wants of another kind. Thus wheat, tobacco, rape, sugar-beets, and mangels demand nitrogen above all other plant foods. Turnips and swedes, on the other hand, ask for phosphoric acid; what plants, if any, seek for potash, is not yet a settled point, though in all longcultivated light lands where the manure cart is an infrequent visitor, I should be loath to leave it out of a rotation; and we know that clover, vetches, pease, and all other pod-bearing plants show a wonderful predilection for plaster, that is, I presume, for the sulphuric acid in its special combination in that manure; and this special ingredient of any manure is called by Ville by the expressive term: *the dominant constituent.*

Thus, in Lawes' experiments, he shows that upon the unmanured plot and upon that where salts of ammonia alone are used, the crop is limited in its supply of minerals, or ash-constituents, to the amount it can obtain from the soil. Where superphosphate is added to the ammonia, the power of the crop to obtain the alkalis from the soil is shown, and so on.

Again, we find that superphosphate has much greater effect on barley than on wheat; that the alkalis aid wheat more than barley; which I take to be because alkalis take a longer time in the soil to become fit for plant-food than is afforded by a spring crop; for we must remember that *wheat* in England is always to be read, unless otherwise indicated, *full* wheat (1) The extraordinary influence of phosphoric acid on swedes and turnips, and the comparative indifference of mangels to this constituent are also shown, together with the uselessness of ammonia or nitrates for pease, clover, &c.

And, observe, that the object of these experiments has not been to prove that this or that manure applied to this or that plant will *pay*, but to show the characracteristic peculiarities of the nutrition demanded by that plant. For otherwise, it might be fairly said, as it is often said: "these experiments only show that such and such a manure is demanded by such and such a plant in this particular locality," whereas the plant itself is the same, and demands the same nutrients wherever it is grown, while the amount of the nutrients afforded must depend upon the richness of the soil in those nutrients.

Again, many a hundred experiments have been tried as to the effect different manurial matters have on permanent meadows. Any one who has applied plaster to his grass land in this country will have observed—if he has any powers of discrimination at all—that while that fertiliser has great influence on the growth of the clovers, wild vetch, &c., it has very little effect if any on the grasses. And so with the different dressings applied to the permanent meadows at Rothamsted. Phosphoric acid, in the form of mineral superphosphate, or of bone ash dissolved in sulphuric acid, was most strikingly effective on the *clovers*, &c., while ammonia-salts and nitrates were wasted on such plants, though, when they were applied to similar plots of permanent meadow-land, the *grasses* were so much benefited that they almost over-powered the leguminoæ. These meadows, my readers will understand, have been in grass for, probably, centuries, and are never broken up. They form, if I remember, part of the park surrounding the Manor-house.

"It is difficult," says Mr. Warrington, "now to believe that the herbage was ever alike over the various plots in the grass experiment, and that the striking differences in the development of individual species of grasses, clovers, and weeds are simply due to the persistent application of certain chemical salts.

Conducting field experiments with perfect accuracy is, probably, impossible, still, I believe we may say that the pains taken without sparing time, labour, and expense, at Rothamsted have imparted to the trials carried out there a degree of trustworthiness unparalleled in our experience of agricultural investigations. An American farmer upon entering "Broad-balk Field" observed to Mr. Warrington. Americans have learned more from this field than from any other experiment in the world.

In this field, wheat has been grown every year for forty-eight years, and it certainly does not seem to have lost its fertility. In 1890, nine of the manured plots yielded upwards of 40 bushels of dressed—emphatically *dressed*—wheat to the acre, and on one plot the yield exceeded 50 bushels.

The great difficulty in the continuous growth of grain on the same land seems to be that of keeping the land clean. A great deal of hand labour is necessarily expended in this work, as the horse-hoe cannot be used in the cleaning of the plots: it would mix the soil of one plot with that of its neighbour.

One of the greatest mistakes I have met with at the experiment-stations on this continent, at Guelph particularly, in former days, is the selection of rich soil for field experiments. The history of the practical exhaustion of the soil of the Rothamsted land I fully treated in a former number of the Journal, see vol. 1887, p. 130. When rich land is operated on, the effect of manures is at first very trifling, and much time and labour is wasted before satisfactory deductions can be made from any series of experiments. I quote from memory, but I think accurately, when I say that the land devoted to experiments on turnips was sown with that crop for seven successive years, until the yield was reduced to a few pounds to the acre—650 lbs I think—, and not till then were the experiments with the different manures commenced

The land intended for wheat, too, was not put under trial, until a whole unmanured rotation of crops had been carried off—turnips, barley, seeds, wheat, were grown in succession and no manure applied, then, and not until then, the experimental application of different fertilisers began.

The size and shape of the experimental plots and their general arrangement, are not simple matters for consideration. How shall uniformity of soil in all the plots of each individual series be secured? At Rothamsted, the practice recommended is to mark out the plots, and to grow the crop intended for experiment all over the field, without manure of course; and to do this one or two years in succession, weighing the produce of each plot. In this way, any irregularities in the soil will be easily detected

Very small plots are always to be avoided, for they cause a considerable area of the field to be taken up by footpaths, a condition fatal to trustworthy results, the supply of light, moisture, and plant food by the side of a footpath being much in excess of that in the midst of a crop; as any one may see by comparing the outside rows of two pieces of different root crops, say of swedes and carrots sown side by side. There is, too, always a greater produce on that side of a land, or ridge, facing the south, in fact, it is impossible to exaggerate the effect on the yield of crops of the slightest variation of treatment. On this, consult Stephens' Book of the Farm, the reference to which I hope to find on my return home.

How to distribute artificial manures equally over the surface of a plot, is another difficult task. Choose a day free from wind, mix the manure with finely pulverised soil, and sow broadcast, going over the land twice. For root-crops, the superphosphate can be sown with the drill.

In the experiments on fattening animals, which were carried on from 1847 to 1851, no food was used without previous analysis.

The composition of the fattened animals, and especially of their increase while fattening, ascertained in these experi-

(1) Practically speaking, there is no spring wheat sown in South-Britain. A. R. J. P.