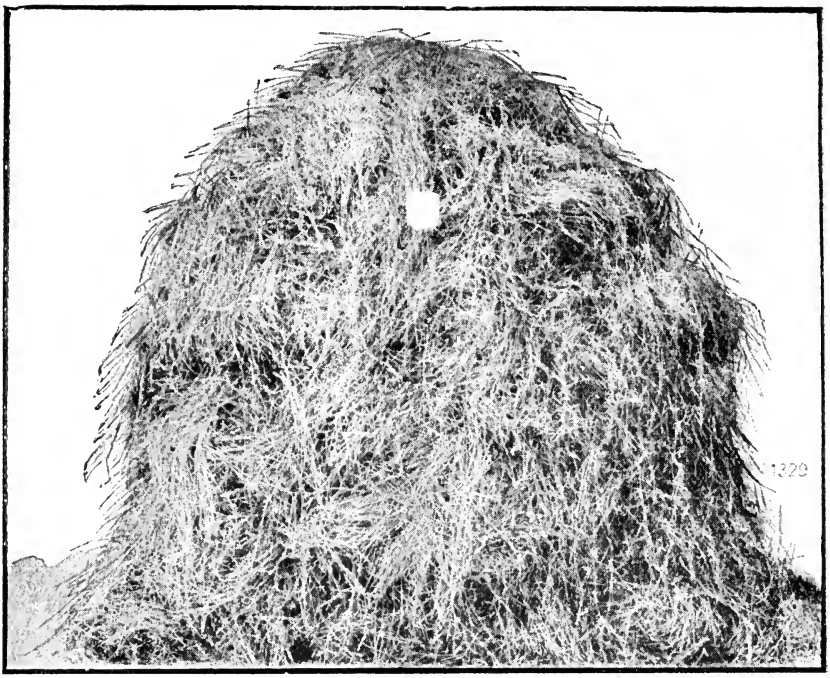


PLATE VIIA.

7,680 lb. per acre. Manured with 1,600 lb. Thomas phosphate and 1,600 lb. kainit per acre.

although the quantities are not mentioned.) Other experiments, also made at Upper and Lower Seehof, but on poorer and not so moist soil showed that the combination of phosphoric acid and potash gave in 1896 more than double the yield, and in 1897 six times, and nearly eight times, as much as the unmanured land. The best manuring of grass lands was at Goettingen found to be lime, kainit, Thomas phosphate, and nitrate of soda. The unmanured was as 100 to 160.6, but Dr. Edler recommends to manure with 5 to 6 cwt. of kainit and 4 to 5 cwt. of Thomas phosphate per acre as better paying, the increase in such case being as 100 to 139.3.

Professor Dr. Bardenheuer manured at Lamersdorf in 1892-3 his meadows with 4 cwt. Thomas phosphate and 4 cwt. kainit per morgen ($\frac{1}{2}$ acre), and had $21\frac{1}{4}$ cwt. of hay, against 6 cwt. from the unmanured. Mr. Jans, however, in Eiderstedt, used on his clayey soil only 2 cwt. of Thomas phosphate with 4 cwt. kainit, and cut 23.6 cwt. of hay, against 12.6 cwt.

One hundred and twenty-eight experiments in Lorraine have also resulted in showing that if Thomas phosphate was used in March or beginning of April (here July or August) the first cut of hay

PLATE VIII.

On a good meadow under the Hachtskopf (734m.). Experiments made by Agricultural Union of Csasel

Manuring of Pasture.

Unmanured.

Average of 3 years,
1,272 lbs. per acre.

Thomas phosphate
and kainit.

Average of 5 years,
2,548 lbs. per acre.

Thomas phosphate,
kainit, and lime.

Average of 5 years,
2,641 lbs. per acre.

had hardly increased or the pasture much benefited, but the second cut was from one-third to one-half better. Where Mr. Werenskiold used potash and nitrogen with superphosphate and Thomas phosphate the latter gave a little better crops, and the after-effect was rather striking. The experiments, made under direction of Agronomical Teacher Fr. Von Oppenau, in Alsace, so far as they deal with the drier portions in Muensterthal, seem for us applicable. Where 900 lb. of Thomas phosphate and 576 lb. of kainit were used on a dry sandy loam upon stone at no great depth 1,000 lb. more hay was obtained in two cuts per acre. At another place, with the same quantities of manures, on similar soil, 1,080 lb. more hay were cut; and again, where the soil was simply dry, with no stony substratum, 2,880 lb. more were cut.

The Agricultural Union of Gotha made experiments in 1897, giving 4.40 cwt. of Thomas phosphate and 6.60 cwt. of kainit per acre. The worst gave a net profit of 7/3, the best of £6/3/6 per acre.

Mr. R. Krug, a German agricultural travelling teacher, reports about a medium meadow, with sandy soil on a loamy subsoil, that stable dung gave a loss; liquid manure, a net profit of £2/3/; 4 cwt. of kainit, £2/2/9; 4 cwt. of Thomas phosphate, £3/7/9; 4 cwt. kainit and 4 cwt. Thomas phosphate, £5/8/9 per acre.

Professor Maercker found at Lauchstaedt that potash alone did not pay, but when 2 cwt. of Thomas phosphate was added to 10 cwt. of kainit per acre 5 cwt. more hay was taken from one cut the second year, and 11 cwt. more in two cuts the third year. The result was botanically of much importance, and the hay contained more albumen, according to a chemical analysis by Professor Fleischer, in Berlin, who found 0.99 per cent. of potash and 0.44 per cent. of phosphoric acid in the unmanured hay, against 2.00 per cent. potash and 0.66 per cent. phosphoric acid in the manured hay.

That you may improve the feeding value of your hay very much by manuring with Thomas phosphate and kainit has been shown by experiments made at the Marburg Agricultural Station, on the meadows of the Rhoen Mountains. The results at per morgen, a little more than half an acre, were:—

	Unmanured.	Two cwt. Thomas Phosphate and 2 cwt. Kainit.		
	Without Lime.	Without Lime.	With 2½ cwt. of Lime.	With 5 cwt. of Lime.
Average of hay for 5 years	10·6 cwt.	22·9 cwt.	27 5 cwt.	30·5 cwt.
Albumenoids ..	8·96 p.c., 81 lbs.	13·98 p.c., 273	11·43 p.c., 269 lbs.	12 64 p.c., 329 lbs.
Fat	3·50 p c., 32 "	2·72 p.c., 53	2 55 p.c., 60 "	2·73 p.c., 71 "
Extractive matter without nitrogen	52·27 p.c., 471 "	48·24 p.c., 941 "	50·23 p.c., 1,180 "	50·10 p.c., 1,303 "

Irrespective of the smaller quantity of hay from the unmanured land, the quality of the manured hay

is better. It may contain only 0.4 per cent. of phosphoric acid, but that manured as above, or with more Thomas phosphate, up to 0.6 per cent., and more. Sometimes complaints have been made that the taste was not as good. Dr. Max Passon believes that this may be in consequence of the magnesia in the kainit, and recommends the use of muriate of potash with Thomas phosphate. After all, the feeding value is of great importance, as our young cattle or lambs will grow quicker, their bones requiring phosphoric acid and lime; in fact, four-fifths of an animal's mineral portion consists of these, which they obtain through their food from the soil, and the albumen will also nourish them so well that you may rear excellent animals fit for work, for the butcher, or to supply large quantities of rich milk.

The feeding value of crops produced wth dfferent manures has also only quite lately been tested, during the last three years by Dr. Somerville, at Cockle Park, on plots of three acres each, and the difference was remarkable. He says: "We find that it has taken pasture equal to less than 21 lb. of hay to give 1 lb. of live weight increase in the case of plot 3 (the large dressing of ½ ton of Thomas phosphate per acre), and of plot 7 (superphosphate plus potash). In other words, for equal weights of herbage the feeding value of the material on plots 3 and 7 has been nearly double that which was grown on plots 2 and 6." Plot 2 received 4 tons of caustic lime and 6 was unmanured.

Professor Maercker gives the following composition of grass hay, equal to a greater nutritive value in manured against unmanured, viz., 288 lb. to 200 lb.

	Manured.	Unmanured.
Albumen ...	11.46 per cent.	7.91 per cent.
Fat	2.57 per cent.	0.66 per cent.
Phosphoric acid	0.59 per cent.	0.30 per cent.

MM. Briers and Schreiber manured at Tongres one block with 2,000 lb. of lime, 400 lb. of kainit, and 800 lb. Thomas phosphate per acre. The result was:—

	Manured.	Unmanured.
Green grass	16,544 lb.	9,016 lb.
Lime in hay, per cent. ...	16,879 lb.	14,853 lb.
Phosphoric acid, per cent.	4,701 lb.	3,480 lb.
Potash, per cent.	17,723 lb.	14,662 lb.
Nitrogen, per cent. ...	13,737 lb.	12,457 lb.

Mr. J. C. Ruwoldt, of Mount Gambier (32 in.), manured in June, 1900, 18 acres of a field of 27 acres with 2 cwt. of bonedust per acre, leaving 9 acres unmanured. He put in September 90 sheep, 10 cattle, and 9 horses into the field, and kept them there until February, 1901, all of them being then healthy and fat. They had cared very little for the herbage on the 9 acres which received no manure, upon which there was still plenty of grass when he removed the stock. Any other phosphatic manure with some nitrogen would produce there the like result, where sufficient potash seems available.

Mr. Woolley, known as the farmer who produced the great wheat crop of 77 bushels per acre in Skimblescott Farm, had used for many years annually from 40 to 60, or, lately, even 70 tons of Thomas phosphate. More than half of his 346 acres are now left in pasture, and the most remarkable thing was that where there was a general outcry of drought and scarcity of fodder, the fields of Skimblescott were full of grass, literally calf-leg deep, and all his stock—17 horses, 360 sheep, and not long before 90 head of fat cattle—were in excellent condition. Sixteen acres were once in wheat, and the crop valued in 1879 at only £14. By liberal treatment with phosphate, the last being 5 cwt. per acre of Thomas phosphate, this field has so improved that it fed in 1899 70 wethers—bought in March—and now sold at upwards of £1 per head profit. Mr. Woolley pins his faith on the liberal use of Thomas phosphate and cake. He can now get this phosphate at half the price it formerly cost him in bones. If it had been introduced ten years earlier he should now be richer by some thousands of pounds than he is.

In fairly wet seasons as many as 6,751 acres of grass hay are mown in Tasmania, yielding 980 tons. As much as 2 tons per acre was, however, gathered where 7 cwt. of bonedust was used; and in North Bruni 1½ tons of hay with 3 cwt. of phosphates.

The foregoing remarks, although intended mostly for grass-hay, or pasture, are also applicable for our hay, which consists chiefly of wheat and oats, cut before too far advanced towards ripening of the grain.

The majority of our farmers, however, do not sow these specially for hay, and this would not manure the land, except for either wheat or oats, from which they cut portions for hay for home use, being either too poor or too luxuriant to leave for a grain crop, or too dirty. Where a hay crop is sown it should be manured as well as for a crop of wheat or oats. A farmer reported that he carted from a paddock, on which wheat was drilled with phosphates the year before, quite one-third more hay, as compared with land unmanured last year. Bonedust drilled in at the rate of 1 cwt. per acre gave no apparent result for oats, with wheat, however, half a ton of hay more per acre. Mr. Ruwoldt, of Mount Gambier (31.82 in.), had 1 ton more. Where on 60 acres fallow of strong land 1 cwt. of bone phosphate was broadcasted and Tuscan wheat sown, 32 cwt. of hay were gathered, against 24 cwt. per acre from unmanured land. Professor Lowrie, with mostly under 17 in., when using 2 to 3 cwt. of superphosphate or bonedust per acre for hay, at a cost of 12/6 expects to get at least a ton more per acre. One hundred and twelve pounds of guano from Kangaroo Island, with 11 in. rain gave as good a crop as 112 lb. of superphosphate; that is, 1 ton of wheaten hay per acre, against 10 cwt. where the land was not manured. The same resulted with oaten hay, which had received 3 cwt. of Kangaroo Island guano per acre, broadcasted, viz., 1 ton:

while the unmanured land gave half a ton. At Port Elliot 3 cwt. of this guano gave 25 per cent. more hay than unmanured, and 2 cwt. of bone phosphate to Algerian oats gave 50 per cent. more hay from the manured crop, on black soil in Teatree Gully (about 25 in.) 1 ton of hay per acre. Mr. Isaacson, of Auburn (24.40) had 6 cwt. more hay per acre where he had manured with Thomas phosphate. Of course, the above poor results were in an exceedingly dry season, but, irrespective of the hay obtained from land manured with phosphates and potash, containing much more albumenoids, actually up to 11 per cent., against 6 per cent., and to 0.6 per cent. of phosphoric acid, we are all well aware that hay or grass grown on dry land, and in dry seasons, is far preferable to that grown even in our South-East with a greater rainfall. The proportionate feeding value is at least 104 to 100.

CLOVER.

M. de Vuyst declares his experiences made in fruitful clayey soils to be that potash has there been profitable for clovers, and recommends the application of 480 lb. of kainit per acre. Mr. Hy. Thompson, M.R.C.V.S., Secretary of the Aspatria Agricultural Co-Operative Society, which supplies to its members large quantities of commercial manures, says: "Kainit is invaluable for clover. The best results are got where not less than 5 cwt. per acre are applied at the back-end of the year." Professor Dr. P. Wagner says in Heft. III. of his "Manurial Questions": "In the same soil, where cereals grew but miserably unless manured with nitrogen, and where manuring with potash and phosphoric acid remained without effect, red clover was indifferent to nitrate of soda; but manuring with potash and phosphoric acid brought them to luxuriant development." He admits that on the very poorest soils a small quantity of nitrate of soda may after all be advisable. Red clover sown without manure in pots gave in three cuts 33 g., 49 g., and 29 g., against 94 g., 98 g., and 69 g. where potash and phosphoric acid was given. I give now a few experiments made in France, which might be followed here, adding potash. M. Lefeuvre, at Dominelais, harvested with 32,000 lb. of dung, in two cuts, 3,688 lb. of clover per acre; with 1,600 lb of Thomas phosphate, 7,064 lb. Abbe M. Quillet, of Malans, obtained without dung only one cut; but he had with 80 lb. of Thomas phosphate two equally good cuts of 2,664 lb. each, or an excess over the one cut of 3,328 lb. M. Bessirard, of Argentan. had, with 320 lb. per acre of Thomas phosphate, 1,680 lb. more hay, and with 480 lb. of Thomas phosphate 3,120 lb. more than without any manure. Whether the soil for these experiments also obtained potash or was rich in potash, I cannot say. At all events potash would have increased the crop. In a favorable soil plants two months old should have their roots 2 ft. deep, at five months to 5 ft. and more.

The Agricultural Union of Spelle, in Hanover, had three experimental plots sown with clover without any cereal. No. 1, un-

manured; No. 2, manured at the rate of 4 cwt. of Thomas phosphate and 6 cwt. of kainit; No. 3 at the rate of 6 cwt. of Thomas phosphate and 10 cwt. of kainit per acre; and while the unmanured yielded 24 cwt., No. 2 had 92.80 cwt.; No. 3, 116 cwt. in one cut, second being fed off.

In the North Island of New Zealand I observed clover to be a great success. Crimson clover is spreading around Millicent (29.02) and Mount Gambier (31.82), and Mr. R. Smith had already a crop of it for three years. Mr. F. Lines, of Kanmantoo (17½ in), has done well with several varieties of clover. You may cut crimson clover for seed or hay, and it will still re-sow.

In the report of experiments on clover conducted at the Council Farm, Hutton, it was found that the average increase in using 4 cwt. of Thomas phosphate over an unmanured acre was 3 cwt. of the first cut of partially dried hay; with an addition of 117 lb. of muriate of potash to the 4 cwt., 12 cwt.; with a further addition of 1 cwt. of sulphate of ammonia, 19 cwt. 3 qr.; substituting 142 lb. of nitrate of soda for the 1 cwt. of sulphate of ammonia, 22 cwt. Ten tons of farmyard manure increased the crop to 21 cwt. 1 qr. over the acre which received no manure. None of the commercial manures used singly, except the nitrogenous manures, although increasing the crop slightly, met the cost of the manure. The grass derived too great benefit from the dung, operating against the proper growth of clovers. The application of a mixture of muriate of potash and Thomas phosphate encouraged the growth of clovers more than any other treatment. On light land it is advisable to refrain from using nitrogenous manures, and if only potash and phosphoric acid are given early in spring there need be no fear of leaving the land in poorer condition for next year's crop. In spring, 1899, some of the experimental plots were top-dressed with sulphate of ammonia at the rate of 1 cwt. per acre, and it was found that the plots which in 1898 received full manuring, viz., 1 cwt. muriate of potash, 2 cwt. Thomas phosphate, and 1 cwt. nitrate of soda gave the best result in the second year. The farmyard dung gave no increase with the above addition of 1 cwt. of sulphate of ammonia. All classes of soil were represented, especially in experiments made in 1898, and strong, medium, and gravelly soils in 1899.

Mr. J. C. Ruwoldt, of Mount Gambier (31.82 in.), had 2 acres under clover thirty years ago, and mowed in two cuts 4 tons of clover hay per acre. White clover killed all the sorrell in a paddock sown with 1 lb. per acre of seed, and used as pasture.

Bokhara Clover (Melilotus albus) is a biennial plant, and grows the second year to 3 or 4 ft. It has been grown near Millicent (29 in.) on peaty land, and either cut for hay, when commencing to flower the second year, or left for seed, or sheep and cattle may feed it down till only the stalks are left, which will then in a few months bring forth again a good bite. Mr. H. Stewart had 17 bags of seed from 4 acres. It requires about 4 lb. to sow an acre. It grows also well in poor sandy soil, and should do well in Yorke

Peninsula and on the West Coast in calcareous soil, provided the roots, which penetrate 3 to 4 ft. deep, are not stopped by solid limestone. Like all other pea-flowering plants, it is sure to give largely increased crops when manured with phosphoric acid and potash, and enrich the soil with nitrogen. Forty years ago I found this clover to grow well in Bugle Ranges on a deep light soil with a rainfall of about 28 in.

RAPE AND MUSTARD

I have always recommended as good fodder plants. The land should be will pulverised, and even if ploughed under as green manure, or fed off, should be manured, so as to give a fine crop. The late Mr. J. L. Thompson, of Beefacres, Dookie, and Hawkesbury College, so well known as a good farmer, certainly produced good crops of rape in rotation from wheat-sick land without manuring; but he ploughed fully 6 in. deep in January, and worked the land so as to bring its tilth to the proverbial "onion bed" before he did sow in April after the first rains, about 6 lb. of seed broadcasted. As a protection against the fly a top-dressing of soot and ashes, or perhaps lime is advisable. If intended for green manure it should be ploughed under when commencing to flower. In about seven or eight weeks it should be fit for sheep, and one acre fattens ten lambs, especially if fenced off by a movable wirenetting. Mr. H. Hart, of Millicent (with 29 in.), fenced across his mustard field, taking 2½ acres at a time for 300 sheep, which lasted them, with an outlet into an adjoining grass paddock each day, for six days. Care must be taken that the luxuriant growth does not blow them. For seed the sickle must be used when most of the seeds are ripe, and thrashed on a tarpaulin. Seed sell at 12/6 a bushel. To sow a few pounds of rape into a clean stubble gives after a light harrowing sometimes a good bite after a summer rain, such as we have sometimes. Members of the Bureau at Yarrow and Port Elliot advise the cultivation of rape.

In Tasmania from 2 to 2½ cwt. of phosphatic fertilisers are used sometimes per acre for rape upon which sheep and lambs are to be fattened. In New Zealand no less than 125,367 acres have been (1900) under rape, or actually 21,446 acres more than in 1899. On two farms in the Tokomairiro Plain manures (not mentioned) were drilled in, and an exceptionally good growth was the result.

Mr. J. C. Ruwoldt, of Mount Gambier, S.A. (31.82 in.), fattened after well-manured potatoes 100 sheep on 25 acres sown with mustard. Mr. G. H. Vickery, of Meadows (34.56 in.), praises the Broadleaf Mustard for the earliest crop. Drill it in 1 in. deep in February to catch the first light rains. The plants run to seed in December, often 7 ft. high. Mr. T. Lewis, of Cherry Gardens (over 30 in.), had a single plant weighing 12 lb. In the hills you can, of course, sow at any time. Mr. E. Lamming, of Paskeville (15.49 in.), fed his pigs for three weeks on mustard, and afterwards his sheep, for whom such early feed is very valuable. Mr. H.

Hart had September-sown mustard 3 ft. high in eight weeks. For seed he sows earlier, and requires four months. Rape sown in spring by Mr. W. Vigar, of Mount Pleasant, did well, but when sown in autumn by Mr. H. A. Giles it was destroyed by wet weather. Mr. S. J. Stuckey, of Millicent (29.02) had skimmed off a bit of the swamp lands, and burned it, thus giving potash to the soil, and had heavy crops. From 1½ to 2 acres he sold half a ton of seed at £25 a ton. Mr. C. Faulkner, of Stansbury (17.26) had Broad-leaf Mustard 4 ft. high, with which he feeds his cows; and Mr. Plummer, of Bowhill (11.50), thought every farmer ought to grow it

Both require a soil in very good heart; and in Europe dung was formely given freely to the preceding crop. Fertilisers can, of course, be used, but I cannot give quantities from experiments.

TURNIPS (For Fodder).

Mrs. C. Poss, in East Prussia, manured per morgen (½ acre), with 2 cwt. of Thomas phosphate, 2 cwt. of kainit, and 1½ cwt. of nitrate of soda, at a cost of £1/7/, and harvested 350 cwt. of turnips, against 200 cwt. from an unmanured morgen. The net profit was £2/8/. J. Goebel, of Ernsthofen, produced from one ar (one-fortieth of an acre), without manure, 386 lb. of turnips, or 153 cwt. per acre. When manured per ar with 12 lb. of Thomas phosphate, 24 lb. of kainit, and 12 lb. of nitrate of soda, or per acre with 480 lb., 960 lb., and 430 lb. respectively, he harvested 1,338 lb. per ar, or 534 cwt. per acre at a net profit of £4/15/6 per morgen, or about £8 per acre. (See plates IX. and IXa.)

Plate IX.

Turnips on very poor clay. Joh Goebel, of Ernsthofen.
Without Manure.—Produce from 4 perches, 386 lbs.

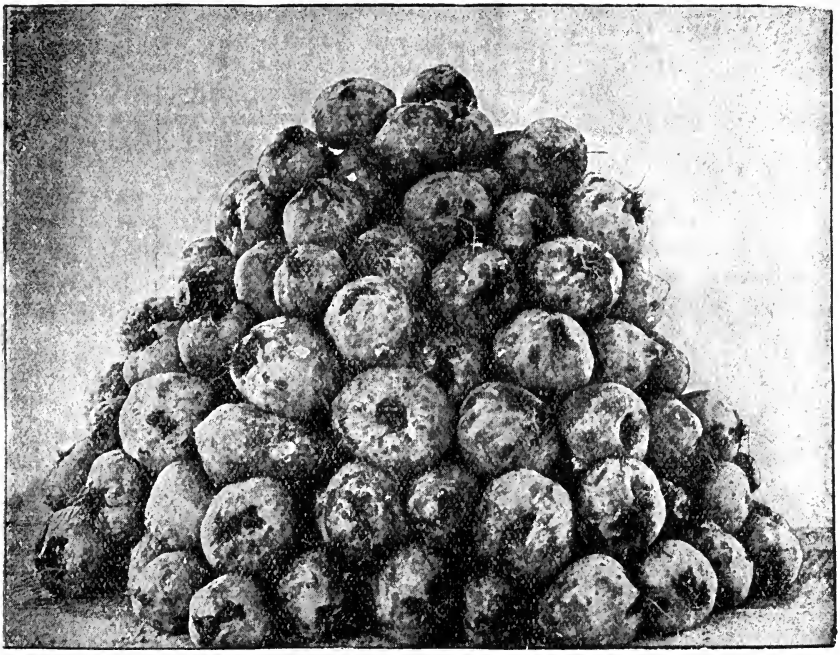


PLATE IXA.

Four perches manured with 24 lbs. kainit, 12 lbs. Thomas phosphate, and 12 lbs. nitrate of soda produced 1,338 lbs. turnips.

Mr. R. Agnew, of Millicent (29 in.), sows 7 oz. of turnip seed; Mr. Hart, 5 oz. per acre. At Moorak, near Mount Gambier (31.82 in.), there were in 1893 100 acres with turnips (Purple Top and Swedes), upon which 2,500 sheep were kept for a week, as the caterpillars made their appearance. Mr. Williams had fattened 600 sheep on 10 acres. An acre gave from 15 to 20 tons per acre, and he fully expected that with turnip growing the district could fatten off 100,000 sheep. He produced one Purple Top turnip weighing 7 lb., Mr. McColl, of Rendelsham, some up to 25 lb., Mr. Chant, of German Flat, one of 35 lb. with the leaves. Mr. Hart, of Millicent, a swede of 16 in. diameter. Mr. A. Bairstow, of Narridy (16.78 in.), raised fine turnips 5 and 6 in. through from land manured long before he sowed the seed, but afterwards he cultivated the crop well. Mr H. A. Giles, of Mount Pleasant (27.09 in.), in February put in 30 acres with turnips after good rains, and by hurdling off portion at a time kept 650 sheep on them for fourteen weeks. Mr. P. Trimmer, of Tanunda (21.58 in.), found Thomas phosphate very beneficial for a crop of turnips; and Mr. Hunter, of Watervale (27 in.),

considered it the best phosphatic manure for them. Mr. Wm. Proud, of Tod River, near Port Lincoln (20 in.), produced Yellow Stone turnips, weighing up to 10½ lb. At Mount Gambier turnips are sown ½ lb. per acre with drill during September in drills 2 ft. apart, but even when sown in July or October good crops resulted. Mr. Langberg, of Naracoorte (22 34 in.), considered there was not much waste in feeding turnips off with sheep if put on when the leaves begin to wither. Mr. Sage, of Balaklava (15.94 in.), transplanted them from seedbed on ordinary mallee land, and some were 15 in. in circumference.

The turnip crop is the most important in the Waikato district in New Zealand. If it is a failure and a wet winter the mortality amongst the stock is very great. Frequently sheep must be removed from North to South, or the reverse. On high and dry land the crops are frequently inferior for want of moisture to germinate the seed. The Auckland district had in 1898 32,485 acres under turnips; Wellington, 31,619; Canterbury, 141,898; Otago, 178,393 acres. In 1899 the total for New Zealand was 519,945 acres. At the experimental Station at Wyndham, Southland (N.Z.), the Purple Top turnips were sown on fifty-two plots with fertilisers, and with or without lime. The cost of the manure is given at about 15/ per acre; broadcasting and seed, &c., 11/; but if drilled, &c., £1/18/ per acre.

	Roots per Acre.		
	Tons.	Cwt.	Qrs.
No manure	21	19	2
No manure, but 2 tons lime	37	13	0
3 cwt. pure crushed bones	36	15	1
Ditto, with lime	39	13	1
2 cwt. Tison's superphosphates ...	38	8	0
Ditto, with lime	35	7	2
2 cwt. Thomas phosphate	38	8	0
2 cwt. Hend. & Badger's fert. No. 2...			
Ditto, with lime	39	8	1

The average rainfall at the experimental station is about 45 in., with a temperature from 40 deg. to 70 deg. With the Thomas phosphate the tops weighed 5 cwt. more per acre, the roots sometimes more, at others less, with equal quantities of manure. Experiments made in the Transactions of the Highland and Agricultural Society of Scotland of 1892 were a little in favor of Thomas phosphate and nitrate of soda against superphosphate and sulphate of ammonia of the same value.

At Ringarooma, in Tasmania, as many as 40 tons have been taken from an acre without manure. Elsewhere 10 tons have been harvested with 2 cwt. of Thomas phosphate; and at Ellendale from

15 to 20 tons also with phosphates. In 1898-9 4,857 acres, with an average of 12.08 tons per acre, were under cultivation; in the dry year of 1899-0 only 3,350 acres, with but 8.67 tons.

Trials were made with a large number of varieties of turnips during five very dry months in 1894 at the Hawkesbury Experimental Station in New South Wales, when hardly 5 in. of rain fell during their growth. For table use, Orange Jelly, Early Red American, and White Nepaul were the best; for cattle, Yellow Tankard and Purple Top Mammoth. At Momohaki, New Zealand, 120 lb. of steamed bonedust and 224 lb. of Thomas phosphate gave the best results of twenty experiments. In the Middle Island New Zealand, 1 to 1½ cwt. of superphosphate have also given good results, as stated by Mr. Murphy, F.L.S. From ½ to 1 lb. of seed is sown with the drill, and the manure dropped in front of it, or given in a liquid state by a water drill. This latter invariably secures a rapid and vigorous braird, forcing the young plant into the rough leaf, after which it is secure from the attack of the turnip beetle. If broadcasted and too thick the harrow is run over them, or thinned by a drill-grubber or scuffler. An acre with a little hay will fatten from eight to ten sheep.

MANGEL WURZEL

appears to do well almost everywhere in this State, where there is a fair rainfall. Thomas phosphate and muriate of potash mixed should be given some time before sowing, nitrate of soda one-half at that time, and the other half when hoeing, but care should be taken not to spread it while the plants are wet from rain or dew on account of its corrosive action. Mr. J. Goebel, of Ernsthofen, experimented in using on poor loam the following manures:—

Manure.	Average Yield in Cwts. per Acre.	Cost of Manuring.	Profit on the Larger Crop.
No manure	154	—	—
9½ cwt. of kainit, 4⅘ cwt. of Thomas phosphate, 4⅘ cwt. nitrate soda	535	£3 15 8	£7 12 10
Potash omitted ...	385	£2 18 10	£4 0 10
Phosphoric acid omitted	344	£3 4 10	£2 8 10
Nitrogen omitted ...	348	£1 7 10	£4 8 5

Kainit and Thomas phosphate were given on the 18th January, nitrate of soda one-third on 14th June, two-thirds on 5th July.

Mr. P. Heddaeus, of Wolfskehlen, used on a rich loam on four plots:—

Manure.	Average cwts. per Acre.	Costs of Manuring.	Profit on Larger Crop.
No manure	433⅘	—	—
12⅘ cwt. kainit, 4 cwt. Thomas phosphate, 4⅘ cwt. nitrate of soda	734⅖	£3 16 2	£5 1 2
Potash omitted ...	620⅕	£2 17 2	£2 15 2

Kainit, Thomas phosphate, and one-third of the nitrate of soda were given on the 30th day of May, one-third of the latter on the 7th July, and one-third on the 25th July.

In South Australia even the best of these crops are not considered large, so at Yankalilla (with 28 in.), where the roots frequently weighed half-a-hundredweight, and at the Glencoe Estate, near Mount Gambier (31 in.), the manager weighed in 1892 a measured portion of the crop, and found it to average 66 tons per acre. Mr. W. Pearson, of the Meadows (with 34½ in.), considers from 40 to 60 tons of roots per acre a good crop, whilst the summer pickings of leaves and thinnings will give almost as much feed as he could get from many green crops. Besides, the crop is available probably for ten months of the year. But he emphasises the necessity for heavy manuring. His neighbor had roots scarcely larger than radishes; while he has had crops up to 80 tons per acre. He gives a good coating of forty loads of stable manure when ploughed in May; in July ploughs again, dresses with 4 to 6 cwt. of bonedust, with 4 to 5 cwt. of salt where the land does not naturally contain salt. He sows at the end of August or beginning of September in drills 1½ in. deep, from 2 ft. to 2 ft. 6 in. apart, after another light ploughing. Afterwards he thins, and hoes, or cultivates. He calculates the whole cost per acre in manure and labor at £12/10. Mr. J. Lawrie, of Port Pirie (with 12¾ in.), grows always good crops of mangolds, although his land is of a dry nature. Mr. Jarrett, of Maitland, Yorke Peninsula (19.80 in.), stated that mangolds at Mr. Gready's weighed fully 35 lb., measured to 27 in. in circumference, and were 2 ft. long. At the Sewage Farm mangolds are said to absorb 3 in. of water every fourteen days during the hot months, but grow well enough with much less. Sixty to eighty tons per acre have been grown there. Single roots often weigh 56 lb. each. I measured myself one at Mr. Hart's Farm at Millicent having a diameter of 16 in. When the roots are matured and removed they should be stored for a few weeks to allow sugar to be formed in them. If left too long in the ground the feeding value of the roots deteriorates in becoming too fibrous and woody. Mr. T. Corlett, of Yorketown (with 18 in.), reported that, although mangolds when sown on salt patches did not germinate; young plants transplanted did well. Some of them

were measuring 6 in. across the top. Mr. J. Christison, of Clare (24.30), had 40 tons of roots per acre. Mr. J. C. F. Lauterbach, of Woodside (31.14 in.), also cultivated mangolds for forty years successfully. Mr. D. Keilly, of Millicent (29 in.), had mangolds up to 42 lb. in weight, and another member had 80 tons to the acre. Mr. S. Vanstone, of Minlaton (17.62 in.), stated that mangolds, especially if manured with superphosphate, had done well on his salt lands, before considered valueless. Mr. G. H. Vickery, of the Meadows (34½ in), says that 15 in. of rain are desirable for mangolds, but they can be grown also at the Burra, Booleroo, Netley, in the North-East, Bundaleer, Wirrabara, and many other places of the North. He fallows the land mainly to destroy insects.

The late Dr. Voelker recommended 3 cwt. of superphosphate 2 cwt. of kainit, and 1 cwt. of nitrate of soda per acre. The late H. C. C. Schmidt, of Tanunda (21.36 in.), recommends 20 to 24 tons of farmyard manure, or 3½ cwt. bonedust or superphosphate, 1 cwt. muriate of potash, and 1 cwt. of sulphate of ammonia. The "Farm, Field, and Fireside" recommend 15 to 20 tons farmyard manure, 3 cwt. of phosphate, 2 cwt. nitrate of soda or of sulphate of ammonia, 2 cwt. kainit, and 3 cwt. salt. Nitrate should be given in two doses. Sulphate should be applied before the other fertilisers, and some prefer it to nitrate for mangolds. Mr. T. Williams, of the German Creek Estate (31.82 in.), near Mount Gambier, had 55 acres under mangolds in 1895, and the crop, which was estimated to contain from 80 to 100 tons of roots per acre, was expected to fatten off 1,000 sheep. He sows in drills 30 in. apart about 3 lb. per acre. They grow only to half-size during the spring, and the autumn rains make them grow full size. If used too soon they scour the stock. Mr. Langberg steeped his seed in liquid manure, and put them to sweat in an iron tank. The Globe Mangels are best for shallow soil, the Long Red richest in saccharine matter.

At Ringarooma, in Tasmania, up to 30 tons per acre are grown without manure; 16 tons with stable manure in North Bruni, and 15 tons with 4 cwt. bonedust. In 1898-9 the average of 1,540 acres was, however, 19.32 tons, and in the dry 1899-0 13.40 tons on 1,244 acres. At New Zealand 8,051 acres were under mangolds in 1900. At Momohaki Experimental Station unmanured plots yielded only 14 tons 7 cwt. per acre; 7 cwt. steamed bonedust and 1½ cwt. of Thomas phosphate, 53 tons 12½ cwt. of roots, and 10 tons 1½ cwt. of top; with green bonedust and phosphates, somewhat less.

LUCERNE OR ALFALFA.

Very interesting experiments were made by Mayor Heddaeus, at Wolfskehlen, on medium heavy clay soil at two different farms. In November, 1894, he manured six plots each of 1 ar (10=¼ acre) at the rate of 800 lb. per acre of kainit, adding for a crop of oats 80 lb. of nitrate of soda in April, 1895; six others with

the same, and at the rate of 1,600 lb. of Thomas phosphate; and six with the kainit and nitrate of soda, and at the rate of 2,400 lb. of Thomas phosphate of 16 per cent. In April, 1895, he put in oats and lucerne. No further manure was given in 1896 and 1897. The crop of oats was on an average benefited by the Thomas phosphate by 2 bushels 10 lb. of grain per acre, but there were 124 lb. less of straw per acre. The crop of lucerne was in 1896 manured at the rate of 1,600 lb. Thomas phosphate per acre (given in 1895), and yielded on an average 651 lb. more of hay per acre; and with, at the rate of 2,400 lb. per acre of Thomas phosphate, 1,284 lb. more. In 1897 the result was still better, the average crop of lucerne hay being respectively 2,604 lb. and 3,240 lb. more per acre. From these experiments it is apparent that the soil contained sufficient phosphoric acid for the oats, but for the lucerne the Thomas phosphate increased the crop considerably, and the crop was a paying one.

Lucerne and all legumens demand plenty of phosphoric acid and potash, and will then also enrich the soil with nitrogen. Wolff states that 1,000 lb. of lucerne hay contained 23.6 lb. of nitrogen, and in the ash 17.3 lb. of phosphoric acid, 21.9 potash, lime 34.9, silica 8.2, magnesia 4.2, sulphuric acid 4.9, oxide of iron 1.6, chlorine 2.5 lb. The ashes on granitic soil, chalky soil with flint, clayey soil with chalk, or very chalky soils show great variation in the percentages of mineral compounds. Professor Boiret says that you find much more phosphoric acid in leguminous plants than in grass hay, which contains in a ton about 7 lb. of phosphoric acid; while in lucerne hay the quantity is 10 lb. 3 oz.; in clover hay, 11 lb. 3 oz.; in sainfoin hay, 8 lb. 3 oz. He gives only instances of the manuring for sainfoin, giving an increase of one-fifth to one-third, which prove the great advantages of applying large quantities of Thomas phosphate, up to 8 cwt. per acre, in preference to other phosphatic manures, the land there generally being poor in lime.

I find the following results of experiments made in France:—M. Divoux, of Merviller in Meurthe and Moselle, had 2,640 lb. of lucerne hay without manure in the two cuts; 5,840 lb. with 400 lb. of Thomas phosphate; and 6,400 lb. with 400 lb. of Thomas phosphate and 400 lb. of kainit per acre. M. Barraud, of Villereal (Lot and Garonne), harvested from the two cuts without manure 4,680 lb. per acre; with 320 lb. of Thomas phosphate, 7,802 lb.; with 640 lb. of Thomas phosphate, 8,705 lb. per acre. M Chevais, of Tournelles (Loir and Cher), obtained from the two cuts without manure 4,142 lb.; with 320 lb. of Thomas phosphate, 6,859 lb.; with 320 lb. of Thomas phosphate and 120 lb. of muriate of potash, 7,428 lb. of lucerne hay per acre.

I think it is desirable to give some cultural advice. Although lucerne grows well in the moister parts of South Australia, or where water can be supplied, I am not aware that other manures have been used than dung. I am pleased to be able to record

that the acreage has been doubled in the last three years, especially in the Lower North.

Lucerne thrives best in a warm, friable soil and subsoil and depends more on a subterranean than a surface water supply. The seed-bed must be well pulverised, and the seed covered not more than 1 in.; 12 lb. of seed is perhaps sufficient per acre if intended for seed-raising, 30 lb. where fine hay is desired. The several cuttings should not be too near the ground, and the sickle bar of a mowing machine, therefore, set high. The great injury done here to lucerne by the springtail insect Smynthurus can be minimised by spraying the field with either 1 lb. of Paris green or London purple to 50 gallons of water. Kerosine emulsion has also proved effectual.

In Mr. E. J. Hector's paper it is stated that he lost many acres of lucerne where the water lodged too long on it, as well at Langhorne as on the Broughton, and no stock should be allowed on it in winter. Mr. Dombasle fed sheep on 2 one-seventh lb. of dry lucerne hay as a sufficient ration for the day.. Seven pounds was equal to $3\frac{1}{2}$ lb. of barley, or 14 lb. or raw potatoes, or 16 lb. of the best Silesian beetroot. One acre subdivided may feed four horses, as continual grazing on the same piece will kill the plants The first cut for hay must be made before the grass seeds are ripe Mr. W. Pearson, of the Meadows (with $34\frac{1}{2}$ in.), says that lucerne is the most valuable for the stiffer soils in the hills, and answers well to sow with barley, oats, or rye on such soils, provided they are sown thinly, and cut early if at all rank, or they may choke it. His first two cuts he dries for hay. If liberally top-dressed with manure four or five cuts of 2 ft. long each can be obtained. After the last cutting he manures again, and harrows it in. At the Adelaide Sewage Farm, with irrigation, they cut four or five times in summer, and for the remainder of the year there is a fair crop. There is danger in feeding lucerne during its early stages of growth, as it contains a gaseous liquid, which inflates the stomach. At the flowering stage dry fibre develops, which makes its consumption safe. Mr. Hailey, of Findon (about 22 in.), 4 miles west of Adelaide, has taken eight cuts where irrigated from the Torrens by a steam pump. At Baroota Whim (13.72 in.), it grows well on stiff clay when once established, having been protected against severe frosts by a hay or cereal crop. Mr. Rice-Kelly, of Renmark (11.43 in.), says that 10 bushels of seed have been obtained from lucerne five or six years old, and at that time an acre of lucerne should be worth £30 per year. One ton per month of the hay and three quarts of shelled maize per day should keep a pair of horses while working hard. Mr. H. W. Hughes, of Gladstone (15.19 in.), has been very successful. The chief reasons so many fail is sowing the seed too deep, cutting too close, or feeding too long at a time. He uses only 10 lb. of seed and a heavy roller, but no harrow after sowing, only later, after the young plants have got into full leaf. Mr. Byerlee, of dry Eurelia (about 12 in.), had a growth of 18 in. in twelve months after sowing. Messrs. Ward Bros.

of Ulooloo (probably 15 in.), had a crop yielding two cuts within a few weeks in the first year. They did perhaps sow in water-courses, where the spring water was shallow, such localities being praised by them. Messrs. Simson Brothers, of Limestone Ridge, near Naracoorte (22.34 in.), had 30 acres under lucerne. Mr. J. Vaughan, of Angaston (21.93 in.), gives a good dressing of manure in July of each year. He sows and harrows in a few oats, which will give a nice cut about September. The same course is recommended by the Murray Bridge Bureau (13.90 in.), with barley or wheat; and Mr. E. J. Hector, of Port Pirie (12¾ in.), sows 15 lb. of Cape barley or oats per acre in April or May for the North, later in the South without a cereal, and uses on a well-pulverised seed-bed only 4½ to 5 lb. of seed, while others sow up to 12 lb. and more. Mr. R. Cross, of Kanmantoo (17.44 in.), got from 60 to 70 tons of hay from lucerne sown thirty years ago. Mr. T. Lewis, of Burra (17.77 in.), recommends lucerne for light soils of Eastern plains. Mr. Weyland, of Bowhill (11 in.), grew lucerne on rubbly land without irrigation.

The Veile's formula for manuring an acre of lucerne is superphosphate 352 lb., muriate of potash 176 lb., gypsum 352 lb. Professor Lowrie recommends 400 lb. of a phosphate, 5 cwt. and up to 2 tons gypsum, and later 6 cwt. of wood ashes, or even 10 cwt. Where lime is wanting 6 to 8 cwt. bonedust is most profitable, and also annually, in winter, according to the crops cut, from 4 to 10 cwt. Others recommend from 480 to 720 lb. of Thomas phosphate and the same of kainit, or from 120 to 160 lb. of muriate of potash. Thomas phosphate is for such a perennial crop preferable to superphosphate.

According to these formulas, and another used in New Jersey Experiment Station, where a little nitrogen (in three years 90 lb.), was given beside the phosphoric acid and the potash, the lucerne crop was enriching the soil very much by drawing nitrogen from the air. The three years' crop at New Jersey contained actually 912.8 lb. of nitrogen! What a large sum would be required to apply the 822 lb. of nitrogen by means of fertilisers after deducting the 90 lb. supplied!

Professor Maercker's experiments at Lauchstaedt proved that 4 cwt. kainit on good soil given to barley and afterwards yearly manurings, with 5 cwt. kainit and 3 cwt. Thomas phosphate gave the largest profit per half-acre, viz., 14/3. An increase to 10 cwt. of Thomas phosphate increased the crop by 2.39 cwt. of lucerne hay, but not the profit, which was only 6/3.

It should be mentioned that lucerne does not grow well where there is an excess of iron in the soil, but it feeds most heavily on lime, potash, magnesium, and phosphoric acid, so that a top-dressing is advisable after some years if you do not manure every year. Without lime you cannot expect large crops. Mr. Jared G. Smith, an agrostologist, says: "There is no better hay plant than alfalfa in regions where it will grow, and the field should be cut when the first flowers appear, before the stems begin

to become hard and woody. With proper care the limit of profitable production need not be *five*, or *twenty*, or even *fifty* years."

At the Experimental Station, Manhattan, Kansas, disc harrowing even four times in four months has been a remarkable success. The crop was very thin and poor, but with 1.19 in. of rain in June, 4.51 in. in July, and 2.84 in. in August four cuttings were made.

SORGHUM AND OTHER SUMMER FODDER PLANTS.

The best time for sowing seems to be the end of September, or first week of October, if possible shortly after rain, after the land is again in a mellow condition. Sorghum will grow fairly well even without rain or irrigation, where millet or maize will not prosper. It should be cut just as the seeds begin to turn color. If not sown broadcast and hoed several times in summer the crop should be good, and a second crop is in that case sure to grow. Mr. H. Carter, of Clare (24.30 in.), thinks 10 lb. of seed sufficient, Mr. D. Hanna, of Gumeracha, 15 lb. Mr. A. Steinwedel, of Balaklava (15.94 in.), prefers the black seed varieties and early amber-cane for fodder, and dhurra for seed. The rows should be 2 ft. apart, the soil kept open by cultivation, and 2 in. of soil drawn towards the stems, which will cause another ring of roots. He sows in September with only about 2 lb. of seeds per acre, and cuts when in blossom. The "Farmers' Guide" for the United States, states that sorghum is much benefited by muriate of potash. Mr. Jas. Wilson, of Petersburg (12.17 in.), having tried many fodder plants without much success, recommends, however, sorghum, which should there be sown in July. If weeds are growing too freely with the sorghum he turned cattle in, and on removing them in January sorghum was soon again 1 ft. high. Wheat following sorghum did not always do well with him. Cattle seemed to prefer amber-cane, took afterwards to sorghum, and last to Farmers' Friend, where the three were in one paddock. Cows gave abundance of milk. He sowed 3 lb. of seed per acre (cost 3d. per lb.). Sorghum makes good ensilage, if chaffed into the pit. Johnson Grass (Sorghum halepense) gives good crop, but should not be planted in land intended for other crops, it being so difficult to get it out of the soil. The late Mr. Kluske, of Eudunda (16.96 in.), had different sorghums 5 and 6 ft. high in March, and Johnson's Grass 3 ft. Mr. A. Plush, of Calca (15 in.), also had sorghum and Kaffir Corn 5 ft. high. Mr. Bishop, of Mallala (16.56 in.), had still in June Kaffir Corn 4 ft. high. Mr. R. Marshall, then of Templars (about 18 in.), ploughed in, 3½ in. deep, with a multi-furrow plough 300 acres with sorghum, using 3 lb. per acre broadcast, and the crop was very good, in spite of the exceptionally dry season.

Mr. T. Serle, of Millicent (29 in.), raised a crop of dhurra 8 ft high; and J. Grunicke and J. Moseley, of Woolundunga (16.98 in.), considered dhurra a very valuable fodder plant. Mr. Westerman-Smith, of Golden Grove (about 24 in.), feeds with sorghum after February until April or May. Mr. W. J. Trembath, of Daven-

port (9.24 in.), recommends Johnson Grass (Sorghum halepense) as growing without irrigation in the hottest weather. Mr. T. Gray, of Amyton (12.41 in.), had grown sorghum for several years without impoverishing the land much, and other members said that in wetter districts it had proved to be beneficial to the wheat crops. (In what way?).

Millets are doing well at Millicent (29.02 in.). For green fodder it should be sown there from September to December, so as to increase the yield of milk from a given number of cows in April and May when butter is dearest. This is better than to increase the number of cows. Twelve pounds of seed in drills 18 inches apart, or 15 to 25 lb. broadcasted, is recommended. Crops of 7 to 10 tons per acre are not unusual. Mr. J. Bawd, of Mount Gambier (31.82 in.), grows Hungarian millet without any irrigation to perfection.

At the Hawkesbury Experimental Station (N.S.W.) many varieties of sorghum, millet, &c., were sown on land previously cropped with peas, the haulms then being ploughed in 10 in. deep on 12th November, and the following manures spread broadcast and harrowed in (per acre), viz., 1 cwt. kainit, 1 cwt. superphosphate, 2 cwt. bonedust, 1 cwt. sulphate of ammonia, at a cost ~~the two, says that the yield of potatoes was in every instance larger~~ of 30/. They were first cut on the 20th February, and a second cut was made on the 12th day of May; but suffered from the weather. Pearl millet gave the best results, viz., 16 tons 17½ cwt. at the first cut and 2 tons 7½ cwt. at the second cut. Next came early amber cane, with 9 tons 11½ cwt. and 4 tons 11¼ cwt.; Kaffir Corn, with 6 tons 5½ cwt. and 3 tons 10¼ cwt.; and dhurra, sorghum, with 5 tons 18½ cwt. and 4 tons 11¼ cwt.; Planters Friend, 8 tons 13¼ cwt. and 2 tons 12 cwt.

I do not find manuring mentioned, but no doubt a complete manure will greatly increase the crop.

Kale does remarkably well in Millicent and other parts of the South-East, and requires manuring, as stated under "Cabbages."

POTATOES.

Next to Germany, I believe the United States are growing the largest crops, and also as regards acreage under crop. The Director of Geneva Station, New York, U.S., states that the ash of potatoes contains 59.8 per cent. of potash, and experiments showed that larger quantities of potash were required than usual in potato manures. The average yield without potash was 85½ bushels per acre: with sulphate of potash 112½ bushels; and with muriate of potash, 135 bushels. The latter was a good fertiliser, even on some clay soils, where potash may be said to be present in considerable quantity. In Oregon Mr. French reported that kainit produced 145 bushels, against 81 bushels per acre unmanured, and Director Flagg, of Rhode Island, stated that muriate of potash produced 76 bushels per acre more in combination than where sulphate of

potash was so used, while, on the contrary, Director Giessmann, of Massachusetts, when making experiments to compare the effects of the two says that the yield of potatoes was in every instance larger where sulphate of potash had furnished the potash of the fertiliser; and Director Scovell, of Kentucky, appears to be of the same opinion. He adds that the potatoes contain the largest amount of dry matter, and are, therefore, of the best quality. Mr. W. P. Brooks, of Amherst Station made eight experiments comparing muriate and sulphate of potash, when the latter gave an average of 22.1 bushels more of merchantable tubers, and the eating quality has generally been better, as containing less water and more starch. Mr. T. M. White, of New Brunswick, New Jersey, says that, averaging three experiments, muriate and sulphate yield practically the same; but that potatoes grown with the latter are best when cooked, while muriate is somewhat cheaper. The New Jersey Experimental Station in U.S. harvested on three farms also more tubers from muriate of potash, but from sulphate of potash they contained slightly more starch, viz., 16 lb. per acre. Mr. Whittemore, of Colebrook, New Hampshire, says for that State the composition of manures should be 9 to 11 per cent. of phosphoric acid, 9 to 15 per cent. of potash, and 2 to 4 per cent of nitrogen. Phosphoric acid used alone at Storr's Station, Connecticut, or in combination with nitrogen, brought but little over nothing. Professor Wagner records the same result of a sandy soil, and Director Scovell, of Kentucky, said that 200 lb. of sulphate of potash produced slightly more than 80 loads of stable manure, and results showed decidedly that there was a profit in the use of potash compounds. The money expended in sulphate of ammonia and superphosphate was entirely lost. Mr. D. D. Johnson, of West Virginia, obtained from 800 lb. of kainit with phosphoric acid (as 2 to 1) 161⅓ bushels per acre, or a net profit of £11/9/6 per acre, less the cost of digging the increased crop. The careful experiments at the New York Experiment Station concerning the relative effect of muriate and sulphate of potash upon the composition of the potash were inconclusive.

Professor Dr. Maercker made experiments in large vessels filled with a light sandy soil, to which 2½ per cent. of peat was added for the purpose of ascertaining the results with different potash salts. Each vessel received 2 g. of nitrogen in form of sulphate of ammonia, 1 g. of soluble phosphoric acid, and 20 g. of carbonate of lime. One-half of the vessels received also at the rate of 97 lb. of potash per acre, the other at the rate of 193 lb. The variety "Professor Maercker" potatoes were planted on the 10th day of April, 1896, and harvested in the first days of October. Those with less potash gave, where kainit was used, 141 g.; with sulphate of potash, 159 g.; and muriate of potash, 234 g. of tubers. The double quantity of kainit gave 195 g., of sulphate of potash 298 g., and of muriate of potash 337 g. The starch was with the smaller doses of potash almost equal: with the larger, muriate of potash had a percentage of 16.67, and sulphate of potash of 17.30, but the larger crop of muriate gave 23 g. more of starch.

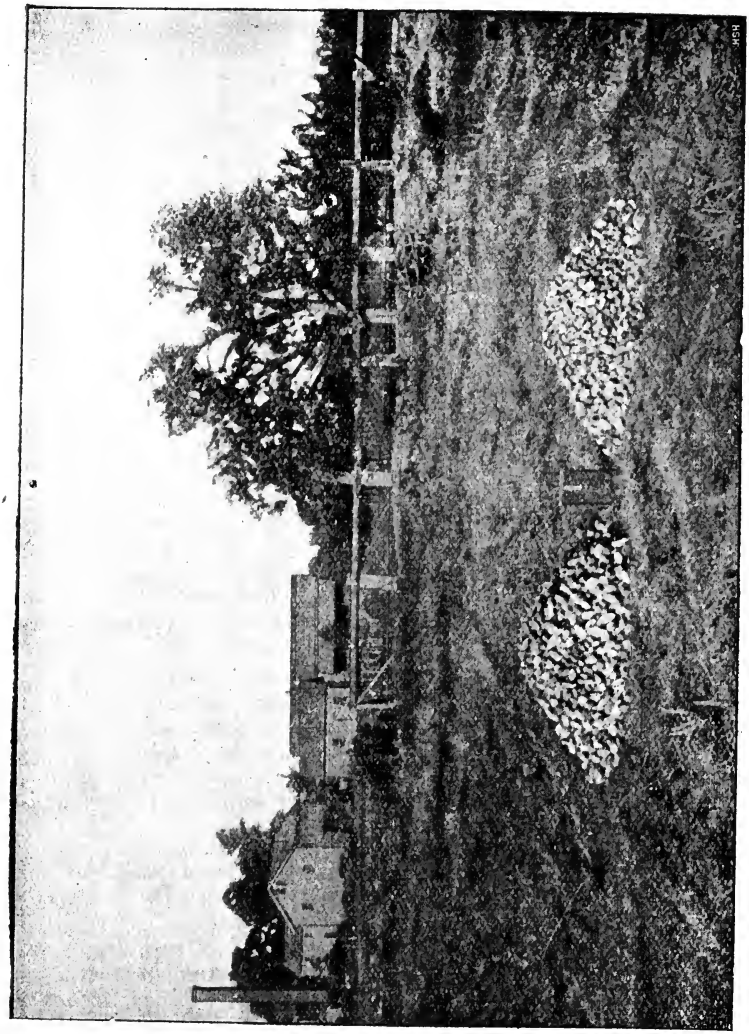


PLATE X.

Experiments made by Mr. T. F. Stroud, of Shakes Station, Connecticut, 1895. The photos. represent the crop on $\frac{1}{5}$th of an acre.

Unmanured.

Result per acre—3,952 lbs. of potatoes.

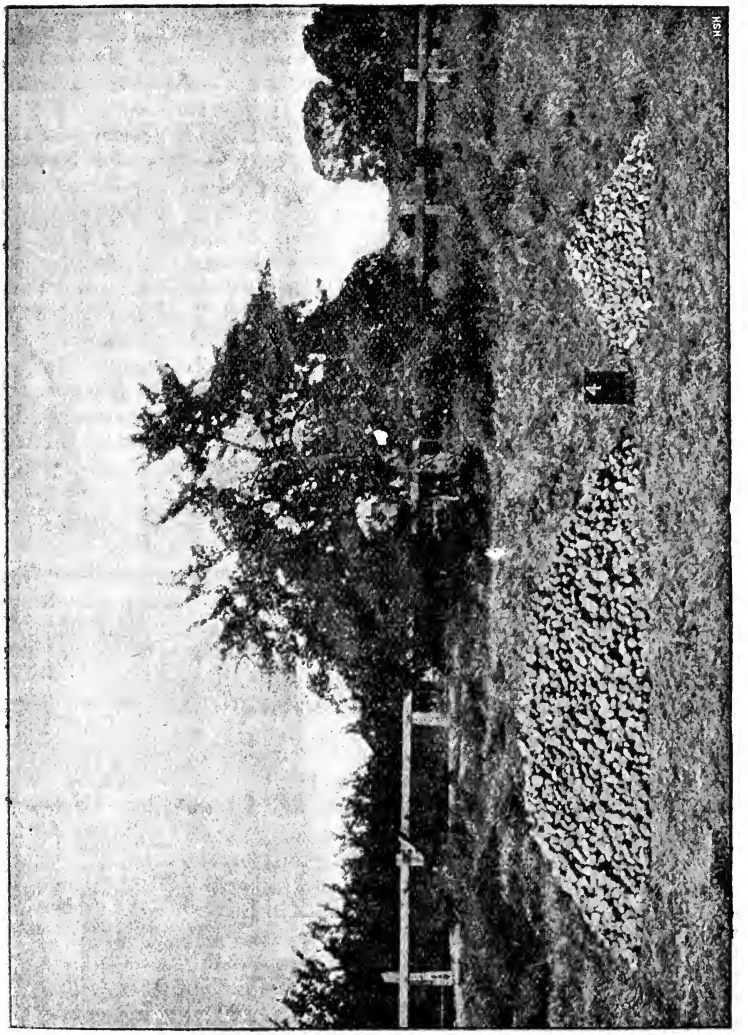


PLATE XA.

Manured per acre with { 215 lbs. muriate of potash
551 lbs. superphosphate
358 lbs. nitrate of soda

Result per acre ... 12,835 lbs. of potatoes.

With tops returned to the soil a crop of 200 bushels per acre removes 36 lb. nitrogen, 13 lb. phosphoric acid, and 60 lb. potash. If the new German potatoes are, however, planted, and such crops as 300 cwt. and more are grown, the proportion of plant food removed is, of course, so much more, although the larger growth on the surface returns also more into the soil if turned under. Professor Maercker demands for these varieties, to obtain a fairly full crop, 58½ lb. of nitrogen, 24 lb. of phosphoric acid, and 79½ lb. of potash per acre, but he says also that you cannot use only commercial manures. The potatoes would only be able to take up about two-thirds of the nitrate of soda or sulphate of ammonia, one-third of the phosphoric acid, and about 60 per cent. of the potash contained in the respective manures applied, and, if larger quantities to make up for the deficiency were used, it would at least with nitrate of soda and kainit (unless the new kainit is used) be injurious, and 6 cwt. of nitrate per acre also too expensive. From 100 to 150 cwt. of the very best farmyard dung, supplemented by commercial manures, are, therefore, wanted. When green manuring is possible after a sufficient rainfall in February or March, and the potatoes are planted in August or later, you might obtain from 80 to 100 lb. of ntrogen per acre. The Long Island Farmers Club use instead of dung 440 lb. of high-grade dried blood, and only 127 lb. of nitrate of soda per acre.

The Permanent Nitrate Committee offered in 1896 prizes for growing potatoes on not less than an acre with dung and fertilisers used in the discretion of the competitors, but in conjunction with nitrate of soda of 95 per cent. purity. The best return obtained, the Cupar and North of Fifeshire Agricultural Society, on sandy, clayey loam, with 30 tons of dung at time of planting, 4 cwt. of superphosphate, ¾ cwt. of sulphate of potash, 1 cwt. of steamed bone-flour in drills, and 1 cwt. of nitrate of soda sown broadcast before earthing up last time. The land had been two years in pasture, and only in 1895 had a crop of oats. Result, 23 tons 12 cwt. 1 qr. and 25 lb., against 15 tons 19 cwt. and 8 lb. not manured. The soil was, therefore, in very good heart before. The Blandford Farmers' Club applied to strong loam on clay 15 loads of dung in winter, ¼ cwt. of nitrate of soda at planting, and ¾ cwt. nitrate of soda in three dressings of 28 lb. The crop resulted in 13 tons 1 cwt. 1 qr. 20 lb., against 8 tons unmanured. The land had borne wheat in 1893 and 1895 and mangolds in 1894. Skelton-in-Cleveland Agricultural Society used merely 20 loads of dung and 1 cwt. of nitrate of soda on strong soil, and the result was 17 tons 9 cwt. 3 qr. 15 lb., against 11 tons 11 cwt. 1 qr. 26 lb. Previous crops in 1894 seeds, in 1895 oats. The Easingwold Agricultural Club manured sand on sand, which had turnips, oats, and clover in 1893, 1894, and 1895, with 15 tons of dung, 5 cwt. kainit when planted, and 1 cwt. nitrate of soda when earthed up, and the result was 12 tons 4 cwt. 18 lb., against only 7 tons 9 cwt. 10 lb. without manure, or an increase of 64 per cent. (The kainit should have been applied much earlier, and the result might have been still better.) Dr. Aitken reports in the Highland Society Transactions, 1887, that

a complete manure, containing nitrogen, potash, and phosphoric acid gave 7 tons 3 cwt. 32 lb. per acre; without phosphoric acid, 4 tons 19 cwt. 40 lb.; without nitrogen, 4 tons 9 cwt. 24 lb.; and without potash, 3 tons 1 cwt. 56 lb. Experiments conducted in Cumberland by C. D. Hunter, F.C.S., with complete manure, containing nitrogen, phosphoric acid, and potash gave 9 tons 2 cwt. and 8 tons 3 cwt.; without potash, 5 tons 7 cwt. and 4 tons 10 cwt.; without manure, 4 tons 14 cwt. and 3 tons 4 cwt. Dr. Aitken finds that 2½ cwt. per acre of refined potash salts with other manures give best results. Professor Dr. P. Wagner says to produce 400 cwt. per acre potatoes require 80 lb. of phosphoric acid, and in an article on the necessity to supply nitrogen to the land, gives us the results of four experiments with potatoes grown in a sandy soil at Arheilgen. While respectively 156 cwt., 128 cwt., 100 cwt. 40 lb., and 167 cwt. 20 lb. per acre were obtained without manure, against 186 cwt., 242 cwt., 197 cwt. 60 lb., and 229 cwt. 60 lb. with potash, phosphoric acid and 4 cwt. of nitrate of soda, when omitting the nitrate of soda the first plot gave no increase over the unmanured plot, the others respectively 69 cwt. 20 lb., 49 cwt. 20 lb., and 18 cwt. 40 lb. per acre.

From twenty experiments made in Southern Pines, N. Carolina, U.S., the following conclusions are formed, that an increase of potash showed a gain in the percentage of first-grade potatoes by 12 per cent. when double the normal ration was given. Increasing the phosphoric acid to double normal ration increased the first-grade potatoes by only 3 per cent., and where the nitrogen was so increased the first-grade potatoes were 4 per cent. ahead. But both phosphoric acid and nitrogen promoted the total yield of tubers by 8 per cent. of all sizes. Two plots unmanured of one-twentieth of an acre, yielded 86.4 and 98.7 lb. of potatoes, while 250 lb. of nitrate of soda, 400 lb. of acid phosphate, and 160 lb. of muriate of potash yielded 239.4 lb., and with an addition of 2,000 lb. lime, 306.7 lb. tubers. French experiments generally show the importance of nitrate of soda, even where large quantities of farmyard dung were given, except where M. Monville had at Bellevaux planted Magnum Bonum in very good soil, rich in humus. He had three plots of 150 ft. square, giving to No. 1, 4 lb. of Thomas phosphate and 2 lb. of sulphate of potash; to No. 2, 4 lb. of Thomas phosphate, 2 lb. of muriate of potash, and 2 lb. of nitrate of soda; and to No. 3, no manure. The crop was alike in No. 1 and 2 of more than double the quantity of finer tubers than taken from No. 3.

M. Le Henry's, of Ferre, experiments resulted from no manure in 9,600 lb. of tubers; No. 2, with farmyard dung, in 11,200 lb.; No. 3, with farmyard dung and 480 lb. of Thomas phosphate, in 24,000 lb.; No. 4, with the same as No. 3 and 80 lb. nitrate of soda, in 26,720 lb.; No. 5, with the same as No. 4 and 160 lb. of sulphate of potash, in 28,800 lb. per acre.

M. Gallien, of Leotoing, had nearly one-third more tubers when he added 800 lb. of Thomas phosphate to farmyard dung, and netted £6/14/6 per acre. M. Kunsch, of Montfaucon, planted "Magnum

Bonum," and harvested, without commercial manure, 22,700 lb. of tubers per acre; with 480 lb. of Thomas phosphate, 28,160 lb.; with 480 lb. of Thomas phosphate and 80 lb. of nitrate of soda, 30,880 lb.; and with 480 lb. of Thomas phosphate, 80 lb. of nitrate of soda, and 160 lb. of muriate of potash, 31,040 lb. The soil seemed to require hardly any potash, except that in the farmyard dung and in the soil to give a full crop. M. Houry, of Val-Notre-Dame, obtained from one-fortieth of an acre, without manure, 128 lb. of potatoes; from farmyard dung, 422 lb.; and adding Thomas phosphate to the dung, 576 lb., as reported by Dr. Smets.

M. C. Ribaux, of Plan-Jacot, who has great faith in the lasting qualities of Thomas phosphate of from four to seven years, planted potatoes without commercial manures on land that had 14,000 lb. old dung for a crop of wheat, and again 12,000 lb. a fortnight before planting, and his crop was 16,198 lb.; with 550 lb. of Thomas phosphate the yield was 18,832 lb.; with 550 lb. Thomas phosphate and 480 lb. kainit, 18,304 lb.; with 225 lb. nitrate of soda added to the above 550 lb. and 480 lb., 20,240 lb.; with the Thomas phosphate and nitrate of soda, 19,164 lb.; and with only 275 lb. of Thomas phosphate, 17,240 lb. The profits over the cost of the commercial manures were respectively 60/, 29/, 60/, 36/6, and 19/.

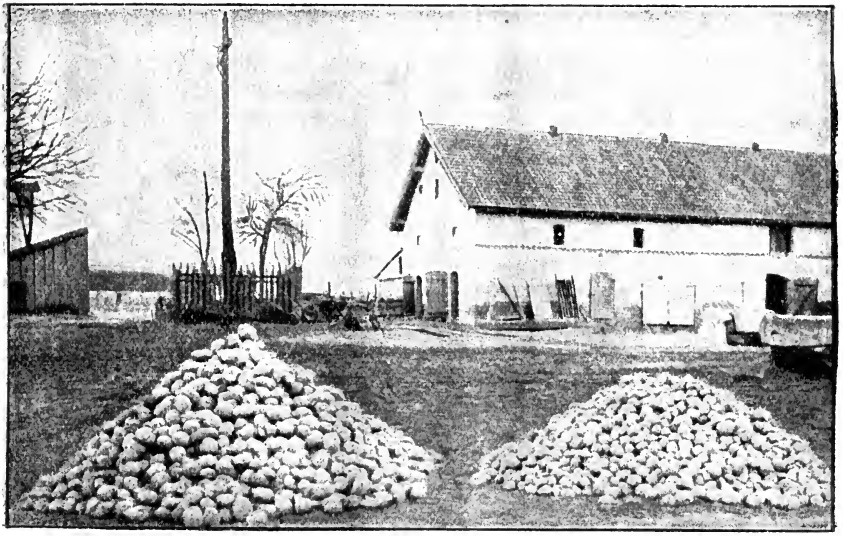
Mr. Hoppenstedt, of Sladen, Germany, found a large increase in his crop of heavy soil, where he used potash to three varieties of potatoes, but he used only kainit, and proved how necessary an earlier application of this salt is, especially with later sorts, that could utilise the potash for a longer time. He used 128 lb. of nitrate of soda and 96 lb. of superphosphate to 480 lb. of kainit at the planting of the potatoes, and had 4,800 lb. more than from not manured land, and 1,974 lb. more than where only the nitrate of soda and superphosphate had been given. Where the 480 lb. of kainit had been applied in autumn he had 5,386 lb. per acre more, and, where given to a previous crop, 8,852 lb. more harvested than from unmanured land. The starch was only 16.5 per cent. where kainit was given at the planting, 18.7 per cent. if given in autumn, and 19.9 per cent. if to a previous crop. (See last page as to application of manures).

Another interesting experiment was made by Mr. Hofmann, of Urnshagen. He manured in 1897 with 4 cwt. of kainit, 4 cwt. of Thomas phosphate, and 196 lb. of nitrate of soda at per acre for oats and vetches, and harvested 6 cwt. 80 lb. per acre more grain and 16.78 cwt. more straw than from an unmanured block. He then planted in 1898 potatoes, and had on the unmanured 82 cwt., and on the land manured in 1897 at the rate of 168 cwt. per acre, or, after deduction of the cost of the manure, a profit at the rate of £7/17/9 for the two years.

Mr. Wermter, of Robertshof, in East Prussia, manured good medium soil with stable dung, and had at the rate of 156 cwt. of potatoes per acre; but where he supplemented the stable dung with at the rate of 8 cwt. of Thomas phosphate, 2½ cwt. of 40 per cent. kainit (here to be substituted by 2 cwt. of muriate of potash), and 3 cwt. of nitrate of soda, the result was at the rate of 250 cwt. per acre. (See plate XI.)

PLATE XI.

Experiments made by Mr. Wermter, of East Prussia.
Photograph of produce from 4 perches.



Stabledung and
8 cwt. Thomas phosphate
3 cwt. nitrate of soda
$2\frac{1}{2}$ cwt. of 40% kainit
(or 214 lbs. muriata of potash)
250 cwt. per acre.

Stabledung,
150 cwts. per acre.

Professor Dr. Wagner gives his latest experiences with nitrate of soda and sulphate of ammonia. He referred to half an acre of potatoes manured with $1\frac{1}{2}$ cwt. of nitrate of soda, and another half an acre which received sulphate of ammonia, containing an equal quantity of nitrogen. Of both he used one-half on the 18th April with the planting of the tubers, and the other half on the 2nd of May as a top-dressing. The half an acre with nitrate of soda had 33 cwt. more potatoes than an unmanured half an acre; but sulphate of ammonia gave 45 cwt. He explains this that the soil was very percolative, and the spring of 1898 had so much rain that the nitrate was more washed out than the sulphate of ammonia.

Dr. G. Smets says in "La Potasse" of 1900 that potash applied in too great a quantity can interfere with the first development of the potato plant and the starch, but if applied earlier, potash can considerably increase the crop, even double it. In the sands of the Campine he obtained 30 per cent. more through potash, which should be applied to a former crop, or in winter. Entire tubers are four times as safe to use with potash than cut tubers.

If potash is properly applied it increases the crop, the starch, and the number of large tubers.

Professor Maercker had from loamy soil from the "Magnum Bonum," without potash, 20,456 lb. per acre; with 8 cwt. of kainit applied to the former crop, 23,848 lb., or 3,848 lb. more; with another 8 cwt. given in spring the crop increased to 27,760 lb. per acre, or 7,304 lb. more.

Mr. Rassmann, of Amoenau, Hesse-Nassau, on good sandy soil realised from stable dung at per acre 67.20 cwt.; with stable dung and 320 lb. Thomas phosphate, 640 lb. kainit, and 120 lb. nitrate of soda, 117.20 cwt., or 50 cwt. more, at a cost of £1/6/ for the mineral manure. (See plate XII. of a similar experiment by him).

PLATE XII.

Experiments by Mr. Rassmann, of Amoenau. Red sand in good cultivation after oats, 1899.

Photo. of produce from $\frac{1}{16}$th of an acre.

Produce per acre—146 cwt. 30 lbs. 84 cwt.
Manured with stabledung and 30 cwt. stabledung.
4 cwt. Thomas phosphate
8 cwt. kainit
1½ cwt. nitrate of soda per acre.

Net profit on the commercial fertilizers, £3 0s. 6d. per acre.

In the year 1899, at the experimental station at Koeslin, Pomerania, potatoes received the following mineral manures per acre of medium soil:—

Plot.	Nitrate of Soda.	Thomas Phosph'te.	40 per cent. Kainit.	Increase against No. 1.	Starch.	Cost of Manure.	Net Profit.
1	—	—	—	—	18·8 p.c.	—	—
2	160	400	160	37 cwts.	18·5 "	27/6	28/4
3	200	400	160	50 "	18·4 "	34/	41/4
4	—	400	160	12 "	18·4 "	14/9	3/2
5	160	—	160	24½ "	18·5 "	18/9	18/6
6	160	400	—	23½ "	18·7 "	22/	12/11
7	160	400	160 + 1,600 lbs. Lime.	42½ "	18·5 "	3 /7	38/10 at 1/6 pr. 100 lbs.

May be changed here by 125 lbs. of Muriate of Potash.

The phosphoric acid and potash were given some little time before planting, together with one-half of the nitrate of soda when the potatoes appeared above ground, and the other half before hilling them up.

Dr. Somerville, of Newcastle-on-Tyne, writes as regards experiments made at Cockle Park: The addition of 7½ cwt. of mixed artificials without potash to 15 tons of farmyard manure has produced an average increase of 6½ tons of marketable potatoes. The addition of 1 cwt. of sulphate of potash, costing 9/ (here 12/) has resulted in a marked increase, 1½ tons in one case and 1 ton in the other plot. Where 15 tons dung, 1½ cwt. of sulphate of ammonia, and 6½ cwt. superphosphates were applied, the percentage of "small" to the total crop was 25, whereas plus 1 cwt. of sulphate of potash to these manures, the percentage of small potatoes was reduced to 18. The same was observed where the dressing with muriate of potash was doubled. With 1 cwt. per acre the percentage was 34; with 2 cwt., 23. At the potato-growing competition of the East Lothian Agricultural Society there were separate plots of half an acre, which received the same manures as others, but in addition potash and all used 3⅓ cwt. kainit, and the increase on some plots was 2 tons 4 cwt. 3 qr., 2 tons 1 cwt. 3 qr., and 2 tons 14 cwt. It was said that near the sea the winds would carry sufficient muriate to the land, but where 3 cwt. kainit was there applied to very rich land it yielded 28 cwt. more merchantable potatoes.

I may remark here that there have been cases reported by members of our Branch Bureaus that soaking potato setts in a solution of 1 lb. of sulphate of ammonia and 1 lb. of nitrate of potash in 5 gallons of water had proved a successful manuring; if soaked for twenty-four hours, and then left twenty-four hours before planting. This solution has as least rotted cut potatoes, and has certainly shown in many instances that it required more water, so as to be harmless, and even then was not always a success. At Hawkesbury College, New South Wales, also solutions of ¼ lb. of sulphate of ammonia and ¼ lb. potassium nitrate with 1¼ gallons of water and other solutions often prevented germination.

View of Competition Crop at Rhodes Farm, North Berwick, where the kainit dressing had been applied.

View of Crop at Rhodes Farm adjoining the competition crop, manured in precisely the same way, except that the kainit dressing was withheld.

In a recent publication, "Manuring with Brains," it is, however, claimed that potash in the form of kainit is invaluable for preventing "scab" and "sprain" in potatoes. Sprain manifests itself by black bands through the tubers, which render them unsaleable. Mr. A. C. Brown, Pinkie Mains, Musselburgh, pioneer of early potato growing on the East Coast, could only prevent the above diseases by applying an annual dressing in early winter of 5 cwt. per acre of kainit, and he has, in fact, grown potatoes five years in succession on the same field. While scab is a great source of loss throughout Great Britain, sprain is most prevalent in the eastern midland counties of Scotland; but those growers who regularly apply a liberal dressing of kainit enjoy an enviable immunity from both diseases. It is little use to apply kainit in spring, and much better results are on light land than on heavy. Professor Campbell, of Yorkshire, says:—"The necessity of using potash for potatoes has been forcibly demonstrated."

In the United States potatoes grown in Colorado are known as perfection, but the planting of land previous under lucerne is partly responsible for this.

Very few reports for Australia are recorded of crops obtained, and hardly any stating what kind of manure was applied. Mr. T. C. Ruwoldt, of Mount Gambier (31.82 in.), used in 1898 1 cwt. of bonedust per acre to wheat, and planted in 1899 potatoes without more manure, which yielded him 6 tons, against 8 tons, and a net profit of £1/15/ where he applied 5 cwt. of bonedust. It is stated that experiments where potatoes were manured under, or at the sides, give a far heavier crop, and contain more starch than where the manure was mixed with the whole of the soil. It is satisfactory to know that a larger area has been planted in 1899, viz., 8,405 acres, from which 19,716 tons were gathered, against 6,653 acres and 14,445 tons in 1898. New Zealand had in 1898 38,604 acres under potatoes, yielding an average of 4.95 tons, but in 1899 7.73 tons on 22,593 more acres. Near Invercargill, N.Z., there were many sorts planted in 1899 in good garden soil merely with rotten stable dung, the season being very good. Many varieties gave from 10 to 17 tons per acre. White Elephant gave 26 tons, Early Regent the same, Bruce 23 tons, Early Rose 24 tons; but it must be remembered that the rainfall was very evenly distributed through the year, with a temperature varying from 40 deg. in winter to 70 deg. in summer. At the Experimental Farm at Momohaki, N.Z., commercial manures alone were used with the Early Rose variety, and 3½ cwt. superphosphate gave 7 tons 8 cwt. 1 qr. 13 lb. per acre; 3½ cwt. Thomas phosphate, 7 tons 14 cwt. 1 qr. 21 lb. No nitrogenous or potassic fertiliser was used with the phosphates, only some commercial mixtures that yielded less except a root manure, which produced 7 tons 16 cwt. 3 qr. 18 lb. Experiments on 51 plots at Wyndham, N.Z., yielded but little better results on account of a flooding and severe frost. Four hundredweight of bonedust and 2 cwt. of Thomas phosphate gave 9 tons; 3 cwt. bonedust and 3 cwt. kainit, 9 tons 8 cwt.

Experiments at Hawkesbury College, New South Wales, with a rainfall of 10 in. from August 25 to January 29, and a temperature up to 100 deg. in summer, did not give good yields with 730 lb. per acre of a mixture of 300 lb. kainit, 200 lb. superphosphate, and 100 lb. of sulphate of ammonia. Early Rose yielded best with 6 tons 3 cwt. 52 lb.

In the North-Western Division of Tasmania, which includes Circular Head, no less than 20,351 acres were planted in 1900 out of nearly 27,000 acres for that State; but the average yield was in 1898-9 only 4.35 tons, and in 1899-00 3.78 tons. I am told that the potatoes are there mostly planted on land newly cleared of the forest, and but little manure is used except at Flowerdale, where 4 cwt. of bonedust or Thomas phosphate secured 5 tons; and at another division, where 2 cwt. of Thomas phosphate yielded 5½ tons.

The Editor of the "Farm, Field, and Fireside" recommends as the basis of a manure for potatoes 15 tons of farmyard manure, 2 cwt. of superphosphate or 3 cwt. of Thomas phosphate, 2 cwt. sulphate of potash, and 1 cwt. of nitrate of soda. Professor R. P. Wright, in his report on experiments on the manuring of potatoes in 1889, comes to the following conclusions, amongst others: A moderate quantity (10 tons per acre) of farmyard manure along with suitable commercial manures is more profitable than a still greater quantity of farmyard manure. Potatoes grown on farmyard manure alone deteriorate in nutritive value and cooking quality. The best are those grown on commercial manures alone. Potatoes grown with commercial manures alone suffer more readily from drought on light soils than where farmyard manure had also been given. It is best to use both, and the quantity of potash found in such case most effective and profitable was that contained in 1½ cwt. of sulphate of potash of 97 per cent. purity. Kainit is less effective, and the roots distinctly inferior in nutritive value and in cooking quality; and, although to some extent potatoes grown with muriate of potash, are also inferior to those with sulphate of potash, the crop is mostly greater. (See Potatoes after Peas, pages 75 and 76, at Hedwigsberg).

Peas and Beans are a crop which leaves the soil in better heart as regards nitrogen, and many South Australian farmers had used these nitrogen gatherers long before the late Professor Dr. Hellriegel's important discovery. Thus, practice has for once forestalled theoretical discovery, for all knew that a good pea crop told upon the succeeding wheat crop, and it became here almost the only rotation of crops. How to obtain a good crop of peas has been shown by many experiments made in pots, and a few in the field. Mr. W. Pearson, of the Meadows, S.A. (with 34 in.), read a paper after twenty years' experience, and stated that for the hilly districts peas are simply invaluable as a fertiliser, and more reliable for a subsequent hay or grain crop than bonedust or any other artificial manure he has tried. For the peas he had, however, been more successful with bonedust than with other fertilisers. (This was challenged!) Mr. Spence, of Clarendon, used also 4 cwt. of Conrad's bonedust with excellent results. He reduces the soil to a fine tilth in April, destroys any wild oats and other weeds spring-

ing up by running sheep on it until June or July, when he ploughs the peas in 4 to 5 inches deep with the manure broadcasted, and he cross-harrowed thoroughly. He uses the roller when the peas are well out of the ground, and harrows again across the previous harrowing. The peas are mowed when the top pods are just full, not dry, and puts them in small heaps, from which you cart them in and thrash them out at once (to save stacking) on a merely warm, but not a hot day, to prevent the breaking of the haulms too small. At Port Broughton the blockers planted in 1896 quite 50 acres with peas for the Adelaide market, and did well with 14 in. rain. At Lobethal the peas are put through a chaffcutter, and then, after being winnowed, are stored for winter fodder. Mr. H. W. Robinson, of Balaclava (with 16 in. rain), advocated the cultivation of 20 to 30 acres of peas annually, and never the same piece twice in succession. He drills them in 14 to 16 in. rows apart in June with 1 cwt. of superphosphate per acre. The Early Dun pea is recommended by him as the best variety; by Mr. H. Roediger, of Gawler River (18.90 in.), the Yorkshire. The pea likes a light soil, with a good proportion of lime in it, and Thomas phosphate could supply this. From ½ to 2 bushels per acre is usual. Mr. Harper, of Clarendon (32.46 in.), sows 3 bushels. For ensilage a mixture of peas with barley is very good. Mr. H. Gray, of Hindmarsh, had on a black flat 73 bags from 5 acres. Mr. J. Lewis, of Cherry Gardens (about 36 in.), used 3 cwt. per acre of Thomas phosphate for his peas, and had a splendid crop. Mr. R. Wood, of Dalkey (15 in.), had 13 bags of peas from 3 acres broadcasted. Professor Wagner recommends the use of 440 lb. of any phosphate of 16 per cent. and 160 lb. of muriate of potash per acre. Plates could show clearly how little difference a nitrogenous manure makes, while potash and phosphoric acid are required for the full development of the peas. Without manure the peas and straw show 2.02 g. of nitrogen; with the potash and phosphoric acid manuring no less than 6.11 g. of nitrogen. We have, therefore, enabled the peas to draw so much nitrogen from the air on giving a sufficient supply of potash and phosphoric acid. Only in a very poor soil as regards nitrogen it may be advisable to assist peas for their first development with a small quantity of nitrate of soda, not exceeding, say, from 40 to 50 lb. per acre. At the Agricultural Station at Georgia, U.S., a very much larger application of nitrate of soda was given, and the crop was also much better than with potassic and phosphatic manures alone; but it is more than doubtful that the crop was payable, and the air had not been drawn upon for nitrogen so long as the manure contained it. At Hedwigsberg, near Frankfort, ten experiments were made with peas in sandy soil, poor in lime, and quite impoverished. The whole of the ten plots received per acre 480 lb. of Thomas phosphate (No. 1, nothing else) and eight of them 6,400 lb. of lime. After harvesting the peas the straw was ploughed in for a crop of potatoes in 1894. (It should be mentioned, however, that the late Dr. Voelcker classified the value of pea straw as first, even better than oaten straw and bean straw with the pods).

Plot.	——	Per acre of green peas in lbs. 1892	1893.	Potatoes in 1894.
1	Only lime and Thomas phosphate	2,186	1,914	13,112
2	Only lime with 640 lbs. kainit	2,276	2,140	16,220
3	Only lime with 1,280 lbs. of kainit	1,744	2,154	14,932
4	Only lime with 160 lbs. muriate of potash	2,680	2,312	16,000
5	Only lime with 320 lbs. muriate of potash	2,520	2,328	16,132
6	Only lime with 166 lbs. sulphate of potash	2,936	2,512	17,868
7	Only lime with 332 lbs. sulphate of potash	3,220	2,481	16,088
8	Only lime with 450 lbs. potassium and magnesium carbonate ...	2,872	2,392	13,732
9	Thomas phosphate and 450 lbs. potassium and magnesium carbonate	2,712	2,544	12,268
10	Thomas phosphate with 640 lbs. of kainit	2,572	2,248	12,756

All the plots received in 1893 240 lb. of Thomas phosphate, and plots 2 to 10 the same quantity of potash. In 1894 no manure was given to the potatoes.

Professor A. Bourgeois publishes in his "Essais d'Engrais Chimiques" some experiments with peas made by teachers in the Department of Meurthe and Moselle. They had to use 1,600 lb. of Thomas phosphate and 160 lb. of sulphate of potash; and M. Haillany, in Uruffe, harvested from one square yard of unmanured land 1,385 g. of green peas; from the manured, 2,400 g. M. Leclerc, of Courielles, from the former per acre of green sugar peas, 1,200 lb.; and from the manured, 1,600 lb. Three others had also good results with the above manures, and where M. Gryer added 160 lb. of nitrate of soda he had luxurious plants, but few peas. Mice did not attack the peas on the manured lands.

Near Osterode peas were sown between newly-planted raspberries, for whose benefit nitrogenous manure was given in excess of what might have been given to peas alone. The manure was given in February, and on the 17th of May as top manure 240 lb. of muriate of potash and 400 lb. of superphosphate. The results were per acre:—

Plot.	—	Green Peas. Lbs.	Dry Peas. Lbs.
	Unmanured	612	400
1	Unmanured, but top-dressed	1,152	752
2	520 lbs. Thomas phosphate and 232 lbs. of sulphate of ammonia	2,076	1,356
3	232 lbs. of sulphate of ammonia and 960 lbs. of kainit	1,814	1,180
4	520 lbs. Thomas phosphate and 960 lbs. of kainit	1,175	770
5	520 lbs. Thomas phosphate, 232 lbs. sulphate ammonia, 960 lbs. kainit	2,624	1,712

In Tasmania peas are generally grown without manure, and give but very poor crops, from 10 to 20 bushels; at Frankfort, 30 bushels of grey peas were grown and 6 cwt. of bonedust used.

With broad beans an experiment was made by Mr. E. Lierke, of Westeregeln. Potash and phosphoric acid showed there also very much increased crops, while nitrogen was barely doing this as regards the ripe beans. Unmanured, the crop of green beans was 9,472 lb. per acre, the green stalks and leaves 14,368 lb., ripe beans 2,246 lb. Manured with 153 lb. of sulphate of potash and 216 lb. of double superphosphate, the green pods weighed 11,265 lb., the stalks, &c., 16,304 lb., the ripe beans 3,502 lb. Nitrate of soda being substituted for the phosphoric acid, the pods and stalks weighed more, but the dry beans less, only 3,098 lb.

Mr. Jas. Mason, of Witney, Scotland, manured exhausted soil as regards cereals with phosphoric acid, lime, and magnesia (probably the potash manure containing much magnesia, sulphate of potash-magnesia), tilled well, had a strong crop of beans, followed by a fair crop of clover hay, and another clover crop. He collected, without nitrogenous manure, 376 lb. of nitrogen per acre in the three years, equal to 1 ton of nitrate of soda. This supported in the fourth year so voracious a nitrogen-eating crop as potatoes.

Farmyard dung has about the right proportions of potash, viz., 2 per cent. to 1 per cent. of phosphoric acid, but the 2 per cent. of nitrogen in it are far in excess of the need of the bean, and it is, therefore, wasted, and prevents the drawing of the nitrogen from the air. Professor Wright records the experiments made with beans at Pumpherston in a cold, thin, high-lying, poor clay. All the plots received nitrate of soda and phosphoric acid except one, which had only potash salts, and this plot gave 26½ bushels of dressed beans per acre. Of plot 1, that had sulphate of potash, the crop was 43½ bushels; plot 2 had muriate of potash, and returned 48½ bushels; plot 3 had only the nitrate and superphosphate, and the crop was only 5½ bushels and 2¼ cwt. of straw. Professor Wagner has shown how little nitrogen is required for beans in plot 10, in his "Anwendung Kunstlicher Dungemittel." Dr. Aitken's experiments at the same place gave as the average return of four plots without potash, plot No. 1 unmanured, No. 2 with phosphate, No. 3 with nitrate, and No. 4 with nitrate and phosphate as 5½ bushels per acre; while the average of four other plots, 1 with potash, 2 potash and phosphate, 3 potash, phosphate, and nitrate, and 4 potash, phosphate, nitrate, and gypsum, was 41¼ bushels per acre. The quantities of manure used were at the rate of 160 lb. of phosphoric acid, nitrogen at the rate of 40 lb., and potash at the rate of 120 lb. per acre. Director Dabney, of North Carolina, U.S., says: "Kainit and peas together are the most promising agents for improving our southern soils;" and Mr. McCallum, of Robeson County, says: "The plot on which I used kainit made twice as many peas as any of the others. You could plainly tell the very row where the kainit commenced by the number of peas." Experiments made by J. Harms, of Neuendeich, Holstein, on heavy soil, after receiving at the rate of 64 cwt. of lime per acre, gave a profit of £1/7/6

per acre over the unmanured, 6 cwt. of Thomas phosphate, 65 lb. of kainit, and 130 lb. of nitrate of soda having been applied. I conclude this with the words lately frequently used: "Potash is the dominant manure for leguminous crops."

HOPS.

Experiments in manuring have been made in 1899 in Germany. There were in each case five plots of 100 plants. One unmanured, No. 2 complete manure, with 100 gramm. Thomas phosphate, 90 g. of 40 per cent. kainit, and 110 g. of nitrate of soda, No. 3 omitted nitrate of soda, No. 4 omitted potash, No. 5 omitted Thomas phosphate. The mean crop of the experiments was 54 per cent. more from the complete manure, No. 2, than from the unmanured plot. The cost of the manure was 3/6 for the 100 plants, and the crop more than 18 lb. better. Mr. Deininger had with complete dung 22 lb. more dry hops, Mr. Distler 24 lb. more. Without nitrate of soda they had each 12 lb. more, without potash respectively 8 lb. and 12 lb. more, without Thomas phosphate 11 and 16 lb. more than from the unmanured plot of 100 plants. The profit was with the complete manuring respectively 11/6 and 14/. In an experiment made by Mr. Baumeister the soil had sufficient potash, but hardly any phosphoric acid, so that the results were: With complete manure and without potash, these were equal; without Thomas phosphate, equal with the unmanured plot; and without nitrate of soda, only 4 lb. more. Mr. J. Meyer found in his soil so much phosphoric acid that the omission of Thomas phosphate was not so serious a diminution of the crop against complete manuring; the former was 21 lb., the latter 26 lb. But the omission of nitrate of soda gave only 6 lb., and the omission of potash 11 lb. more than the unmanured plot. Mineral manuring influenced the quality of the hops favorably.

In Kent, England, large quantities—3 to 4 cwt. of dissolved Peruvian guano—are said to be used.

In Tasmania a crop of about 595,000 lb. was the average taken during the last two years from 651 acres under crop. Last year there was an increase of 118 acres. New Zealand had 994 acres with hops, and exported 6,228 cwt.

TOBACCO.

Mr. W. W. Heath, of the Finniss Branch, says in his paper: "Deep and thorough working will always pay, and the more manure the greater and better (?) the crop. Old land in good heart, with artificial manure, is good, but new land or virgin soil, with the same quantity of manure, is far better." American authorities are not of opinion that all manures, or even suitable manures, in excess are desirable. Chlorine contained in common salt, kainit, muriate of potash, are very injurious to the burning of tobacco. Even sulphate of potash and phosphoric acid should not be used to excess, nor nitrogen in the form of raw animal fertilisers or fresh dung. Mr. Butterwick, of Florida, says that generally from 200

lb. to a ton of commercial fertilisers is applied per acre; seldom more for a high-grade leaf for wrapping. In the Connecticut Valley applications of 3,000 lb. of concentrated chemical fertilisers is the rule rather than the exception, the nitrogen being supplied in various forms, and at different times, and the phosphoric acid and potash broadcasted before planting. The proportion is about 60 lb. of phosphoric acid to 75 lb. of nitrogen and 120 lb. of potash per acre. Professor Keszler's remarks on the burning of tobacco in my paper read on August 29, 1892, at the Central Agricultural Bureau, should be well considered before manuring. He recommends from 400 to 480 lb. of sulphate of potassium and magnesium in autumn and 240 to 320 lb. in spring per acre, well mixed with the soil. Professor Stutzer recommends Martellin to be used some time after other fertilisers.

ORCHARDS.

Planting of fruit-trees was being carried on in 1900 in South Australia more than ever before. In 1899 there were 15,477 acres, irrespective of the trees grown in cottage gardens. But I doubt very much that manuring of them has been properly carried out, if at all. Only during the last six years the manuring of fruit-trees with anything but compost or farmyard dung has been called attention to. The few experiments made with commercial fertilisers have been made to trees only a few years old, or at planting. This much is certain, that we have not to judge by the contents of the several fruits what the trees require as plant food. The late Professor Dr. Barth said: "Not in the fruit is the preparation of their sugar; the leaves do this with the aid of the sunlight by means of the chlorophyl in them, and the water from the roots. The sugar thus produced proceeds from the leaves, through branches and twigs, and forms with other plant food received from the roots new wood and leaves, &c., and only later in the season obtain the fruits the sugar after the actual growth of the tree is less energetic." He and Dr. Steglich have at last found that the plant food required in a year by apples, pears, cherries, and plums is very different. An apple-tree requires yearly in grammes, if its stem has a circumference of 10 in., 59 g. of nitrogen, 11 g. of phosphoric acid, 51 g. of potash, and 109 g. of lime. A pear-tree of like dimensions wants 37 g. of nitrogen, 7 g. of phosphoric acid, 40 g. of potash, and 69 g. of lime. A sweet cherry-tree requires 30 g. phosphoric acid, 95 g. of potash, and 209 g .of lime. A plum-tree, 11 g. phosphoric acid, 74 g. of potash, and 75 g. of lime. The quantity of nitrogen is not certain for the two latter; but the yearly requirements per square yard may be only 3 to 4 grammes for the cherry and 7 to 8 g. for the plum, not 17 g. as mentioned by A. Wagner, Director of the Agricultural Winter School at Gelnhausen.

Quite lately Dr. Steglich, of the Experimental Station at the Botanical Gardens in Dresden, has favored me with fuller information. He says, in concord with M. Lechartiers, that fruit-trees require comparatively little phosphoric acid, two to three times as much nitrogen, and three to four times as much potash, or per

square yard annually 10 to 15 g. nitrogen, 5 g. phosphoric acid, and 12 to 18 g. potash, and 40 g. lime. For heavy soil sulphate of ammonia should be applied in autumn, after the leaves have dropped. For light soil nitrate of soda in spring before the leaves appear. At planting he recommends bonemeal and Thomas phosphate and muriate of potash, but REJECTS STABLE DUNG AS QUITE UNSUITABLE AT PLANTING. Lime he puts on in autumn, but not with other fertilisers at same time. A tree of 20 in. circumference requires to be manured on 25 square yards with say, 15 x 25 = 375 g. nitrogen in 3.75 lb. of sulphate of ammonia of 20 per cent., or 5 lb. nitrate of soda of 15 per cent.; 15 x 25 = 375 g. potash in $1\frac{3}{4}$ lb. of muriate of 40 per cent.; 5 x 25 = 125 g. phosphoric acid in $1\frac{1}{4}$ lb. of superphosphate or Thomas phosphate; 40 x 25 = 1,000 g. of lime in 2 lb. of fresh lime, or 2.6 lb. carbonate of lime.

The cost would be about 6d. He plants in holes ten yards wide with 400 g. nitrogen, or 8 lb. blood manure, 200 g. phosphoric acid in 3 lb. Thomas phosphate, 600 g. potash in 3 lb. muriate of potash, or 10 lb. of kainit and 4 lb. of lime. The annual manuring, I presume, he will modify somewhat in accordance with the before-mentioned requirements of the different fruit-trees.

Authorities, however, do not agree at all, and this shows how few experiments have been made extending over a number of years. Mr. Grobben, a lecturer on fruit-trees, mixes the soil on planting for each tree with 20 to 40 lb. of Thomas phosphate and some potash. This, he thinks, will ensure fruitfulness for fifty years, and preferable to manuring every year, and that you will never hear of the die-back disease. But Councillor of Economics Goethe, of Geisenheim, an undoubted authority, plants apple and pear trees into holes 2 ft. 6 in. deep, and mixes the soil with only 1 lb. of kainit and 1 lb. of Thomas phosphate, and these quantities have been used with success by my son in Bugle Ranges for most of his young trees. Goethe recommends that they cannot any longer dispense with fertilisers, if they hope to obtain payable crops.

After the first two years the quantity of manures to be given should be in accordance with the extent to which the roots of the young trees have spread around the stem. They generally extend to a greater circumference than the branches, and this stands to reason, as the roots are allowed free development, while young trees are cut with a view to shaping. In thin soil the roots spread farther out in search of plant food, less in strong soil. Pear-trees trend their roots more to a depth. If it is intended to plough between the rows it is advisable (and perhaps in any case) to cut the subsoil 6 in. further around in the hole underneath the surface soil, instead of sloping the soil downwards from the surface, as is seen almost everywhere. To know how much manure is required for larger trees we have to ascertain the number of square yards the crown has spread, and then to add one or more yards in circumference, as far as the roots may eventually extend. Director A. Wagner recommends to give per square yard: 1, animal liquid manure, in addition to phosphoric acid in quantities of 10 pints in spring and summer; 2, sewage, with wood ash or potash,

3 to 4 lb.; 3, compost, 22 lb. in autumn, winter, or spring; 4, farmyard manure, 10 lb., same time; 5, Thomas phosphate, 1½ to 2½ oz., same time; 6, muriate of potash, ¾ to 1 oz., same time; 7, nitrate of soda, ¾ to 2 oz., half at the time of potash and phosphate, half in spring. The mode of ascertaining the number of square yards to enable you to work out the quantity of manure to be given to a tree is to multiply half the diameter of the crown of the tree by itself, and again multiply the product by 3.14, as 5 x 5=25, and 25 multiplied by 3.14, say, 75 square yards. The tree would require 75 times 2 oz. Thomas phosphate, or 9 lb. 6 oz.; 75 times 1½ oz. nitrate of soda=5 lb. 14 oz.; and 75 times 1 oz. muriate of potash=4 lb. 11 oz. Closely planted orchards would require per acre 7 to 10 cwt. Thomas phosphate, 2 to 3 cwt. muriate of potash, and 2 to 6 cwt. of nitrate of soda, the latter only to be increased from 2 cwt. if wood formation must be forced.

M. J. S. Wagner says in the "Journal de l'Agriculture" that trees must be manured not less than one yard in circumference beyond the surface covered by the crown of the tree. He recommends 9 lb. of an organic fertiliser like blood manure per square yard in autumn, winter, or early spring; also liquid manure, about 9 pints, in spring or summer, supplemented with a phosphatic fertiliser, 5 to 7 pints of nightsoil, supplemented by a potash salt, can also be given in spring or summer 20 lb. of compost in autumn, winter, or spring. If commercial fertilisers are to be used, 20 to 50 grammes of a phosphatic-potassic dressing, consisting of 40 to 60 gr. of 15 per cent. Thomas phosphate and 20 to 30 gr. muriate of potash should be used in autumn, winter, or early spring, and 30 to 50 gr. of nitrate of soda in spring.

A London paper, "The Fruitgrower," says that analysis has shown that in each 10 lb. of apples there is but 0.008 lb. of nitrogen and only 0.001 lb. of phosphoric acid, and that, therefore, both are not much required. But there is in 10 lb. of apples a larger quantity of potash, 0.013 lb., and in an average crop of 75,000 lb. per acre 7½ lb. would be removed. After ten such crops the orchard would probably cease to bear, simply because there is nothing in the soil to produce fruit, and the trees may still appear fairly vigorous. The remedy is, of course, to manure.

The London "Fruitgrower and Market Gardener" proposes 2 cwt. per acre, to be applied in autumn of one part of potash and three parts of phosphoric acid. To obtain nitrogen for the trees he advises green manuring, and prefers before all others to grow turnips until a good bulb is formed, and then to pull and toss them in a heap, which, when decayed, is spread and ploughed in.

Mr. E. Beekman, of Middleton, New Jersey, U.S., used per acre on Pippins 512 lb. of bonedust, 28 lb. of nitrate of soda, and 153 lb. of muriate of potash, and collected 6,726 lb., against 5,504 lb. where not manured, and the apples were of far finer quality and color. With double the quantities given to Keswick Codlins, and especially if 307 lb. of muriate of potash was used with the bone-

dust and nitrate, 3,384 lb. more apples per acre were gathered. In a letter received by me in August, 1900, he qualifies this by stating that muriate alone will not do more than unlock the natural fertility of the soil, and add to the general health of the trees, and that 200 to 250 lb. per acre is enough, if used year after year with bonedust and nitrogen obtained from clover or horse manure.

I find that apples and pears receive in Tasmania frequently 6 cwt. of bonedust and from 2 to 4 cwt. of kainit per acre. 13,172 acres were planted with apple and pear trees, and the estimated crop 643,209 tons of apples and 34,629 tons of pears. New Zealand had 23,956 acres under orchard.

A large number of cherry-trees have been planted at Feldbrunnen, in Germany, in 1890, and most of these have been regularly manured with 3 lb. 6 oz. of Thomas phosphate and 1 lb. 9 oz. f muriate of potash. On an average they returned 7 lb. 7 oz., against 4 lb. 9 oz. where not manured. Those trees that also received 1 lb. 7 oz. of nitrate of soda averaged 9 lb., and the fruit was heavier and of superior quality when manured.

Experiments made with peach-trees in New Jersey, U.S., during five years showed that only where potash, phosphates, and nitrogen were applied, leaves and trees were healthy and the fruit of good quality. Nitrogenous manures produced wood and foliage, potash and phosphoric acid encourage fruit buds and maturation of fruit, refined potash salts increase the size of the fruits. They were beautifully colored, and have a most excellent taste. Use 90 to 180 lb. of nitrate of soda, 320 to 640 lb. of phosphatic fertiliser, and 110 to 220 lb. of muriate of sulphate of potash.

You have perhaps to wait a dozen years before the crop of olives is payable, but these trees require little attention, are regular croppers, and last for hundreds of years, provided you can give some manure. Irrigation brings them quicker into bearing; and Professor Bioletti says that although the soil must not be poor, sandy, and loamy, even rocky soil within 100 miles of the sea, is suitable. I find nothing recorded that commercial manures have been used. Trees raised from seed are longest living, but the flesh of the olive must be removed, or many will not germinate. The pits should be placed in water, and those that float rejected. After that the pits must be cracked with care before sowing to quicken germination, or placed for twenty-four hours in a solution containing half a pound of caustic soda to a gallon of water. A sandy bed heavily manured with thoroughly rotten manure is required. The pits are actually surrounded by well rotted manure, which facilitates transplanting, as a ball of earth may adhere to the plant.

Almonds seem to be specially adapted for South Australia, and ought to pay well if planted in suitable localities, where the blossoms are not damaged by frost. I have not heard of any manuring. Perhaps that proposed in a handbook for the Association of Ammonia Manufacturers for apricot and nectarine trees will be also suitable for almonds. It states that a good luxuriantly-growing tree will with profit consume about 7 lb. of sulphate of ammonia in March and

a similar quantity in July; and, best, just before a shower of rain, 8 lb. of nitrate of soda would be useful.

I have repeatedly recommended the growing of prunes. California lately had a good crop of 114,227,000 lb., and there is undoubtedly a good sale for them. Here prunes frequently bear too large a crop, and drop most of the fruit on account of drought or want of plant-food. A dry position is, however, fairly safe if they are budded on the peach, and fertilisers, together with the thinning of the fruit, may give you a good-sized French prune. When Coe's Golden Drop or the Silver Prune are grown where there is a good rainfall, Myrobalan stocks may be preferable.

That South Australia can produce fine trees and fine apples is undoubted. So Mr. Wescombe, of Upper Sturt, had 70 bushels of apples in 1892 from a tree planted forty years go, and at Watervale I saw an apple-tree twenty years old, which was 5 ft. in circumference at the base, and was 44 ft. across the branches. The finest Calville Blanc and Gravenstein have been grown in Bugle Ranges and Norton Summit, and London knows by this time some of our good keeping varieties.

We have, however, to use great care in grading and packing. Quality is, of course, a feature which cannot be neglected. Without using fertilisers—for stable manure may produce mainly leaves and wood—you may obtain small fruit; perhaps prematurely matured, woody, a mass of skin and core. But if you have your fruit not of one size it should not be forgotten that some of the dealers at home have customers that demand only the best and largest fruit, for which they are prepared to pay high prices; while other dealers can do best with medium fruit, and grading thus suits both, and helps the trade. Of course, only the best varieties fit for export should be planted, and the public taste must be studied, but also the eye pleased by color and equal size when the case is opened.

Finally, it is a mistake to believe that because a tree has borne well one year it cannot give any fruit next year. If moisture and plant food is not present the tree is unable to mature fruit, but with these in sufficient quantities it should bear every year, except when blossoming in unfavorable weather. The answer I received from the Angaston Bureau, a district where apricots are grown in large quantities was that the trees had not yet received any manure. But is the crop always as good as it might be? In supplying chiefly potash and Thomas phosphate I have myself never been without a full crop of apricots, peaches, plums, loquats, and figs. Other fruits I do not cultivate in Adelaide plains. Shelter towards the south-west and north is not only desirable, in many localities imperatively demanded for a profitable orchard.

Since the above was written I have been favored by His Grace the Duke of Bedford with his first and second report on the Woburn Experimental Fruit Farm. The ground was trenched in 1894, and in the absence of leading data a normal mixture was given of fertilisers to replace the food constituents which, according to

E. Wolff's analyses of the ash of crops of apples, are removed, and double that quantity was allowed for waste by drainage, &c. This consisted of 94 lb. of sulphate of potash, 152 lb. superphosphate, 32 lb. sulphate of magnesia, and 97 lb. nitrate of soda per acre, and was applied around the young trees for a distance of some 6 in. beyond the extension of the roots. Upon the trees reaching maturity the whole of the ground will be manured. The relative proportions of the manuring were also those which Lawes and Gilbert used for their best results in grain-growing. The fertilisers were applied in autumn, except the nitrate of soda, used in spring or even July. The cost was £1/10/ per acre, equal to about an equivalent in dung. One half plot received before planting at the rate of 30 tons of London manure to the acre, the other half annual doses of 10 tons per acre, and all these trees received also the commercial manures. The results after six years showed that the store of food material in the trenched and well-cultivated soil was ample for the young trees, and that even the largest applications of fertilisers had hardly any effect at the Woburn Experimental Tree Farm. In little else than sand or exhausted agricultural land it will doubtless be quite different. His Grace admits also that older trees, which have exhausted the ground around them, want manure, and too rarely get it. Another result is of great interest. Where grass was on purpose sown and allowed to grow around his young trees, otherwise treated normal, and the grass, when cut, allowed to rot on the plots, the increase in the weight of these trees when lifted after three years was not so much as doubled, while other trees had increased 10 to 15 fold in weight. Even total neglect, careless planting in untrenched ground, no manuring or tending of the soil or trees, produced no greater effect than grass; weeds being mostly annuals, are not quite so bad as grasses.

I will add here a list of quantities of fertilisers that have been recommended for average full-grown trees, and which I have found to answer fairly well. For oranges and lemons I have used years ago bonedust, but subsequently have once in every year applied the following in pounds, viz.:

	Kainit.	Thomas Phosphate.	Nitrate of Soda.
Prunes	16	5	2
Plums	12	4	$2\frac{1}{2}$
Apricots	16	5	2
Peaches	12	4	$1\frac{1}{4}$
Cherries	14	5	1
Oranges	4	3	$1\frac{1}{2}$
Lemons	1	3	$1\frac{3}{4}$

As regards lemons, it has been no success with me, and I find that probably the quantities were too small. Professor Hilgard stated in 1894 that these fruits removed the following quantities of plant food from one acre, viz.: 20,000 lb. oranges, 42.2 lb. potash, 10.6 lb. phosphoric acid, 36.6 lb. nitrogen; 20,000 lb. lemons, 53.8 lb. potash, 12.2 lb. phosphoric acid, 30.2 lb. nitrogen. Of course,

leaves and wood require and contain also large quantities, and much more plant food must be given. With a complete manure another advantage is that the rind is 22.5 per cent. less than where no manure was given. Professor Woodbridge also states that although a soil may be rich in not available potash, quantities of Stassfurt potash salts were needed for good crops. At Dumville Grove, in Florida, a lemon-tree that yielded from 8 to 10 boxes a year received during three successive years in three equal divisions each year, 48 lb. sulphate of potash-magnesia, 25 lb. sulphate of ammonia, and 27 lb. acid phosphate of 18 per cent. Previously, until eight years old, the trees received only 5 lb. of the above mixture. The fertilisers were put into a ditch around the tree nearly 1 ft. deep, and covered with water. Oranges received at Dumville Grove the same quantity of potash, only 16 lb. of sulphate of ammonia, and 36 lb. of acid phosphate of 14 per cent. The application was the same. When young the trees received 5 lb. of the mixture; after the sixth year, 20 lb. It appears from the above that my lemon-trees died probably 20 and 22 years after planting from want of plant food and excessive fruiting.

The quality of oranges being so important, I give the following:

Fertiliser per Acre.	Cost of Fertiliser.	Total Sugar in Juice.	Percentage of Increase of Sugar.
Nothing	—	8.37	—
20 lb. nitrogen	12/9	10.64	27.1
50 lb. phosphoric acid ...	12/	10.77	28.6
75 lb. potash	19/6	9.80	17.
20 lb. nitrogen, 50 lb. phosphoric acid ...	24/9	9.55	14.
20 lb. nitrogen, 75 lb. potash	32/3	10.64	27.1
50 lb. phosphoric acid, 75 lb. potash	31/6	11.38	35.9
Dung	—	9.90	18.
20 lb. nitrogen, 50 lb. phosphoric acid, 75 lb. potash	44/3	11.52	37.6

In the United States a fertiliser is used, consisting of 4 per cent. ammonia, 5 to 6 per cent. phosphoric acid, and 13 per cent. potash, spread broadcast twice a year, with great results.

To make the fruit of oranges sweet, juicy, and of fine flavor, potash and phosphoric acid are necessary; an excess of nitrogen produces much wood, but coarse, thick-skinned, late-ripening fruit, with little sugar or aroma, and it does not keep well. A good crop takes from the soil equivalent to 220 lb. of lime per acre, 325 lb. of nitrate of soda, 310 lb. of a phosphatic manure, and 96 lb. of sulphate of potash (in preference to muriate of potash) per acre, and these fertilising quantities, with much more phosphoric acid, may be required for old trees, according to Senor Alino, F.R.H.S. of Valencia, Spain, who also warns orchardists not to spread the fertiliser, nor give water too near the trunk of orange-trees. The nourishment of the orange is required to be continuous, as its sap

is always moving. Organic manures should, therefore, not be neglected, but you should apply commercial fertilisers at the time the tree is expected to produce a large crop. Young trees need not more than 260 lb. of sulphate of ammonia, or 360 lb. nitrate of soda, 260 lb. of superphosphate or 300 lb. of Thomas phosphate, 60 lb. muriate of potash, and 44 lb. sulphate of iron per acre. In medium clayey soils, Senor Alino omits potash for old trees, but gives from 80 to 110 lb. wood ashes or from vine cuttings. Gypsum and sulphate of iron fix the fruit, and are repressing the excessive growth of wood and leaves by directing the fertilising elements to the fruit. To prevent the dropping of the fruit nitrogen may be most required, as it is always more quickly absorbed than phosphates and potash, and, therefore, perhaps not present in sufficient quantity.

MANURING OF GARDEN CROPS—VEGETABLES AND FRUIT.

These are generally heavily manured with dung, and it may yet be more or less true what Dr. Bernard Dyer said of British Gardens three years ago: "Nowhere is the worship of dung more devoutly practised than in market gardens." But, although dung adds to the store of humus or organic matter in the soil, and corrects the physical shortcomings in rendering the condition of the soil more porous and capable of holding more moisture, it requires more frequent and heavier rains than we get in many localities in Australia, and on that account is the plant food in dung, especially the nitrogen, still later available than elsewhere.

If you are trenching for a vegetable garden nothing is better than to bring into the subsoil as much as from 10 to 16 cwt. of Thomas phosphate, 10 cwt. of muriate of potash, and from 50 to 60 cwt. of burnt lime for heavy clay soils, or marl for sand. You may then for some years use chiefly nitrogenous manures, and nitrate of soda or sulphate of ammonia for the particular crops, in such quantities as hereinafter indicated, and perhaps some superphosphate or Thomas phosphate.

It is one of the great advantages, which some of the commercial manures have, that they need no conversion. They are in such soluble form as to feed the plants at once, and force them on, so that the crop is much earlier ready for the market or table, and also better able to resist disease or attacks from insects. Still, gardeners, while they collect, cart, and distribute dung with great labor, if not at great direct expense, do not seem to value commercial fertilisers sufficiently, and a comparison may find here its place.

Even the best dung does not contain more than 16 lb. of nitrogen to the ton, more likely from 8 to 11 lb., from 8 to 17 lb. of potash, from 4 to 9 lb. of phosphoric acid, and from 10 to 39 lb. of lime. Ten tons of dung may contain 100 lb. of nitrogen and 100 lb. of nitrate of soda, 16 lb. of it, and yet, as the former has to be converted by nitrification, the latter will produce better results, being at once available, both feeding and stimulating, espe-

cially if the intended dosis is divided and given at different times. Professor Voerhees tried 20 tons of dung, containing 60 lb. of nitrogen, against 160 lb. of nitrate of soda, containing only 25 lb. of nitrogen, and the latter produced a larger crop of tomatoes. You can, through its nature to rapidly permeate the soil, push forward foliage, wood, flower, or fruit; in fact, develop your plants almost at will. In strong and clayey soils sulphate of ammonia, which should contain 448 lb. of nitrogen to the ton, is more lasting than nitrate of soda, but it should not be applied to chalky and limestone lands, as lime expels the ammonia in the shape of gas. Peruvian guano should contain in a ton 357 lb. of nitrogen, 213 lb. of phosphoric acid, 182 lb. of potash, and 198 lb of lime. Its nitrogen (cost £12 to £14 per ton) is so easily soluble that it is said to be equal to 22 tons of dung. Our coastal guanos may be more or less leached out by rain, and their composition demands a guarantee more than any other commercial fertiliser. Prices from £2/12/6 to £4. Our bonemeals contain from 2.7 to 4.14 per cent. of nitrogen, and from 36.66 to 52.96 per cent. of acid soluble phosphate at a price varying from £5 to £5/15/. Next to bonemeal our Australian cultivators had the most acquaintance with superphosphate, and those in the market contain from about 37 to 41 per cent. of soluble phosphate. It is conceded that it gives a very early, rapid, and vigorous growth to plants, and the price is from £4/10/ to £5 for mineral superphosphates, and £6/10/ for bone superphosphate per ton. Thomas phosphate or basic slag is less known, and only lately has Professor Dr. Wagner acknowledged its use as a top-dresser; but it is most valuable as giving a more lasting supply of phosphoric acid, which will ensure the healthy development of all plants that require a longer period for growing, or as biennials or perennials. When subsoiling, it should be mixed with it, as it is not lost through leaching. The price is from £3/5/ to £3/15/ per ton. Potash is generally neglected in Australia, and yet there are garden crops that require it more than any other manure. The high prices of muriate of potash, £13/15/, and sulphate of potash £14/5/, seem to prevent even experiments, while the cheap kainit, £4, is not often applied on account of its large contents of common salt.

Green manuring should not be omitted where it can be successfully carried on. Lime, marl, salt, gypsum are indirect manures, i.e., they influence the fertility of the soil in an indirect way, as they convert inert fertilising matter in the soil into available plant food, and exert a considerable effect on the texture of the soil. Dung cannot be surpassed in the matter of mulching, unless the fruit, as, for instance, strawberries, rest on the ground. Weight for weight, the refuse portion of vegetables, which we ought to return to the soil, abstracts more plant food from the soil than the marketable portion, as can be seen in the following table.

In fresh condition 1 ton of 2,240 lb. of the following vegetables contains in pounds the following constituents, viz.:

—		ASH.					
	Dry Substance.	Nitrogen.	Total.	Potash Contents.	Phosph'c Acid Contents	Water.
Asparagus ... ... lbs.	150	7	11	3	2	2,072
Cabbage—Head of ... "	224	6	21	10	4	1,989
" Stem of ... "	246	5	35	13	3	1,954
Carrots—Roots of ... "	336	5	18	7	3	1,881
" Leaves of ... "	399	1	54	6	2	1,776
Celery .. .. "	356	5	39	17	5	1,840
Lettuce ... ... "	134	5	18	8	2	2,083
Onions ... . "	314	6	17	5	3	1 903
Peas—Seeds and pods of "	1,919	80	52	23	19	189
" Vines of ... "	1,881	23	97	22	8	239
Potatoes—Tubers of ... "	515	8	21	13	4	1,696
" Haulms of ... "	1,919	11	44	22	8	266
Turnips ... ... "	—	3lb. 12oz.	—	11b. 6oz	6lb. 6oz.	—
" Leaves of ... "	—	2lb. 14oz	—	11oz.	2lb. 6oz.	—
Swedes ... ... "	—	5lb.	—	11b. 3oz.	4lb. 9oz.	—
" Leaves of ... "	—	2lb.	—	5oz.	11b. 2oz.	—

The totals of "ash" do not agree with the potash and phosphoric acid, as it contains also soda, magnesia, lime, &c.

Dr. Bernard Dyer, consulting chemist and district analyst to many Agricultural Societies, in conjunction with F. W. E. Shrivel, F.L.S., made many experiments near Hadlow, in Kent County, at the request of the Permanent Nitrate Company, and where I mention "Hadlow" their experiments are given. The field chosen was ordinary clay loam in low agricultural condition, just sufficiently manured to enable it to bear fair crops in ordinary rotation. After a crop of wheat it was, at the close of 1894, ploughed and well dug on receiving 2½ tons of lime per acre, which was repeated a year later. The four seasons were very dry. For the several crops were then in each case six plots marked out. They were one-fiftieth of an acre each, or rather more than three square perches, together one-eighth of an acre. Their manurial treatment was:

F. 50 loads (about 25 tons) of London dung.

E. 25 loads (12½ tons) of London dung.

A. 25 loads, with phosphates and potash (or ½ of a plot salt) and 1 cwt. of nitrate of soda.

B. 25 loads, with phosphates and potash (or ½ of a plot salt) and 2 cwt. of nitrate of soda.

D. 25 loads, with phosphates and potash (or ½ of a plot salt) and 4 cwt. of nitrate of soda.

C. No dung, phosphates and potash, 1 cwt. nitrate of soda.

Phosphates were the first year 8 cwt. per acre, one-half superphosphate and one-half Thomas phosphate (I presume applied at different times). The second year, 4 cwt. superphosphate; the third year, 6 cwt. superphosphate; the fourth year, 7 cwt. Thomas phosphate. Guano or bonedust was not used, as they contain also

nitrogen, and matters would have become complicated. As potash, mostly 4 cwt. of kainit were used. A proper system of rotation was followed. No two crops of the same kind were grown on the same plot.

Asparagus.—The application of potash in the form of kainit has been followed at Hadlow in each case by the most striking results, especially with a liberal supply of nitrogen. Twenty-five loads dung alone gave 687 bundles of 50 heads each per acre; with the addition of phosphates, salt, and 4 cwt. nitrate of soda, 804 bundles; and if kainit was substituted for salt, 1,158 bundles.

Beetroots.—Twenty-five tons of dung worked in before sowing with a few hundredweights of phosphates, and followed by two dressings of 25 cwt. nitrate of soda at each time, are sure to give good results, and from 17 to 25 cwt. of beet in excess against dung alone. Potash produced no appreciable effect at Hadlow. Mr. T. Foussat, near Nancy, tried 24,000 lb. compost per acre, against 240 lb. nitrate of soda. Result, a small loss and £30 profit.

Beans.—(See page for Broad Beans.) For green beans much nitrogen must be used, so that 100 lb. of nitrate of soda or sulphate of ammonia may be hardly sufficient per acre, the former to be given in two or three doses. 250 to 500 lb. of a phosphatic manure, and 70 to 140 lb. of muriate or sulphate of potash, are also frequently applied in the United States, with either nitrogenous manure.

Beans.—(See page 77 for Broad Beans.) French.—Professor A. Bourgeois reports that at the experiments made by French teachers, M. Leclerc, of Courcelles, had with 16 cwt. Thomas phosphate and 40 lb. sulphate of potash 1,200 lb. of green beans, against 880 lb. from unmanured land. M. Gryer, of Villey St. Etienne, had a proportion of two to three from unmanured to the manured beans. Mr. E. Lierke, of Leopoldshall, has made many experiments, of which the most successful was with 272 lb. of superphosphate, 240 lb. sulphate of ammonia, and 240 muriate of potash, which resulted in 11,711 lb. of green beans and 2,006 lb. of ripe beans per acre, against 7,424 lb. of green beans and 1,302 lb. of ripe beans at a net profit of £10/16/. Beans, being nitrogen-collecting, a smaller quantity of sulphate of ammonia would have been more than sufficient, but was used for the fruit-trees in the garden. Dr. von Spillner, of Wittenberg, says, however, that in his own experience and from one experiment by Mr. Scheer, he found that beans are for a considerable time at a standstill unless they receive some dung or a quick-acting nitrogenous fertiliser until sufficient tubercles have been found able to assimilate nitrogen from the air.

Cabbages (Imperial).—The average yield of three crops was at Hadlow as follows: Plot E, 12½ tons dung was the standard; F, with 25 tons, had 2½ tons per acre more; A, B, and D, 5¼, 4⅜, and 6¼ tons more; and C, without any dung at all, merely the fertilisers, 4 tons per acre more than E, at a cost of £2/10/. against £5, the cost of the dung. See manuring of plots on page 88.

Savoys did not differ in results. Spring cabbages appeared on Hadlow soil to be indifferent to the supply of potash; but as

kainit was used, other potash salts might have given better results. All the crops with commercial manures matured earlier and were more crisp and tender. Professor Dr. P. Wagner used in 1897 (per acre) 640 lb. of Thomas phosphate, 480 lb. nitrate of soda, and actually 1,920 lb. of kainit. Result, 21,440 lb. more of cabbages than from the unmanured acre.

CAULIFLOWERS.—Light dunging, with the addition of commercials, produced at Hadlow better results at less cost than 25 tons dung. The average of four crops was per head 4 lb. 5 oz. from the former, against 4 lb. 3 oz. from the latter, when 12½ tons dung, phosphates, kainit, and 2 cwt. of nitrate of soda was given. According to E. Von Wolff's analysis, 15,000 lb. of cauliflowers and trunks per acre require 100 lb. of nitrogen, 371 lb. phosphoric acid, and 109 lb. potash. It may, therefore, be advisable to use 25 loads dung, 400 lb. nitrate of soda in two doses, 200 to 250 lb. Thomas phosphate, and 120 lb. of muriate of potash, or without dung, 6 cwt. nitrate of soda, 5 cwt. Thomas phosphate, and 340 lb. of potash.

CARROTS.—Many French Agricultural teachers made experiments with 1,600 lb. Thomas phosphate, 160 lb. sulphate of potash, and 160 lb. nitrate of soda per acre. The lowest return was 1,600 lb. more than from unmanured soil, the highest 6,080 lb. more. Near Osterode, in the Harz Mountains, experiments were made on a heavy clay soil, which had received stable dung to previous crops of vegetables. When 240 lb. of muriate of potash, 520 lb. of Thomas phosphate, and 312 lb. nitrate of soda per acre were given, the increase over unmanured was 11,200 lb. The muriate of potash seemed to be more required than the other fertilisers, where only two were used. Thomas phosphate and muriate were given with the seed, the nitrate of soda before the first and second hoeing. Some crops have apparently much greater difficulty in obtaining their necessary supplies of potash than others, and carrots seem one of the former. It is generally admitted that it is best to sow carrots on land which received dung to a previous crop, and to use commercials when sowing. Where 12½ tons dung per acre had been used at Hadlow to a previous crop 18 tons of carrots were the result; but with the addition of 6 cwt. of phosphates and 2 cwt. of nitrate of soda the crop was 22¼ tons, and with the further addition of 4 cwt. of kainit 25½ tons. Land that had received no dung to the preceding crop yielded 17¼ tons. When, however, instead of dung 4 cwt. nitrate of soda and the phosphate and 4 cwt. kainit had been applied, 24½ tons was the result.

CELERY.—300 lb. Thomas phosphate, 336 lb. nitrate of soda, and 220 lb. sulphate of potash per acre are recommended. Where dung is to be used it should be applied to a former crop, and only commercials given containing, according to Mr. R. L. James, 10 per cent. potash, 7 per cent. phosphoric acid, and 4 per cent. nitrogen.

CUCUMBERS.—Mr. C. Vibrans, of Calvoerde, manured a good sandy soil with dung and with 480 lb. of Thomas phosphate, 200 lb. nitrate of soda, and 240 lb. of muriate of potash per acre, and obtained on the average 12,877 lb. of cucumbers, against 8,885 lb. from beds not manured with commercials, and the number and size

of them was greater. Kainit in place of muriate of potash was injurious to the crop.

KOHLRABI.—Mr. Buehler, near Laupheim, manured with 40,000 lb. dung per acre. Result, 36,000 lb. of kohlrabi. Adding 400 lb. Thomas phosphate and 200 lb. nitrate of soda, the crop yielded 44,600 lb. When adding to the dung, the phosphate, and nitrate on another plot 400 lb. kainit, he obtained 50,600 lb. per acre, and a net profit of £1/19/.

LETTUCES.—At Hadlow the crops were enormously greater and more vigorous where commercials were given in addition to light dung. Four hundredweights superphosphate or 7 cwt. Thomas phosphate, with 4 cwt. nitrate of soda without dung, were 3¼ cwt. of lettuces better in two crops than 12½ tons of dung alone.

MELONS.—The whole plants of water melons took from the soil, according to Mr. H. J. Patterson, of Maryland Experimental station, the following plant food per acre, viz., 37.20 lb. of nitrogen, 12.82 lb. of lowing plant food per acre, viz., 37.20 lb. of nitrogen, 12.82 lb. of phosphoric acid, 56.65 lb. of potash, and 10.60 lb. of lime. This shows that less phosphoric acid is required than for Cucumbers. At Georgia Experimental Station 360 lb. of superphosphate and 180 lb. of nitrate of soda gave 34 fruits, against an average of 5.75 fruits from three unmanured plots.

Sweet Melons showed at Rhode Island that at the rate of 5,720 lb. of burnt lime per acre was absolutely required to obtain a good crop. At the rate of 700 lb. of superphosphate, 320 lb. of muriate of potash, 180 lb. of sulphate of magnesia, 320 lb. of sulphate of ammonia and 5,720 lb. of burnt lime per acre gave per plot 17.35 lb. of fruits, and where 480 lb. of nitrate of soda was substituted for the sulphate of ammonia 23.40 lb. of fruits. Where dung is also given, of course, much less nitrogen is required.

ONIONS.—M. Marshal, of Vilaine-en-Haye, France, used 1,600 lb. of Thomas phosphate, 160 lb. sulphate of potash, and 160 lb. nitrate of soda per acre. Result, 5,600 lb. more than from unmanured. Considering that E. Von Wolff's analysis mentions that a crop of 16,000 lb. of onions per acre require only 21 lb. of phosphoric acid less Thomas phosphate may be sufficient, as appears also by experiments at Hadlow. Plots with dung were very poor, averaging 3 tons per acre. probably essentially due to the absence of its physical influence in enabling the soil to retain moisture. Twelve and a half tons dung and 4 cwt. each of superphosphate, of nitrate of soda and kainit, gave the best result; in 1897 12¾ tons per acre, partly due to the moisture-attracting power of the kainit in a dry season. In the United States no less than 270 lb. of nitrate of soda, 450 lb. of a phosphatic manure, and 160 lb. muriate or sulphate of potash per acre are used.

PARSNIPS gave at Hadlow similar results as Carrots.

PEAS.—See page 74.

RHUBARB.—The large variety, "Victoria," gave at Hadlow a large increase with 25 tons dung over 12½ tons. The approximate weight per acre was 27¼ tons, against 20 tons. while, however, to 12½ tons dung, 4 cwt. superphosphate, or 7 cwt. Thomas phosphate

(half a plot), with kainit, and 4 cwt. nitrate of soda had been added, the weight increased to 30½ tons; and when no dung was given, but 4 cwt. kainit with the phosphate and nitrate, the result was 34½ tons.

Spinach gave good results where treated like beetroots.

Turnips.—(See also page 52.) Phosphate is the dominating manure par excellence for this crop. "The quick-acting superphosphate has been credited with occasional finger and toes, weak and rotten roots of defective feeding value," &c., says Mr. Frank Wallis in a lecture delivered on 27th December, 1898, before the members of the Southern Farmers' Club. "But a little of it is advantageous for starting and promoting the earlier stages of the growth, while a more stable growth and perfect maturity are secured through the non-acidulated Thomas phosphate." He recommends 2 cwt. of superphosphate and 4 to 5 cwt. of Thomas phosphate per acre as a good reliable dressing for Swedes and turnips on any soils under any circumstances. M. Marshal, of Vilaine, France, used 1,600 lb. Thomas phosphate, 160 lb. each of sulphate of potash and nitrate of soda, and had an increase of 6,800 lb. of turnips per acre over unmanured land. On six farms in Durham, Dr. Somerville tried in 1893 205 lb. of nitrate of soda, 502 lb. of kainit, and 596 lb. Thomas phosphate, and harvested on the average 39,512 lb. per acre, against 29,613 not manured. Mr. P. Dickson used on a field of rather poor loam 20 loads dung, and had 15½ tons of Swedes; but where he had used in addition ½ cwt. of nitrate of soda the result was 26¾ tons. Turnips being rather uncertain in New Zealand, farmers grow

Pumpkins as an excellent winter food for cattle and sheep. Dairy cows give a fine flow of rich, untainted milk. Pumpkins can be grown through a maize crop with advantage to both. The vines prevent the ground from becoming parched. Manure like Cucumbers.

Grapes.—I refer readers also to my pamphlet, "Manuring of Vineyards." Professor Dr. P. Wagner stated before lecturing in December, 1899, that he would like to ask every vigneron present: "In what way do you manure your vineyard? It would be foolish to let your vines hunger." He recommended in 1900 8 tons dung per year, and to add in medium soil not less than 48 lb. of soluble nitrogen (contained in 3 cwt. nitrate of soda or 2½ cwt. sulphate of ammonia), 64 lb. of potash (contained in 1 cwt. muriate), or in sandy soil more, and 24 to 40 lb. of phosphoric acid (in 1½ to 2½ cwt. superphosphate or Thomas phosphate). M. O. Cosset, agricultural teacher, in his "L'Employ Rationnel des Engrais Chimiques," recommends for preparing the soil of a new vineyard 800 lb. of Thomas phosphate and 240 lb. of muriate or sulphate of potash, and when planting 160 lb. sulphate of ammonia and 160 lb. nitrate of soda per acre, and afterwrds for an adult vineyard yearly 480 lb. of Thomas phosphate, 160 lb. of muriate of potash, and 160 lb. of nitrate of soda per acre. An experiment in Tayat, in the Dordogne, gave at the rate of 3,856 lb. of grapes from an unmanured acre, and 7,200 lb. where manured with 480 lb. Thomas phosphate

and 160 lb. nitrate of soda. Mr. R. F. Gow, of Abbotshall Vine yard, Victoria, applied 10 oz. of Thomas phosphate per vine, at a cost of £1/13/11 per 1,000 thirty-seven-year-old Shiraz vines, said to be worn out, obtained 40 cwt. of grapes; but both these experiments might have shown probably still better results with 100 to 150 lb. of potash salts per acre, and in the last case with a nitrogenous manure. Grapes need a large amount of available potash to produce rich and sugary juice.

RASPBERRIES.—I cannot find anything better than the results which Mr. Ewers, of this State, had. He applied 748 lb. of blood manure, 133 lb. of double superphosphate, and 265 lb. of muriate of potash, which gave him a crop of 2,957 lb. per acre, against 1,792 lb. from unmanured canes. The quantity of nitrogen applied is much in excess of what I find recorded elsewhere, and an increase of the above-named manures increased the crop, but not the profit. 568 lb. nitrate of soda, 144 lb. of double superphosphate, and 143 lb. muriate of potash gave 2,598 lb.

STRAWBERRIES.—Where 25 tons dung were applied at Hadlow, in comparison with 12½ tons more leaves were produced, but actually 10½ cwt. less fruit per acre. By adding phosphoric acid (700 lb. Thomas phosphate apparently) and 1 cwt. nitrate of soda to the 12½ tons dung, the yield was 7¾ cwt., and with 2 cwt. of nitrate of soda, 19 cwt. above the dung alone. Potash was found to be unnecessary for the soil at Hadlow; in the form of kainit perhaps even injurious. For a month of the fruiting season or two years had His Grace the Duke of Bedford the dressings dissolved in water, and given in equal doses once a week, so that each plant received about one quart at each application. These dressings consisted of 3.96 lb. of sulphate of ammonia, or 5.87 lb. of nitrate of soda, or 6.98 lb. of potassium-nitrate, or 3.96 lb. of sulphate of ammonia, and 1.65 lb. sulphate of iron. The results from two-year-old plants were about 68 per cent. larger than from one-year plants, but the berries of the latter were larger, and none of the plots thus manured showed, although the season was dry, any appreciable increase over the undressed plot. During the next three years some of the plots received at the rate of 30 tons of London dung per acre, others 12 tons, others an equivalent of 12 tons of dung in commercial fertilisers, but except that the first-named produced in the first year after the manuring an appreciable increase in the crop, and that nitrate of soda gave an increase of 10 to 15 per cent. on the average, and the sulphate of iron, probably in conjunction with sulphate of ammonia, an increase of 26 per cent., there is yet nothing certain in the experiments.

TOMATOES.—160 lb. of nitrate of soda proved almost as effectual as 20 tons dung, showing again that dung is not sufficiently available for short-living plants. From 125 to 250 lb. of sulphate of ammonia, 280 to 560 lb. of a phosphatic manure, and 80 to 160 lb. of muriate or sulphate of potash are used in the United States.

Mr. Wm. Neild, F.R.H.S., of the Horticultural College in Cheshire, mixes no natural or farmyard manure with the soil, as he believes it has a tendency to produce gross shoots, and these are more subject to disease. Commercial manures he applies not until the plant has apparently used up all the available food of the soil. The manures were mixed thoroughly and applied weekly at the rate of $\frac{1}{8}$th of an ounce to each plant, on the surface, and watered in. The best results were from one part nitrate of soda, one superphosphate of lime, and one nitrate of potash, or two parts nitrate of soda and one part nitrate of potash.

APPLICATION OF FERTILIZERS.

This is a matter of some consequence. I have already mentioned that with potash and also phosphoric acid it is better not to apply them at time of sowing. Apply them somewhat earlier—with kainit months before—and so also as to mix them thoroughly with the soil. They may be drilled in or broadcasted evenly over the land, and then ploughed under with a skim-plough, or, on mellow soil, worked into the soil by harrowing. If the farmer has any fear that larger quantities of the acid or the potash might injure the seed, these fertilizers, if drilled with the seed, had better be mixed with dry earth, and when using small quantities it enables him to spread it more evenly.

It is different with nitrogenous fertilizers. You can use either nitrate of soda or sulphate of ammonia at the time of sowing and planting, or as a topdressing at a later time. As regards nitrate of soda it is generally admitted that it is best to divide the total dose intended to be given into two or three parts; the last portion, with cereals, whenever they are commencing to throw up their haulms. The leaves should be dry, and when spreading any fertilizers avoid windy days.

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