in large quantities the free and useless nitrogen into the fixed and useful kind. This problem is of immense importance to the whole world—to every race, to every human being—for as a matter of hard, cruel fact we either must solve this problem or starve. This statement is a most unlikeable one, for it is sensational and alarmist, but how true, it is easy to show.

The invaluable "fixed" nitrogen which we have within us, and which we are continuously using up, we must continually restore. In order to do this we eat it. We eat it in the form of animal food or of certain plant products, such as wheaten bread. But plants and animals, too, depend upon the soil for every trace of the nitrogen they contain, and the soil in its turn has won it from the reluctant air through the slow accumulations of the washing rain, from the lightnings of a million storms, or through slow transformations by billions of nitrifying organisms through what, so far as we are concerned, is infinite time. Not only so, but the valuable nitrogen-containing substances we employ in our civilisation are in the same parlous position of depending upon the soil. Every cannon-shot disperses in an instant the fixed nitrogen which it required millions of microbes centuries to accumulate. We filch this nitrogen from the soil immensely faster than it is restored by natural processes, and the land grows sick and barren and refuses to grow our crops. Everybody knows what we must do to cure the land; we must use manure or fertiliser. In other words, we must mix with the soil substances containing fixed nitrogen which the plant may utilise in building up what we must and will have—bread and meat, to say nothing of other substances such as gunpowder and dyes and medicines. In the olden time natural manure was sufficient to meet the demands of sparse populations accustomed to poor food and little of it; but in these days of rapidly multiplying civilised man, who requires more food and better food, particularly wheaten bread, the natural manure of the world is a mere drop in the bucket of his wants; and this would be true even if he could utilise the fixed nitrogen of the sewage and drainage of his towns, which, it is horrifying to learn, England alone hurries down her watercourses to the sea to the value of £16,000,000 a year.

As a matter of fact we were long ago forced to the employment of three other fertilisers. The first of these was Peruvian guano. This substance was produced from the excrements and remains of sea-birds deposited in a very arid region It contained fixed nitrogen in the form of about twenty per cent. of ammonia. We say the first "was" guano, for while in 1856 the year's sale amounted to 50,000 tons, to-day it is practically nothing at all. We have eaten it up.

The second fertiliser is ammonium sulphate. This is obtained as a by-product in the distillation of coal-tar in the manufacture of coke. In 1900 the world's production of ammonium sulphate was 500,000 tons, worth some £4,000,000. But this amount is a fixed quantity; we may have so much and no more from our coal-tar distilleries, and large as the amount seems, it is inadequate to supply the one-hundredth of the imperious and increasing demands of our Mother Earth.

There is actually but one substance, the third, possible of being used on a world-wide scale as a nitrogenous manure. This is nitrate of soda, or, as it is called Chili saltpetre. It occurs native over a narrow band of land between the Andes and the coast hills, a rainless district, where for countless ages the continuous fixation of atmospheric nitrogen by the soil, its conversion into nitrate by nitrifying organisms, its combination with soda, and the crystallisation of the nitrate have been steadily proceeding against the time when, as now, earth's increasing family would insistently demand it for bread. In order to drive home to the reader the validity of the statement we are about to make, let us examine the pay roll of the years. The Chili saltpetre beds yielded in 1860, 68,500 tons; in 1870, 182,000 tons, in 1880, 225 000 tons; in 1890, 1,025,000 tons; in 1900, 1,453,000 tons; and since 1900 every year has added 50,000 tons to the demand of the year before.

The amount yielded in 1900—1,453,000 tons—was sold for £5,000,000, one-quarter of it passing into the thousands of nitrogen compounds used in our civilisation, and the other three-quarters into food through its fertilising action in agriculture.

European and American agriculture and a hundred varied kinds of industry are thus wholly and implicitly dependent upon a tiny little strip of land in a South American republic, and upon the grace of the "Nitre Kings" who own it; and were the little republic to close her gates of export, hungry months and insurrections would follow as infallibly as the night the day. This is, of course, embarrassing and highly significant of the interdepending conditions of our civilisation; but when we begin to estimate the amount of nitre taken out and the amount still remaining in the beds, and compare this amount with the crescendo ratio of the world's demand, we are more than philosophically interested—we are practically frightened. We see that what has happened to guano will inevitably happen to saltpetre. It is a matter of plain, hard cold-drawn fact, as everybody now knows who knows anything about the Chili saltpetre beds and the needs of agriculture, that these saltpetre beds will not last longer than twenty years, if present conditions continue. About the year 1925, then, there will be no more nitre; and a year or two after that, or before it, famine will stalk on the lands of civilised men. This is acknowledgedly true if present conditions continue.

But the phrase, "if present conditions continue", contains the crux of the whole matter. Why should they continue? We have in the enveloping air an immense and inexhaustible supply of nitrogen—33,880 tons of it upon every acre of land. This is "free" nitrogen and the world demands it "fixed." If man must fix the wandering air into his own bodily substance and into substances that are the implements of his advancement, he will so fix it, and within the quarter of a century which is his margin. Let us see how far we have progressed. In attacking this problem, man of necessity and convenience imitated nature. If the cosmic processes were too slow, it was for man to hasten them.

If there exist certain little organisms capable of fixing atmospheric nitrogen, why not favour them, breed them, multiply them to our needs? It was discovered by Hellriegel that certain leguminous plants, such as clover, beans, and peas, have near the base of their stalks little nodosities, little pimples, which turned out to be veritable colonies or cities of nitrifying microbes. These interesting microbes on every pea plant, for mere board wages, work full time in turning over the useless atmospheric nitrogen to the plant in a

NITROGEN-INOCULATION EXPERIMENTS IN NEW ZEALAND.

BROAD BEANS SHOWING DEVELOPMENT OF NODULES ON THE ROOTS, DUE TO INOCULATION OF THE SEED.

BROAD BEANS (UNINOCULATED) SHOWING COMPARATIVE ABSENCE OF NODULES.