Experiments With Potatoes—Potato Rot—Profits and Losses on Fertilizers.

(A Lecture delivered by W. A. Macdonald before the Middlesex Agricultural Council.)

No. II.

Now if I can explain the causes of these enormous profits and losses, we have at once the key to success; if not, investigation may as well cease, and the use of commercial fertilizers must remain a precarious business.

Before I begin to explain, I desire you to look through this magnifying glass, or even with the naked eye, at the coarser particles of soil from which the clay has been separated. This is ordinarily supposed to be sand, but if you look closely you will see fragments of alkaline rocks, such as granite and limestone, from which we must infer that the soil has an abundance of potash and lime. A great excess of any active alkaline application, without an acid fertilizer to neutralize it, would prove injurious to the growth of the potatoes. This is the reason why the sulphate of potash has produced a smaller yield than where no fertilizer was applied. It is true that unleached ashes are also alkaline, containing both potash and lime, but they also contain an appreciable quantity of phosphoric acid, to which I mainly attribute my gain, viz., 13 percent in the yield. This also proves that the soil is lacking in phosphoric acid, and this is further proved in the success of the superphosphate, from which, as the table shows, I gained 13 percent in the yield and 350 percent on my investment.

Permit me here to deviate a moment while I draw your attention to fertilizers which bear chemical names, such as "superphosphate" and "sulphate of potash" in the above table. The chemical name embraces the analysis—and even more, for it not only indicates the percentages of the elements and compounds contained in the fertilizer, but also sometimes the percentage of soluble or available constituents. For example, when the chemist says "monocalcic phosphate," he understands that the fertilizer is soluble in water; when he says "dicalcic phosphate," he understands that it is partially soluble, and when he says "tricalcic phosphate," he means that none of it is soluble in water. It is not only important to know the chemical composition of a fertilizer, but also its degree of availability. These and other formulas must also be understood before we can comprehend the nature and composition of soils, farmyard manures, and other fertilizers. To know these things is to understand the first principles of agriculture; not to know them is to be swindled by every scoundrel who chooses to perpetrate the most rascally frauds that have ever invaded the farming community, and I desire you to bear these facts in mind in connection with agricultural education, which bids fair to become the leading agricultural question of the day.

When the chemical name of a fertilizer is not and cannot be given, its analysis must be known before its composition and availability can be ascertained. The fertilizer is then usually denominated "brand." Stand shy of those brands which are manufactured and advertised to benefit the crop instead of the soil. For instance, the so called "potato fertilizers" are made rich in potash because the potato feeds largely on potash salts, and yet the soil which you have just examined is actually too rich in potash even for potatoes. A formula made for the crop is only right under the condition that the soil is equally deficient in all the constituents required for the crop.

Having now eliminated the potash from our consideration, the next question is, Is the soil the more deficient in nitrogen or phosphoric acid? We have already seen that phosphoric acid (superphosphate) has produced splendid results without the aid of nitrogen or potash, and that nitrogen (dried blood) has produced a loss of 6 percent in the yield and a loss of 125 percent on the money invested, proving conclusively that it is phosphoric acid that the soil requires. Take up a handful of that soil and you will not see a particle of organic matter in it, and its light color proves the absence of any appreciable quantity of organic or vegetable substance. Dried blood is merely organic matter, and you may think of it as a decomposed crop of clover, but its nitrogen is very active. You all know that organic matter supplies the nitrogen to the crop.

I have now spoken of the *special* fertilizers; let me next compare their results with the *general* fertilizers and manures. I have given an analysis of the fertilizer which has produced the best results, and you see that it may be termed general or complete, for it contains nitrogen (organic matter), phosphoric acid and potash, the acid greatly preponderating—just what the soil required. The other constituents named in the analysis may also have assisted to some extent, all being found in the plant except the alumina. Another general fertilizer, named "mixture" in the table, producing 23 percent gain in the yield and 600 percent gain in the money invested, was composed of one part of dried blood, two parts of superphosphate, and one part of sulphate of potash, and you will observe that, although the first and last mentioned produced injurious results when applied alone, they produced beneficial results in the mixture, for the superphosphate by itself only produced 13 percent gain in the yield, and 350 in the money invested. Beyond doubt, I have now ascertained the fact that the cheapest and most effectual means of restoring the fertility of this soil is to add 500 or 600 pounds of superphosphate per acre to a good dressing of barnyard manure.

A member—Why didn't you test plaster and salt? That's the kind of fertilizers we use around here.

Don't you see that the fertilizer, the analysis of which I have given, contains 25.33 percent of sulphate of lime or plaster, and for which you have not to pay a cent? Don't you know that superphosphate contains a large percentage of plaster? If you use salt and plaster understandingly, you must have a rented farm which you want to exhaust before your lease expires.

Barnyard manure is also a general fertilizer, but you see that it can be misapplied as well as any other fertilizer. I shall not take time here to discuss whether the loss sustained by the farmyard manure was caused by the large quantity applied, 50 tons per acre (about half the quantity applied by some market gardeners), by the want of drainage, by the wet season, by its ill balanced composition, or by other causes. It was pure cow dung, fresh from the stable, no straw or other litter having been used for bedding, and it contained a small percentage of the urine. I applied it as a top dressing. Judging from the food given to the cows, I valued it at nearly $2.00 per ton, according to the then market prices of nitrogen, phosphoric acid and potash; but all I paid was 20 cents per ton. Hen manure is also a general fertilizer. You will see that it was applied at the rate of 3,300 lbs. per acre, and the results in the yield were just equal to those of the best commercial fertilizer, although the gain on my investment was nearly six times greater. It took 33 lbs. of hen manure to produce the same results as 4 lbs. of the analyzed fertilizer, and I am satisfied that I could have doubled the yield by adding a small quantity of superphosphate to the hen manure.

Let me give an analysis of these fertilizers, showing the quantity of nitrogen, phosphoric acid and potash which a ton of each contains, and the commercial value per ton:

Name.	Nitrogen, lbs.	Phosphoric acid, lbs.	Potash, lbs.	Value per ton.
Cow excrement (solid).....	5.8	3.4	2.0	$1.60
Cow excrement (liquid).....	11.6	....	9.8	2.80
Hen manure	32.6	30.8	17.0	10.45
Hard wood ashes (unleached)	....	70.0	160.0	15.00
Dried blood..	240.	80.	....	56.00

The remainder of the rows were devoted to the testing of the different varieties of potatoes and different methods of cultivation, but before I proceed to these tests, I wish to say a word with reference to judging by the appearance of the crop while growing. All the nitrogenous fertilizers — except the dried blood, which was too strong in nitrogen—produced large, bushy tops, some being three feet high The row which received the cow manure appeared to be about as good as any, and promised a splendid crop. In the dried blood row some of the tops grew quite strong, while others were killed more or less outright. The row without manure had a fair average appearance. In the sulphate of potash row, the tops grew slender and sickly, and soon appeared as if struck with blight. Where the superphosphate was applied, the tops grew regularly and fairly strong, but withered away nearly two weeks before those on the rows containing the nitrogenous fertilizers. The ashes row also appeared rather sickly. Where the unanalyzed brands were applied the growth was very irregular, as a rule. I mention these facts to show that no dependence whatever can be placed upon the appearance of the crop while growing. I may also here add that No. 1 fertilizer was used on two rows; in one the application was the same as on the other rows, and on the other the fertilizer was spread in the trench about an inch below the potatoes, and the results in the yield were identical. This experiment was a test of the retentive character of the soil.

A distinction must be drawn between an excessive application of a special fertilizer, which is only a waste, and a more excessive application which proves injurious to the crop. If the excess of phosphoric acid or potash is inert or unavailable, it will remain in a retentive soil for succeeding crops, but this method produces slow returns on the money invested. For this reason a heavy dressing of ashes is not apt to injure the crop, for the potash exists in a somewhat inert form, and will last for years. Nitrogenous fertilizers,