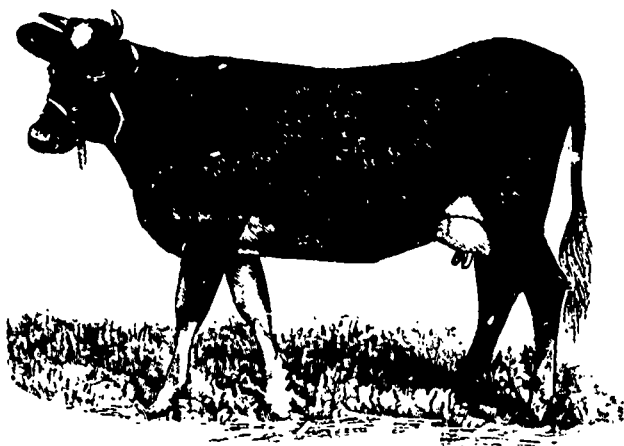


pers, read before the section this afternoon, we shall give his recapitulation before proceeding with his remarks on Manitoba.

"To summarize the points already reached, it has been shown in detail in our former paper and in abstract in the present one, that when crops are grown year after year on the same land without nitrogenous manure, the percentage and the yield of nitrogen decline in a very marked degree. This is the case even when a full mineral manure is applied, and it is the case not only with cereals and with root crops, but also with leguminosæ."

Further, with this great decline in the annual yield of nitrogen of these very various descriptions of plants, when grown without artificial nitrogenous supply, there is also a great decline in the stock of nitrogen in the soil. Thus, a soil source, at any rate, of some of the nitrogen of the crops is indicated. Other evidence was also adduced clearly pointing to the same results. Next, determinations of the demands of nitrogen as nitric acid in the soils of known history, as to manuring and cropping, and to a considerable depth, showed that the amount of nitrogen in that form in the soil was much less after the growth of a crop than under corresponding conditions with a crop.



GUERNSEY COW.

It was hence concluded that the nitrogen had been taken up as nitric acid. In the case of gramineous crops, and some others, the evidence pointed to the conclusion that most, if not the whole of the nitrogen was so taken up from the soil.

It was also clear that some, at any rate, of the nitrogen of leguminosæ had the same source, and some of the results were in favor of the supposition that the whole of it might be accounted for. Still it is admitted that this is not proved.

It has also been shown that, although in the case of the growth of a leguminous crop year after year on the same land, the crop, the yield of nitrogen, and the total nitrogen in the soil, greatly decline; and the nitric acid in the soil may likewise be very small. Yet there may be under parallel conditions very much more nitrogen in the soil after the growth of a leguminous than of a gramineous crop. A consideration of the circumstances of this result led to the conclusion that in some way which could not be explained, leguminous growth and residence were favorable to the development of the nitrifying organism, in the case of deep rooting plants especially, causing the nitrification of the nitrogen of the sub-soil which thus becomes a source of the nitrogen of such crops.

In 1882 several samples of soil from the North-West Territory, taken at intervals between Winnipeg and the Rocky

Mountains were examined for nitrogen, and proved to be about twice as rich in nitrogen as the arable soils in Great Britain. Four Manitoba soils were examined in considerable detail, viz.: one from Niverville 44 miles west of Winnipeg, and the others from Brandon, Selkirk and Winnipeg itself. They all showed a very high percentage of nitrogen. That from Niverville about twice as high a percentage as in the first six or nine inches of ordinary arable land, and about as high as the surface soil pasture land of Great Britain. That from Brandon was not so rich as that from Niverville; but the first twelve inches of depth is as rich as the first nine inches of good arable land. The soil from Selkirk was taken from a farm that had been 25 years in cultivation and showed an extremely high percentage of nitrogen in the first twelve inches and in the second twelve inches as high a percentage as in any ordinary pasture soil. Both the first and second nine inches of the Winnipeg soil were exceedingly rich, richer than the average of old pasture surface soils.

The question arises how far the nitrogen in these soils is susceptible to nitrification, and so to become valuable to vegetation. The soils and sub-soils were submitted in shallow dishes under proper conditions of temperature and moisture for periods of 28 days, and then extracted from time to time. The rate of nitrification decreased after the third and fourth periods, and in the sub-soils there was a marked increase in the rate of nitrification for the eighth as compared with the seventh. This result affords direct evidence that the nitrogen of subsoils is subject to nitrification under suitable conditions, and the result tends to confirm the view that deep-rooted plants favor nitrification in the lower layers. That the soils of Manitoba do not yield large crops is shown by the reports of yield which are annually published (1); but that under present conditions, they do not yield amounts of produce at all commensurate with their richness compared with the soils of Great Britain which have been under arable cultivation for centuries, is illustrated by the fact that the estimated average yield of wheat per acre over the seven years, 1876 to 1882 inclusive, is almost identically that of the United Kingdom.

That the rich Prairie soils of the North-West do not yield higher amounts of produce than they do, is due in part to vicissitudes of climate, and to short seasons of growth, but largely to scarcity of labor, and consequent imperfect cultivation, leading with other disadvantages to a luxuriant growth of weeds. Then, again, in the early years of a settlement, and until mixed agriculture and stock feeding can be had recourse to, and local demand arises, the burning of the straw and deficient production or disregard and waste, are more or less unavoidable, but nevertheless very exhausting practices. So long as land is cheap and labor dear, so long sacrifice of fertility is inevitable in the process of bringing these virgin soils under profitable cultivation; and the only remedy for this serious waste is to be found in increase of population. Still the fact should not be lost sight of that such practices of early settlement do involve a serious waste of fertility. There can be no doubt that the characteristic of a rich virgin soil, or of a permanent pasture soil, is a relatively high percentage of nitrogen and of carbon, and of a high relation of carbon to nitrogen. On the other hand a soil that has been long in arable culture is much poorer in these respects, whilst an arable soil under conditions of known agricultural exhaustion shows a very low percentage of nitrogen and carbon, and a low relation of carbon to nitrogen. In conclusion it has been maintained by some that a soil is a laboratory and not a mine; but, not only the facts adduced in this and former papers, but the history of agriculture throughout the

(1) I think the reporter has put in a *not*, here. The passage should read, I fancy, "that the soils of Manitoba *do* yield &c." A. R. J. F.