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PRINCIPLES OF AGRICULTURE:

EXPRESSLY ADAPTED

TO

THE REQUIREMENTS OF THE SYLLABUS

OF THE

SCIENCE AND ART DEPARTMENT, SOUTH KENSINGTON.

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PRINCIPLES OF AGRICULTURE.

CHAPTER I.

1. Soils.—The routine of operations by which vegetable food is produced from the earth is commonly known as Agriculture (*ager*, a field) or Horticulture (*hortus*, a garden), according as it relates to the field or the garden. The great object of such cultivation is to raise on any given space the greatest quantity of certain kinds of vegetation, with a due regard to the quantity of the produce, at the cheapest rate, and without unduly taxing the energies of the soil.

By the *soil* is meant the surface of the land, consisting of earthy matter of various degrees of fineness.

All fertile soils are composed of two classes of ingredients—organic and inorganic.

The Organic (Gr. *organon*, a member) is derived from animal and vegetable substances.

The Inorganic substances are the mineral constituents of the soil, and are usually said to be derived from the decay or disintegration (*dis*, asunder, and *integer*, whole) of the primitive or crystalline rocks, because these original rocks gave rise to all other varieties of rock formations.

The late Sir Charles Lyell gives the following minerals as chiefly composing the crystalline rocks:—Quartz, Felspar, Mica, Hornblende, Augite, and Zeolites.

Quartz forms the mass of silicious sand. It is found as a hard, six-sided crystal, and is composed of silicic acid, or pure silex.

Felspar is the most abundant in the mineral world, next to quartz. It is chiefly composed of silica, alumina, and potash or soda. It is softer than quartz. The softer minerals occurring in granite are of felspar, and its decay is the immediate cause of the formation of clay.

Mica, from the Latin *mico*, I glisten, forms the glistening scaly crystals in granite. It is composed mainly of silica, potash, and magnesia. It is found in many sandstones, giving to them a silvery appearance, and is also very extensively distributed in rocks, and readily splits into brilliant thin plates elastic in texture.

Hornblende and Augite.—Hornblende (*blenden*, to dazzle) is a dark green or black mineral, consisting mostly of silica, magnesia, lime, and alumina. Its fracture has a horny, glistening appearance.

Augite is of a dark green colour; it contains silica, magnesia, lime, alumina, manganese, and protoxide of iron. Hornblende and Augite differ but slightly in form and mineral composition. The word Augite is derived from the Greek, and means "splendour."

Zeolites are composed of silica, lime, alumina, and water. They are easily decomposed into their component parts, and are found in the form of crystals, also in the cavities of trap rocks and ancient lavas.

From the foregoing particulars it may readily be recognized how intimate is the connection between some of the general principles of Geology and those of Agriculture.

Having noticed the chief substances in the composition of the primitive rocks, we proceed to consider the *agencies* which have decomposed them.

Had the exterior crust of the earth been subject to no modifying causes, the world would have been precisely the same in appearance as at the time of its creation. Such, however, is far from being the case. One continuous series of change and progression has been going on, occasioned by the incessant operations of the various forces in nature—the shivering of the earthquake and the upheaving of the volcano, together with the universal operations of chemical and electrical agencies, being amongst the most direct and powerful in their action. The long continuance of these and other destructive agencies on the primitive rock may induce decay, and yield a soil, or the *débris* may, in course of time, through the agency of water, become hardened into stratified rock, or form beds of clay. These, by the out crop of their edges, and the exposure of part of their surfaces, like tiles upon the roof of a house, may combine to form the inorganic part of a cultivable soil with many of their original chemical properties.

There are three great agencies which thus pulverize Rocks—(1.) *The Atmosphere*, (2.) *Water, and* (3.) *Frost*.

(1.) *The Atmosphere.*—One hundred volumes of dry air under ordinary circumstances contain mechanically mixed, not chemically combined—

Nitrogen	79·12
Oxygen	20·80
Carbonic Acid	·04
Carburetted Hydrogen	·04
Ammonia	trace
	100·00

Many other substances are mixed with this proportion of dry air, aqueous vapour being the most important, and the others sulphuretted hydrogen, sulphuric acid, hydrochloric and nitric acids, ozone, the miasmata of marshes, and various gases liberated from volcanoes. The following bases are also found in varying quantities: —Potash, soda, lime, manganese, and iron; while others probably remain yet to be discovered.

(2.) *Water.*—Atmospheric air and water, or aqueous vapour, are mutually capable of absorbing and retaining each other, and in consequence the carbonic acid of the atmosphere is taken up by the aqueous portion in its various forms of snow, rain, dew, fog, or mist in passing through the air, and reaches the surface of a rock, bathing it in a dilute solution of carbonic acid in water. In course of time this proceeding causes the hardest rock to part with its alkalies, and, gradually loosening the cohesion of parts, the various constituents moulder away in small particles.

(3.) *Frost or change of temperature* may be regarded as a mechanical phase of atmospheric agency, and under certain latitudes is an important modifying cause. During the winter the moisture between the particles of all rocky matter often becomes frozen, and, in this state of ice, expands and forces apart these particles. While the frost lasts the ice holds them together; but when the thaw comes, their cohesion being destroyed, they fall asunder, and offer a greater amount of surface for future pulverizing processes, and in this way, under all latitudes and in all altitudes where frost occurs, vast waste is every winter effected.

Every cliff and railway cutting, every *bare* sloping bank and ploughed field, shows the effect of the "weathering" power of frost.

2. Different kinds of Soils—Variations in their Composition, Texture, and Condition.—Soils may be divided into two great classes—(1.) *Soils in situ*, and (2.) "transported" soils.

(1.) *Soils in situ* are such as have been formed from the underlying rock. They consist largely of constituents identical with the parent rock, with the addition of vegetable matter derived from the decay of past vegetation. A rock once pulverised soon becomes fit to support the lower forms of vegetable life. Fungi and lichens are followed by mosses and grasses, and, as these decay, their remains increase the depth of the fertile layer and give rise to carbonic acid. This, in its turn, tends still further to dissolve and break up the rocky layer beneath,—a process which is undoubtedly supplemented by the growing roots themselves. Soils *in situ* are also known as "sedentary" or "indigenous" soils. Examples are seen in the thin white soils of the Upper Chalk, the Clays of the Lias, the Clays of the Weald, and the Oxford Clays, together with the soils of the Lower Oolite, and Old and New Red Sandstone. Reference to a geological map of the country will show at a glance the large extent of sedentary soils overlying the parent rock, and partaking to a large extent of its special constituents.

(2.) *Transported Soils.*—These need not of necessity correspond in any important degree with the geological features of any given district where they may occur.

When we consider that the grinding glacier, the rolling river, the rushing flood, the molten lava, blinding clouds of ashes from the belching volcano, and even the mighty iceberg, may all have contributed to their formation, the varied nature of their particles will be fully accounted for, and cease to be a matter of surprise.

Glaciers are simply ice-rivers formed from the ever-collecting snow by pressure from above. As they slowly and with irresistible force descend the mountain gorges, they rend, and grind, and scarify the rocks, the resulting particles being carried down to a lower level by the ice-water ever trickling from their extremities as they press beyond the snow line.

Rivers may form deltas, as may be seen in the case of the Nile, the Mississippi, the Amazon, the Ganges, the Rhine, and many others. Alluvial flats may be formed on the site of a lake where a muddy mountain stream is depositing its sediment and filling up its bed. Lake Geneva in this way receives the muddy impurities of the Rhone, which issues from it a pure and sparkling stream.

Floods and Torrents, by their velocity, dislodge and bear away fragments of rocks and stones, the "attrition" or friction wearing away their substance and deepening the water channel.*

Molten Lava finally cools, and in time crumbles slowly into a fine fertile clay, proof of which may be seen in the luxuriant vineyards and olive gardens of Sicily and Italy in the neighbourhood of Etna and Vesuvius. Even in our own country, in the north and extreme west, and in the neighbourhood of Edinburgh in Scotland, there are fertile soils overlying ancient fields of lava.

Volcanic Ashes are simply dust from volcanoes, this dust being nothing more than the very minute fragments of the matter sent out from within a crater. A great proportion consists of fragments of films coating the bubbles produced during the boiling up of the lava. This rises into the air a great height, being so abundant and light that it reaches into the upper currents of the atmosphere. The currents of wind sift it, as it were, and it becomes distributed in uniform beds, some of one size and some of another, over an area amounting sometimes to thousands of square miles. The cities of Herculaneum and Pompeii were, in A.D. 79, so completely buried in ashes and scoriæ as to be lost to sight and knowledge for nearly twenty centuries.

Icebergs.—During what is known as the "Glacial Epoch" a cold period must have set in, and the land in our latitudes and in the north of Europe undergone a submergence of some thousands of feet. During this period icebergs passed and dropped their burdens of boulders, gravel, etc., which afterwards appeared on the surface as the land became again elevated to its present

* "It has been computed that a velocity of 3 inches per second will tear up fine clay; that 6 inches per second will lift fine sand; 8 inches sand as coarse as linseed, and 12 inches fine gravel; while it requires a velocity of 24 inches to roll along rounded pebbles an inch in diameter, and 36 inches per second to sweep angular stones the size of a hen's egg." "Stones of ordinary specific gravity (from 2·5 to 2·8) lose more than a third of their weight when immersed in water"—*Prof. Ansted.*