

soil or manure—that the soil, whose composition I have here stated again, for the sake of illustration, is essentially deficient in regard to four very important agents, viz., potash, soda, sulphuric acid, and chlorine, but containing a superabundance of all the other ingredients required by 24 tons of turnips; that 15 tons of well-prepared farm-yard dung, can furnish a considerable excess of all these constituents, with the exception of 2 lbs. of sulphuric acid, 44 lbs. of potash, 11 lbs. of soda, and 13 lbs. of chlorine; and that consequently in sufficient quantity, it is eminently qualified not only to comply with all the wants of the crop, and the deficiencies of the soil, but to contribute so largely towards it from its own resources, as to leave the soil comparatively unscathed, and replete with all the materials of future crops, with but the trifling exceptions above enumerated. But not so the guano: in it, we notice a large deficiency of all those constituents, which constitute the perfection of farm-yard dung as a manure for turnips, amounting to 6½ lbs. of silica, 44 lbs. sulphuric acid, 36½ lbs. of lime, 10½ lbs. of magnesia, 127½ lbs. of potash, 59½ lbs. of soda, and 27½ lbs. of chlorine, less than what is required by a moderate crop of turnips, and denoting it a vastly inferior application to farm-yard dung, as regards the permanent fertility of the soil. It will be seen by referring to the above table, that the soil, whose composition is there given, contains an almost inappreciable quantity of potash, soda, chlorine and sulphuric acid, and that 24 tons of turnips require 303 lbs. of these bodies, while 3 cwt. of guano, which is a large dose, can only furnish little more than 44½ lbs. To what an inconsiderable extent, then, guano is capable of counteracting the poverty of such a soil, will be sufficiently apparent, as the very constituents of which the soil is most in want, exist also in least abundance in guano. And in the event of that soil being called upon to produce a crop of turnips, having guano applied to it as a manure, how is this deficiency in both to act upon the crop? And there are many soils in the turnip districts, upon the sandstone formation, not better supplied with these ingredients than the one in question. Certain it is, that the rains may convey a very small portion of the alkaline salts to the soil; even snow-water is rendered a little turbid by the addition of a few drops of the nitrate of silver to it, which indicates the presence of a chloride. The supply derived from this source, together with that obtained from the gradual disintegration of the undecomposed parts of the soil, will certainly assist the quantity furnished by the guano, but still a large deficiency must exist; and so soon as the whole available supply of these matters is appropriated by the turnip, the farther formation of these proximate principles which require their presence, will be immediately arrested; and either a plant of an unhealthy and inferior quality be produced, or the growth of the plant must entirely cease; although other constituents may be present in quantity sufficient to produce double the weight of the crop. In support of this opinion, I beg to refer to the table exhibiting the difference of constitution between turnips produced from farm-yard dung, and guano; those produced from the latter, contain eight per cent. of water more than the former, and otherwise are of considerably less value, as regards their adaptation for the food of animals, even supposing that their bulk per acre is equal to that of the former. The oil, gum, sugar, and albumen, amounting to above seven per cent. in those produced from dung, while they only amount to two-and-a-half per cent. from guano. Now the reason is obvious why the produce raised from it should be inferior to that produced from farm-yard manure, as it will be seen by a reference to the table shortly given, that it is capable of furnishing a much less quantity of those mineral constituents upon which the healthy development of the nutritive principles depend. But this inferiority in quality, I conceive, will exist to a greater extent where the guano has been applied to poor soils naturally deficient in such bodies as potash, soda, &c., than in the case of richer lands, fertile with such constituents. In regard to the influence of guano on the permanent fertility of the soil, the large quantity of ammonia which guano is able to afford constitutes its chief value as a manure, to which the rapid and luxuriant growth of turnips produced from it, in the early part of the

season, is to be ascribed, and on this account it is believed by many experienced Agriculturists, to be the best manure that can be applied; and it cannot be denied, but that we have frequently seen as abundant crops raised from it, as from any other application. But the fact is generally forgotten, that its efficacy depends almost entirely upon the stimulating action of its ammonia; and, as before explained, the larger the supply of this ingredient, the greater will be the quantity of mineral constituents appropriated by the turnips; and as the guano can only furnish a trifling amount of them, it is obvious that the exhaustion of the soil of these ingredients will only be the more extensive, in proportion to the large quantity of ammonia furnished. And it is my opinion, that if successive crops of turnips be raised from guano or bones alone, upon poor lands, and be drawn off the soil to be consumed elsewhere, such soils will become so exhausted of the alkalies and others, that they will eventually refuse to produce any crop at all. But the case is to a considerable extent altered when they are consumed on the land by sheep, as then the greater part of the saline matters obtained from the soil by the crop is returned again to it, with the exception of part of the phosphates, which are retained by young stock, in order to build up the structure of their bones. As an evidence of the tendency of such manures as guano, bone dust, &c., to exhaust the soil of the alkalies, and other constituents not furnished by them in sufficient abundance, I beg to refer to the soil whose chemical constitution is detailed in this paper, and which we observed to exhibit a marked deficiency of these bodies. Now this will not appear so strange, when I state, that three or four successive crops of turnips have been produced from it, at intervals of four years, with bone dust alone as a manure; and that fully one-half of the produce was, in each case, drawn off the land, to be consumed by cattle; which we see, in this case at least, to have had precisely such an effect in exhausting the soil as might have been anticipated. It is also a fact worthy of record in this age of guano, that it is ascertained to have been used by the natives of South America, long previous to its ever being thought of by the Farmers of England, and that the lands of a monastery belonging to the Spaniards, had been manured with it for a number of years in succession. At first they obtained large crops, but eventually they were observed to become less luxuriant year after year, until at last they were too insignificant to repay the expenses of cultivation, when the lands were left untilled, and may even be so at this day. Now the gradual, and ultimately complete, deterioration of these lands, can be ascribed to no other cause than the tendency of guano to rob the soil of its alkalies, and other inorganic constituents, as I have before explained. It might be considered a matter easily accomplished, to add such artificial preparations to guano or bone dust, as would render them at once replete with all the materials required by a crop of turnips. For instance, were we to add to the usual quantity of guano or bones 1 cwt. of pearl ash, 4 stons of Epsom salts, and 3 cwt. of common salt, we would supply in abundance most of the ingredients required; and, in a dry season, this addition might be attended with manifest advantage; but owing to their ready solubility in those forms, the first heavy rain that fell would wash the greater part of them into the rivers, so as to be totally lost. And this opinion of the fleeting action of manures in too soluble a form, is strongly corroborated by what I have mentioned, as having been the effects of the continued rains on the turnip crops of 1845, in a former part of this paper. Therefore, the grand point to be attained in the application of all substances as manures, is to apply them in such a form as to be gradually rendered soluble, and as they can be appropriated by plants, so as to guard against their being washed out of the soil on the one hand, or being rendered useless by their insolubility on the other. And such a medium I conceive to be eminently attained in fully rotten farm-yard dung; for by the gradual decomposition of the fibrous part of the straw in the soil, the inorganic matters which chiefly reside there are set free, just in such quantity as is required for the present use of the crop; while any waste is effectually obviated by the complete insolubility of such parts of the fibre as are not yet entirely decom-