been tried by many of us, but, I think, with unsatisfactory results. It does not stand the sea breeze, and it is in leaf for a comparatively short time of the year. We want something better than the Osage orange.

Possibly from California or Oregon we might obtain the plant we require, and with greater facility than from other countries, on account of the regular communication.

There is a common New Zealand shrub, or tree, which may be made useful for shelter, viz., the Ngaio: but to bring it into common use for a hedge plant it must be raised in nurseries, and thus established with good roots before planting out. So long as we have to depend upon getting young plants from the outskirts of the bush, the greater number of them will be sure to die off after being transplanted. This will not suit for hedge planting, as the preliminary expense of preparing the ground is thus thrown away.

The Ngaio is very hardy, is improved by pruning and clipping, and does not seem to be eaten by horses or cattle; but I am informed that sheep will eat it, although I have not myself observed them to do so.

Art. XV.—*Lime as Manure: Its Beneficial Effects when applied to the Cultivation of the Soil.* By D. Hay.

[Read before the Auckland Institute, 2nd October, 1876.]

Common limestone is composed of carbonate of lime, 95·05 parts; water, 1·68; silica, 1·12; alumina, 1·00; oxide of iron, ·75 per cent. The Whangarei limestone, which is said to contain from 96 to 97 per cent. of carbonate of lime, is therefore of superior quality. Lime from its strong attraction for carbonic acid and moisture may thus also be beneficial by affording a supply of both these to plants. Lime exists in nature and in the soil in a state of combination with carbonic acid. Limestone, however, before it can be rendered friable must first be burnt and reduced to a quick or caustic lime. In this state, on the addition of water, it readily pulverizes, and greedily absorbs carbonic acid from the atmosphere. Very few limestones or chalks, however, are pure, the primary marbles and calcareous spars being the exception. Clay, flint, magnesia, iron, and other salts are in a greater or less quantity found mixed in limestones. Slacked lime is a combination of lime with about a third of its weight of water, and is called a hydrate of lime, and when this hydrate, by exposure to air, becomes a carbonate, the excess of water is expelled. When freshly burned or slacked lime is mixed with any moist fibrous vegetable matter, there is a strong action between the lime and the vegetable matter, and they form a kind of compost together, of which a part is usually soluble in water. By this kind of operation lime renders matter which was before comparatively inert, nutritive; and as charcoal and oxygen abound in all vegetable matters, it becomes at the same time converted into carbonate of lime. Marls, and and chalk have no action of this kind on vegetable matter. They destroy worms and other tender-skinned vermin, and they prevent the too rapid decomposition of substances already dissolved, but in other respects their operations are different from that of quick lime. Lime marls, and even shell sand produce wonderful effects on peat soils by absorbing the gallic acid which they contain, and promoting the decomposition of the woody matters.

All soils having a deficiency of calcareous earth, and which do not effervesce with acids, are improved by lime, either mild or quick lime. Sandy soils are improved more than clay. When a soil deficient in calcareous matter contains much soluble vegetable matter, the application of quick lime should always be avoided, as it either tends to decompose the soluble matters, by uniting to them carbon and oxygen so as to become mild lime, or it combines with the soluble matters and forms compounds having less attraction for water than the pure vegetable substance. The case is the same with regard to most animal manures, but the operation is different in different cases, and depends upon the nature of the animal matter. Lime forms a kind of insoluble soap with oily matters, and then gradually decomposes them by separating from them oxygen and carbon. It combines likewise with the animal acids, and probably assists their decomposition by abstracting carbonaceous matter from them, combined with oxygen, and consequently it must render them less nutritive. It tends to diminish likewise the nutritive powers of albumen from the same causes, and always destroys to a certain extent the efficacy of animal manures, either by combining with certain of their elements, or giving them new arrangements. Lime should never be applied with animal manures unless they are too rich, or for the purpose of preventing noxious effluvia. It is injurious when mixed with common dung, and tends to render the extractive matter insoluble; and with almost all soft animal or vegetable substances lime forms insoluble composts, and thus destroys their fermentive qualities. Such compounds, however, exposed to the continual action of the air, alter in course of time: the lime becomes a carbonate, and the animal and vegetable matter enter by degrees into new compounds suited for vegetable nourishment. In this view lime presents two great advantages for the nutrition of plants: the first, that of disposing certain insoluble bodies to form soluble compounds; the second, that of prolonging the action and nutritive qualities of substances beyond the time during which they would be retained if these *substances* were not made to enter into combination with lime.

Lime has been employed as a fertilizer from a very remote period: both Cato and Pliny attest the use of it by the Roman cultivators.

The chemical uses of lime to vegetation may be divided into two parts: first, its direct action on vegetable matter; secondly, its chemical operation on the matters contained in all cultivatable soils. In its direct action as a food, or constituent for plants, its uses are of the greatest importance, for hardly a single plant has yet been analyzed in which the presence of lime has not been detected, in combination with an acid. It is found in the commonly cultivated crops of the farmer in very varying proportions: thus the ashes of the oat plant contain more than five cent. of lime. In two pounds weight of the seeds of wheat are found about 12 grains of carbonate of lime; in the same quantity of rye, about 13·4 grains; in barley, 24·8 grains; 33·75 grains in the oat; and 46·2 in the same quantity of rye straw. It abounds also, with magnesia, in the wood of trees. The ashes of the oak contain about 32 per cent. of earthy carbonates; those from the poplar, 27 per cent.; of the mulberry, 56 per cent. The proportion of lime found in plants varies with the composition of the soil on which they are produced. There are very few soils fit for cultivation from which this earth is entirely absent; and its addition is found by the farmer to promote the fertility of most barren lands. The attraction of lime for the aqueous particles of the atmosphere is considerable, and is, therefore, not without its uses in this respect to vegetation.

The chemical action of lime is also very considerable: mixing with the heavy adhesive clays, it renders them much more friable, less liable to be injuriously acted upon by the sun, and much more readily permeable by the gases and vapour of the atmosphere. It renders them—the cultivator tells you—"more easily workable." And again, the action of lime upon the organic substances always more or less contained in the farmer's soils, is very considerable. This benefit is not merely confined to the vegetable remains in the land, but it extends with equal energy to the dead and the living animal matter with which, in a countless variety of forms, the land is tenanted. There are few substances more destructive to grub-worms, animalculæ, etc., than lime; and where these are destroyed by lime, the soil is, as a natural consequence, enriched by their remains. On soils which abound with sulphate of iron—which is commonly the case with those which contain an excess of peat—the action of lime is not only beneficial in decomposing or rendering soluble the mass of inert vegetable remains, but the lime decomposes the sulphate of iron, and, uniting with its sulphuric acid, forms the well-known fertilizer, the sulphate of lime, or gypsum, of commerce.

The quantity of lime used per acre of necessity varies with the soil, and the expense with which it is procured. The heavy clay and peat soils require the largest proportions; the light lands need a much smaller quantity to produce the maximum benefit. The proportion commonly used on the clay soils in the midland counties of England is 100 bushels per acre; and 25 bushels per acre on light soils. In Scotland they apply sometimes as much as 360 bushels per acre; in Ireland much larger quantities are successfully employed; and on some of the peat mosses in the North of England more than 1,000 bushels have been used with good effect; but, however, the employment of such large quantities can rarely be justified.

ART. XVI.—*Notes on Quartz Crushing at the Thames.**

By J. GOODALL, C.E.

[*Read before the Auckland Institute, 27th November, 1876.*]

I HAVE recounted on a prior occasion the chief errors of quartz crushing as practised on the Thames. I shall now endeavour to show how a great many of them may be avoided even by mechanical means of manipulation, that is without using chemical re-agents. Battery managers in general know too little of chemistry to look with favour on any process of gold saving dependent on chemical means.

That a vast amount of gold is lost yearly all over the world for want of proper means of saving it, is only too evident from the accounts contained in all metallurgical books recently published that treat on gold. It has been ascertained that 50, 60, and 70 per cent. are common losses. That even this has been exceeded on the Thames, a case that came under my notice fully proved. The directors of the "Golden Crown" mine, which at the time I speak of was a large producer, were desirous of ascertaining the relative merits of two rival batteries, so as to get their quartz crushed at the better establishment. To accomplish this they sent 50 tons of quartz to each mill. Special care was taken that the loads from the tip were sent alternately to each place, so as to equalize the quality of the quartz as much as possible. In the one battery, as well as I can now recollect, the quartz was crushed with quicksilver in the boxes, passed over quicksilver plates, then through Chilian mills, then over short blanket strakes. The blanketings and what remained in the Chilian mills were then passed through the amalgamating barrel. The total product of the 50 tons at that battery was less than 25 ounces, or under one-half ounce to the ton.

* For previous Paper by Author see "Trans. N. Z. Inst.," Vol. VIII., p. 176.