PRIMER OF TROPICAL AGRICULTURE

PRIMER

OF

Tropical Agriculture

(ADAPTED AS A READER FOR SCHOOLS)

BY

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COLOMBO.

PREFACE

Nothing in this world should, if possible, escape our observation. Many children look at objects without seeing them. We should try to see with both the outward and inward eye.

The study of plant-life ought not be neglected by anyone since (1) plants, as living things, are interesting objects for study; (2) they are always about us and convenient and easy to study; and (3) they are closely connected with our own welfare.

This last fact will be better understood when we realize (1) that we depend upon plants for a pure atmosphere since they consume the noxious carbonic acid gas in the air; (2) that they supply us with food for ourselves and the animals that are useful to us (as producers of milk, meat, wool, silk, &c.); and (3) that they provide us with the material for our cotton and linen clothing, and also furnish us with drugs, spirits, tobacco, &c.

The earlier a child begins to learn about the life of the plant, and becomes acquainted with common plants, the better; and it is with the object of providing an elementary knowledge of both that this little book has been written.

At the end of each lesson are given a few notes to serve as hints for practical work. Teachers should look upon these notes merely as suggestions, and elaborate them by adding further specimens, illustrations and exercises.

At the end of the book will be found a list of the plants referred to in the text, with their botanical and common names, so that they may be easily recognised.

C. DRIEBERG.

PERADENIYA, 10TH JUNE, 1918.

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AGRICULTURAL PRIMER

ADAPTED AS A SCHOOL READER.

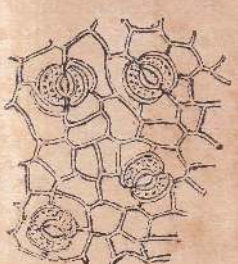
PART I.

THE PLANT AND THE SOIL.

LIFE HISTORY OF A PLANT.

We are taught that a plant is a living thing. Think for a moment what that means. It means that, like ourselves, it needs food and water, and breathes and grows.

But the plant obtains its food in a different way, for while we eat meat and vegetables, the plant finds its food in the soil and the air.



1. Mouth-like Openings on Surface of Leaf.

From the soil the plant takes up its food through very fine hair-like rootlets. These rootlets are like so many tiny tubes which drink in the food dissolved in water, and carry it up to the leaves of the plant.

The food derived from the air is taken up in the form of

gas, and enters the plant through small openings on the surface of the leaves.

In these two ways does the plant obtain the material it requires to build up its body, just as the food we eat builds up our own bodies. And thus the plant grows in the same manner that we do.

Breathing, in the plant, is the same process as in animals, i.e., the taking in of pure air and the giving out of impure air. In plants it is carried on through the openings in the leaves already referred to.

2. Fern Leaf with Spore Cases.

Before the plant dies, it usually bears flowers, which produce fruit and seed.

Ferns do not produce flowers, but bear spores (which take the place of seeds) on the back of the leaves.

The life of the plant runs through the same course as other living things. It begins as a very tiny structure hidden within the seed, and when the seed is planted this little body develops and, striking root in the soil, begins to find its own food from the soil and the air, growing bigger and older, and finally dying as all living things do.

In its early stage the young plant requires special attention, just as an infant does, until it can look after itself; but at all times cultivated plants need our care so that they may have food, water, light and air for their healthy growth. It is only by growing them under the best possible conditions that we can expect them to

yield us a good return in useful produce, whether in the form of leaves (Tea), fruit (Orange), seed (Rice), and so on.

[Carefully lift a young plant out of the ground with the soil adhering to it. If the ground is dry and hard, water it well till it becomes quite soft. Place the plant so lifted in a bucket of water and allow the soil to drop away. Examine the roots and find the root hairs through which the food from the soil is sucked in. Examine a garden Croton leaf with the aid of a lens, and find the tiny mouth-like openings on the leaf, especially on the under side. Examine a bean after soaking a few hours and look for the tiny plant lying between the two seed-leaves. Look for spore cases and spores on the back of a fern leaf.]

THE STEM.

For the study of the plant we may divide it into two parts, viz., the part above ground, and the part below.

The part above, in an ordinary plant, consists of the stem and its branches, bearing leaves and flowers and fruit.

The part below consists of the roots.

The main stem is generally found growing straight out from the ground. It may be unbranched as in the Coconut palm, but is more often branched as in the Mango.

3. *Palm with Unbranched Stem*

In the Coconut palm all the leaves are borne right at the top, while in the Mango the branches divide and subdivide before they produce leaves.

It is the arrangement of the branches that regulate the shape of a tree.

Many forest trees have stems which are very hard

4. Tree with Branched Stem.

and durable, and some of these hard-stemmed trees produce valuable timber, such as Jak and Teak and Satinwood. Others yield a light and tough wood such as Lunumidella.

Soft stems occur in all plants when young, and in those that live only for a short time.

5. *Twining Stem.*

The stems of some plants cannot support themselves; so they climb up or twine round others, or creep along the ground.

Climbing stems have special organs for holding on to other plants as in the Grape-vine, the special organs of which are known as tendrils.

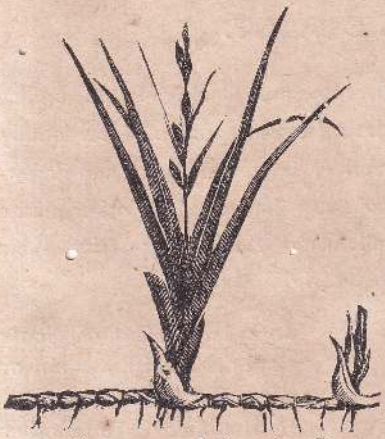
In the Long-bean and in the Yam the stem itself grows round the support and is then said to twine.

The Sweet-potato has a stem which creeps along the ground.

In shape, the stem is usually roundish; but sometimes we find a square stem as in Coleus, or a five-sided one in Bitter Gourd, triangular in the Sedge and of many strange shapes in the Cactus.

Some stems carry hard woody spines or thorns, as in the Orange and Lime.

The stem is generally a solid structure, but is occasionally hollow (except at the joints) as in the Bamboo.



6. Under-ground Creeping Stem.

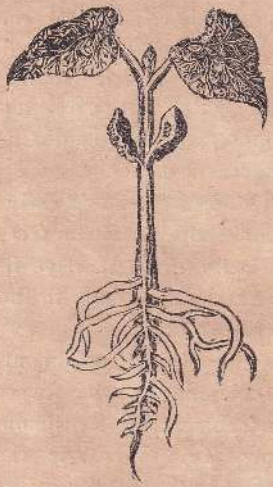
The stem is sometimes found growing under-ground. In Ceylon Couch Grass it occurs as a long slender whitish structure: in Ginger it is short and thick: in the Potato and Yam it is very much swollen and roundish. In the Onion bulb the stem is greatly contracted and packed round with succulent sheathing leaves. Such under-ground stems can be distinguished from roots by their bearing leaves or buds.

It will thus be seen that the stem varies greatly. We find it very tall in the red-flowered Silk Cotton tree, and comparatively short in the Cashew-nut: massive in the Kumbuk and slender in the Arecanut: rough in the Mango and smooth in the Guava, and so on.

[Notice the various forms of stem in the neighbourhood. Observe the method of creeping in the Sweet Potato. Examine the organs of attachment in Antignon, Bignonia, Gloriosa, Snake Gourd, &c. What is the difference in the manner of twining in the Bean and the Yam? Distinguish between the woody outgrowth (spine or thorn) in the Orange and the surface growth (prickle) of the Rose. Examine the structure of the stem of the Bamboo and of Grass. Compare the stem of a Grass such as Guinea-grass with that of a Sedge such as Nut-grass. Look for buds or leaves on under-ground stems.]

THE ROOT.

As already stated, roots are usually found under-ground. They do not bear leaves or buds. Occasionally we find roots above ground as in the Banyan and Screw-pine. Plants whose roots are imbedded in other plants on which they grow and from which they derive their food are called parasites, e.g., Loranthus.



7. *Seedling with Tap-root and Branches.*

In a large class of plants we can distinguish a main or tap-root with its branches, e.g., the Jak. In another large class we find no main root but a number of roots arising from the bottom of the stem where it enters the ground, e.g., Indian Corn.

Some plants have thickened roots, such as the Manioc and Radish. These must be distinguished from thickened under-ground stems like the Potato tuber which contain dormant buds or "eyes."

Roots also serve as organs of attachment for the purpose of climbing, as in the Vanilla and Creeping Fig.

The true feeding roots of plants, as explained in the first lesson, are of very delicate structure, and occur on the

ultimate branches of the root. For these root-hairs to do their work satisfactorily, the soil should be of a free texture and well-drained, so that they may live under healthy conditions and in the presence of air. They cannot thrive in a hard or water-logged soil.

[Observe the roots of the Banyan and Screw-pine which are found above ground. In the Banyan the roots develop from the branches and grow downwards till they reach the ground and there become attached. In the Screw-pine, whose roots are thicker and harder, the same thing occurs. The latter show very clearly the "root-cap" or protective structure found at the end of the root. In the soil this cap protects the delicate tips of the roots from injury as they travel through the soil in search of food.

8. Roots of Grass.

Examine a Loranthus which is frequently found on Mango and other trees from which it gets its nourishment. These "robber-plants" should be cut and removed. Notice how the Loranthus imbeds its roots in the host plant.

Compare the development of the roots in young Jak and Indian Corn plants.]

THE LEAF.

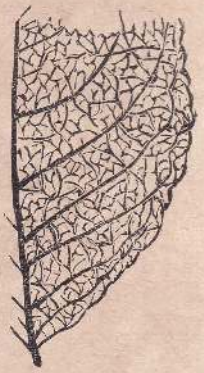
Leaves differ greatly in size, shape and other characters; but are, as a rule, green and flat.

9. Leaf with Stipules.

Leaves are attached to the stem or branch either directly or by means of a stalk or petiole. In some leaves are found a pair of leafy structures at the point of attachment. These structures, called stipules, protect the leaf in the bud stage. In the Shoe-flower the stipules are small; in the Breadfruit they are large and leathery. In under-ground stems (Arrowroot) the buds are protected by scaley leaves.

The leaves of some plants—especially those found in dry regions—are thick and succulent as in the Cactus and Aloe.

The harder and tougher parts which run through the soft structure of the leaf are made up of "veins" which go to form the skeleton of the leaf. When leaves decay the softer tissues decompose first, and the skeleton is left. In some leaves the veins run parallel as in Indian Corn: in others they form a network as in the Mango.



10. Part of a Skeleton Leaf.

The principal vein which divides the leaf into two (generally equal) parts is known as the midrib. When the midrib is fully developed we get leaves like that of the Mango. When

it is contracted, and the veins spread out radially from it, we get leaves like that of the Palmyrah palm or Papaw.

Leaves may be smooth as in Domba, or hairy as in Kaprawalliya. Some leaves have stinging hairs which contain an irritating fluid, as in the Ceylon Nettle.

The shape of the leaf varies from the round leaf of the Lotus to the needle-like leaf of the Casuarina.

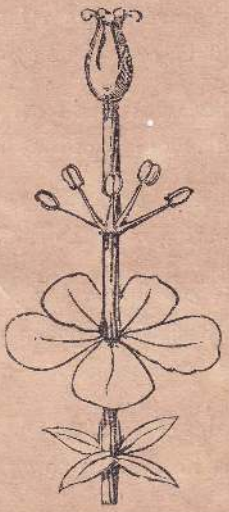
A leaf may be whole or entire as in the Mango or parts of it may be wanting as in the Bread-fruit.

When the leaf is cut up so that each separate part is a miniature leaf in itself it is spoken of as a compound leaf and the parts are called leaflets.

The margin or edge of a leaf may be smooth as in the Orange or irregular as in the Shoe-flower.

[Notice the presence or absence of a leaf-stalk and of stipules on plants in the school garden. Examine a section of Arrowroot and look for the leaf-buds under the membraneous leaves. What is the need for fleshy leaves in dry regions? Look for skeleton leaves among decaying vegetation and examine the arrangement of the veins on them. Make a collection of leaves of different shapes and draw them in outline. Examine the leaves of the Rose, Flamboyant and Murunga, and notice that the first is once compound, the second twice compound, and the third thrice compound.]

THE FLOWER.



11. Diagram of Flower, showing (from below upwards) Calyx, Corolla, Stamens and Pistil.

Every part of a flower is a modified form of leaf. A perfect flower such as a Shoe-flower, in which all the parts are present, is made up of four distinct series of floral leaves.

Looking at a perfect flower from behind, we see first the calyx which is generally green and made up of a number of leaf-like structures called sepals, often united together to form a cup-like body.

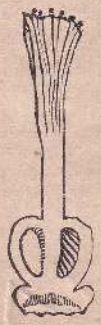
Next to the calyx is the corolla consisting of petals, which are delicate in texture and coloured or white. This is usually the showy part of the flower which makes it attractive to insects.

12. Stamens.

The third series consists of stamens. Each stamen, if perfect, is made up of a stalk or filament bearing an anther, which is, as a rule, a two-lobed structure containing pollen-grains.

The fourth and innermost series is known as the pistil. When perfect it consists of a hollow structure below called the ovary, which contains the ovules or seed-buds. Above the ovary, generally supported on a stalk, called the style, is the stigma, which is the part that receives and retains the pollen brought to it by insects or wind.

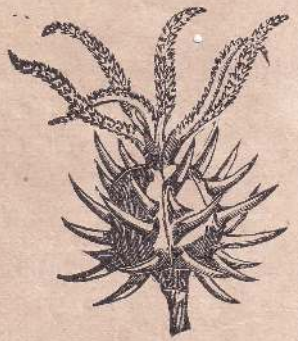
All flowers are not perfect. Some have stamens and no pistil; others have a pistil, but are without stamens. Again we may find a stamen without a filament, or a stigma without a style.



13. Section of Pistil, showing Ovary below and Pollen-grains growing down Stigma.

[Examine the Shoe-flower and note the number of parts that go to form calyx, corolla, stamens and pistil. Notice that below the calyx there is a ring of small leaf-like structures, sometimes called the epi-calyx. Such leaf-like structures on a flower-stalk are known as bracts. Bracts are sometimes very showy as in Poinsettia and Bougainvillea. A large bract enclosing a collection of flowers, as in the Arum lily or the Coconut or Arecanut palm, is called a spathe. Examine specimens of bracts and spathes.

14. Male Flower of Castor.



15. Female Flower of Castor.

[Cut across the ovary of the Shoe-flower and count the number of compartments composing it, also notice the ovules or seed-buds.

[Look for the stamens in Alamanda and notice the absence of the filament or stalk.

[In the Castor-oil notice the two kinds of flowers, one with stamens and the other with pistils.

16. A Shoe-flower cut down the middle: anther splitting open Showing Pollen grains.

[Try to trace the leaf type in the parts of the calyx, corolla, stamen and pistil.]

THE FRUIT.

The fruit is formed from the ovary, and generally contains seeds, which are ovules that have undergone certain changes.

Fruits when ripe may be either dry, like the Bean, or succulent, like the Mango.

Most fruits are formed from single ovaries, e.g., Orange. A compound fruit is formed from the ovaries of more than one flower, e. g., Pineapple.

The structure of some fruits is very simple, consisting of an outer shell (pericarp) with one or more seeds inside, e.g., Bean.

17. *Fruit of Bean (legume).*

In the Mango the structure is not so simple, as the pericarp is made up of 3 distinct layers, the outer skin, the succulent edible portion, and the hard stone which we wrongly call the seed. The true seed is contained inside the stone. Some fruits are formed from ovaries which are situated below the rest of the flower, and are, therefore, said to be inferior : others are formed from ovaries standing above the rest of the flower, when they are spoken of as superior. The Guava is an inferior fruit, and the Orange a superior one. Certain fruits, like the Bandakka, split open when dry : others, like the Mango, do not. As a rule dry fruits split open and succulent ones do not.

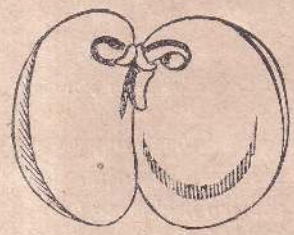
[Watch the development of the fruit in the Papaw and Bandakka. Examine the structure of the Bean. Notice that it corresponds to a leaf folded along the midrib with the margins brought together. The seeds (originally ovules or seed-buds) are always found along the seam formed by the leaf margins. Take a leaf of the plant known as Byophyllum, suspend it by a thread attached to a nail on the wall, keep it moist and notice how buds spring from the margins and grow up into plants.

[Note that the Mango belongs to the same class (stone fruits or drupes) as the Coconut and certain English fruits like the Plum and Cherry. In the Coconut the portion which in the Mango is succulent and edible is dry and fibrous. The edible portion in the Coconut lies inside the stone and consists of a store of nutriment (both solid and liquid) for the embryo or baby-plant.

[Examine the structure of other compound fruits beside the Pineapple, e. g., Jak, Breadfruit, Mulberry.]

THE SEED.

We now have some idea what a seed is. We know that it is formed from the ovule or seed-bud found in the ovary of the flower. What is really the difference between an ovule and a seed? Mainly this, that the seed contains a tiny plant called the embryo, while the ovule does not.



18. Seed of Bean. Showing Embryo and Swollen Cotyledons.

This tiny plant is formed in the ovule by the action of pollen on the ovary of the flower. As a result ovary and ovule become changed into fruit and seed.

A seed is made up of (1) a seed-coat inside which are (2) the embryo or baby-plant with very tiny stem and root, (3) one or two seed leaves or cotyledons, and (4) a store of food for the nourishment of the baby-plant. The seed may be compared to an egg which also has a covering shell, an embryo (which develops into the chick), and a store of food consisting of the yolk and white of the egg. The seed is the plant egg.

In some seeds the store of food lies outside the seed-leaf which is flattish as in Paddy; in others it is contained within the seed-leaves which are then swollen as in the Bean.

A large group of plants have only one seed-leaf (e.g., Paddy and Maize), and these plants have no tap-root and have leaves in which the veins are parallel. Another large group have two seed-leaves (as in the Bean and Orange) and they have a tap root and the veins form a net-work.

19. *Seed of Paddy showing single flat Cotyledon with store of food outside.*

When a seed is planted it goes through a process called germination similar to what is known as incubation or hatching in the eggs, i e., the embryo begins to grow, nourished of the store of food provided for its use and develops, in the one case into a plant, and in the other into a chick.

Seeds vary in size (large in the Coconut and small in Mustard), in colour (being white, red, black or mottled in Beans), smooth or hairy (as in Cotton), and so on.

The store of nutriment in edible seeds (cereal grains and pulses) is what makes them valuable as human food, just as it makes the egg an important article of diet. What is provided for the young plant by nature is taken by man for his own use.

[Soak some Bean seeds in warm water overnight, then examine them after carefully removing the seed coat, distinguishing the various parts of it. Plant a few Pumpkin seeds in a pot and watch their germination. Make a collection of seeds to illustrate differences in colour and other qualities. Classify seeds as producers of starch, oil, tan, dye and drugs.

[Notice that in the case of Paddy there is one seed-leaf which is flat and the store of food lies outside it, while in the Bean there are two fat seed-leaves and the store of food is packed within them. Compare the roots and leaves of Paddy and Bean.

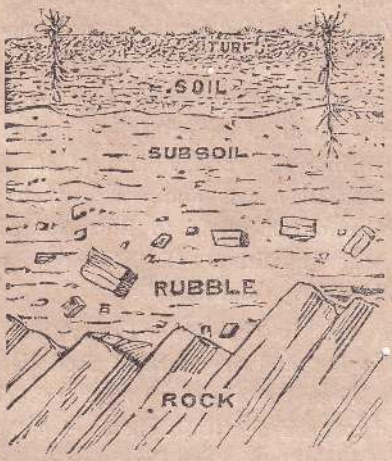
[Observe that in the Nutmeg there is an extra growth covering the seed, known as the Aril.

[Notice the different ways in which seeds are dispersed and the natural provision for dispersal.]

THE SOIL AND ITS TREATMENT.

Soils are formed from rocks by the action of various natural agents, such as air, rain, wind, flowing-water, the sea, heat and cold, and so on. This action has gone on in the past, and is going on today.

Sometimes a soil lies just above the rock from which it has been formed; but, as a rule, soils are found a great way off from the original rocks (having been carried away by wind, water, &c.), and are frequently of a very mixed character.



20. Section showing Soil and Subsoil.

The chief ingredients of a soil are sand, clay, lime and humus. Occasionally we find a soil consisting almost entirely of one of these ingredients; but, as a rule, soils are made up of mixtures of these. A mixture of nearly equal parts of sand and clay is called a loam: if the clay is present in larger portion, we call it a clay-loam, or if in smaller proportion, a sandy-loam.

Humus, which is decayed vegetable matter, is an important ingredient of soils, being generally present in less quantity than sand and clay which, as a rule, form

the bulk of a soil; while lime is present in still less quantity.

The food of the plant must consist of soluble compounds, so that the feeding roots may dissolve and take them in as solutions.

The main object of cultivation is to form soluble compounds for plant-food. This is done by keeping the soil in good condition by means of tillage, so that air and water may pass freely through it and help to prepare soluble plant-food.

In properly tilled soils, the growing crop does not depend for its moisture on the water that falls upon the land, but on the water that is stored below it, and which moves upwards to meet the demand of the feeding roots. To this end, the surface soil should be always kept stirred and loose. This tends to prevent the moisture in the soil reaching right up to the surface and passing away as vapour.

The plant-food which enters the roots in the form of solutions rises up to the leaves where it is, so to speak, prepared. The plant retains a part of the water it needs for its nutrition, and allows the rest to pass out as vapour through the leaves.

[Observe the action of flowing water in wearing away hard structures. Note the action of rain on cabook stones. Observe how water carries away soil from one place to another, especially after heavy rain. Show by washing and sifting, how soil is made up of different ingredients.

[Examine humus and lime. Humus is to be found in pits in which dried leaves have been buried for some

time. A piece of chalk consists of pure carbonate of lime. Burnt coral-lime is quicklime. When water is added it forms slaked lime.

[Pour water into a tumbler half full of sand and observe how it sinks, while water poured on clay does not sink. Notice how water at the bottom of a glass has a tendency to rise up through a porous soil. Observe how moisture is absorbed by a well-tilled bed in the garden, while it runs away from a bed with a hard surface. Notice how stirring the surface soil helps to prevent evaporation and keep the soil moist.]

THE RAISING OF PLANTS.

Plants can be raised in different ways. The commonest way is by means of seed, as in the case of Coconuts, Paddy, &c.

In raising plants from seed, the seed may be sown or planted direct in the place where it is to be grown, or first put in a nursery and afterwards transplanted. The advantage of a nursery is that the plants can receive special attention during their early life, so that they may be strong and healthy and make a good start when transplanted. Some plants, such as Beans, do not stand transplanting so well as others, such as Paddy, and for that reason are better sown direct.

Another way of raising plants is by cuttings, or sections of the branches. Many plants, such as the Grape-vine and Rose, are easily and conveniently raised in this way.

Another method is by suckers, as in the case of the Plantain, which does not usually produce seed but throws out shoots that arise as buds from the under-ground stem.

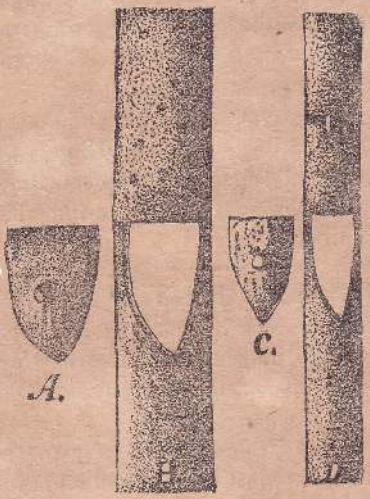
Still another way is by divisions of under-ground stems, as in the Potato, Ginger, &c.

Again, plants can be raised from bulbs, as in the case of Onions.

All these may be described as natural methods.

There are, besides, various artificial methods which come under the head of layering, grafting and budding.

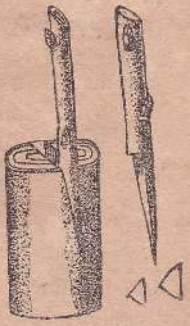
Crown Grafting.



Bud Grafting of Mango.
A. & C. Bud-bark.
B. & D. Stocks.

Inarching.

Saddle Grafting.



Cleft Grafting.

In the first case a branch (e.g., of a Rose) is pegged down to the earth after partially cutting it through so as to induce roots to spring from the injured part.

In "Gootee" layering instead of the branch being pegged down, earth or mould is applied round the wounded part of the branch and kept in place by a fibrous wrapping.

In grafting, a cutting is made to grow upon a seedling plant. In this way a graft taken from a good variety of Mango can be made to grow on a seedling of a common hardy variety.

In budding, a slice of the stem containing a strong bud is inserted under the bark of a seedling plant. In this way a bud from a good variety of Orange can be made to grow on a hardy sour Orange seedling.

[Carry out in practice the different methods of raising plants, by sowing seeds of Indian Corn, Beans, Cucumber, &c., by planting Coleus cuttings, suckers of the Plantain or Canna, divisions of Potato or Ginger; also by layering the Shoe-flower, Gootee-layering the Orange, grafting or budding the Rose.]

KEEPING UP THE FERTILITY OF LAND.

The soil may be looked upon as a bank in which fertility is the money in deposit. If we draw upon the fertility of the soil without making any new deposits, the soil will ultimately become exhausted.

Good cultivation is the first necessity for maintaining fertility, for, when well-tilled, the soil allows of the free circulation of air and water, and provides suitable conditions for the activity of the minute living organisms within it; so that soluble plant-food may be prepared from the insoluble matter in the soil by chemical means as well as by the action of soil organisms.

Another way in which we can help to keep up the fertility of soils is by means of rotations, that is, by cultivating crops of different growing and feeding habits in a regular succession.

Some plants take more of a particular ingredient of plant-food than others. Cereals need more of nitrogen, legumes more of lime, and so on.

Again, some plants are deep-rooted, others shallow-rooted; and by growing these in succession the same layers of soil will not be continuously drawn upon.

But in addition to tillage and rotations, it is always necessary to add a certain amount of manure to the soil—to make up for the exhaustion of one or more of the essential elements of plant-food.

Cattle manure and green-manure are frequently used to make up for lost fertility. They are called general manures because they supply all the ingredients taken up by plants; but there are a great many special manures, like bonedust and kainit, which supply particular ingredients that may become exhausted.

Green-manure may take the form of green stuff gathered outside the land and brought on to it, or of a crop raised on the land with the object of burying it in the soil.

Leguminous, or Bean-bearing, plants are considered *the best for green-manuring* purposes. These plants bear little nodules on their roots which enable them to derive valuable food from the air and, in decaying, add it to the soil.

[Observe the difference in plants growing on well-tilled and badly tilled soil.

[Examine the roots of plants and notice that some have *short roots (e.g., Maize or Indian Corn)*, while others have longer roots (e.g., Beans.)

[Observe the difference between the plants growing on a rich well-manured bed, and those on a poor soil.

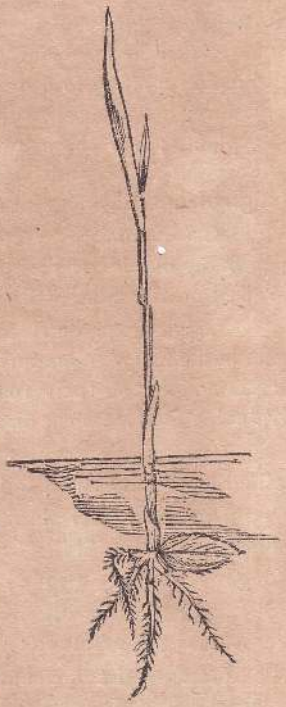
[Make a list of common leguminous or Bean-bearing plants. Examine the roots of a few and see if you can find nodules on them.]

PART II.

SOME COMMON PLANTS.

PADDY OR RICE.

When seed Paddy is sown on wet land it puts out green blades within a few days, and if one of the seedlings is pulled out it will be found that the seed still hangs on to the lower end of it. On examination, the seed-coats or husks will be found empty, for the young plant has used up the contents for forming its little root, stem and leaves. What has been used up is the nourishing material for the support of the young plant in the first stages of its growth. This material is the rice grain which we consume, and which nourishes us as it does the young plant. It consists chiefly of starch.



Paddy Plant.

In cultivating Paddy, if the seed is first sown in a nursery, and the seedlings planted out at regular distances apart (say 6 inches), they form more numerous and stronger roots, and give rise to a larger number of shoots or tillers, and this, of course, means more grain.

The stem of the Paddy plant (and all grasses) is hollow, and only the nodes or joints are solid. This structure is best

seen in the bamboo, which is the giant of the grass family.

The leaf of the Paddy plant is made up of an upper free portion or blade, and a lower sheathing structure, which clasps the stem and so helps to strengthen it, and also protects the tender leaf and flower-buds which spring from within.

The blade of the leaf is narrow, and waves like a flag in the wind, to which it offers little resistance. The markings on the blade, called veins, run in parallel lines from the base to the tip, and do not form a network as in the leaves of the Mango. If you look carefully you will find between the sheath and the blade a tiny structure called the ligule. This prevents rain water from entering the sheath and damaging the delicate structures within.

Paddy Flower.

The flower of the Paddy plant is made up of an outer series of tough structures known as glumes, which take the place of the calyx and corolla in ordinary flowers. The outer pair is small and the inner large. The larger one of the latter sometimes ends in a bristle called an awn. The glumes enclose the important parts of the flower, viz., 6 stamens and a pistil with two feathery styles.

Just within the glumes will be found the tiny fleshy bodies called lodicules. When these swell under the influence of the sun, they press apart and so

open the glumes and expose the stamens. Then the wind carries the dry pollen from the stamens on to the style of a neighbouring flower. After this, the lodicules and stamens wither away and the glumes close up and allow the fruit to ripen within, and in this way is the Paddy grain formed.

Rice is extensively cultivated in India, Japan, America and Italy. It supplies food to millions and is more largely consumed than any other cereal grain.

Under good cultivation it should never yield under 50 bushels of paddy, but the best paddy lands will produce nearly double this quantity.

[Examine the paddy grain, which is a fruit and not a seed. Remove the pericarp or husk, and find the seed which is the rice grain. Sow a few grains of paddy on damp cloth or blotting paper and watch their germination.

[Sow some seed thickly in a pot. When the seedlings are well up, transplant 3 or 4 into another pot, placing them as far apart as possible. Notice that the transplanted seedlings grow up much stronger than those sown thick and left in the original pot.

[Examine the flower, and notice the different parts referred to in the lesson. Make sections to show the hollow stem and solid nodes. Observe the structure and mode of attachment of the leaves.]

MAIZE OR INDIAN CORN.

Maize, or, as it is sometimes called, Indian Corn, is like rice, a member of the grass family. It is very much

cultivated in America where it is usually spoken of as "corn," and in South Africa where it is known as "mealies."

Maize Plant.

The peculiarity about the Maize plant is that it bears two kinds of flowers, the first with stamens only (found at the top of the plant), and the second with pistils only, and closely packed on a cob which is borne lower down. Only the flowers with pistils form seed, which is later on found arranged in dense rows upon the central

pithy column, and covered by wrappings called the "husks" of the cob.

In Ceylon, Maize is carelessly cultivated, generally as a mixed crop with Kurakkan and other grains on chena lands. It is best planted by itself in rows about 3 feet by 3 feet, the ground kept weeded and frequently tilled, and the plants earthed up occasionally.

When the seeds have set, the tops of the plants may be cut, and as the seeds mature the leaves may be stripped off. Both tops and leaves are good fodder for stock.

The great thing about Maize is its quick growth. The grain can be harvested within three months of sowing, and in suitable localities 2 or 3 crops may be taken off the same land in one year. The plant also stands drought well.

On good land the yield will vary from 50 to 80 bushels per acre.

The corn is converted into flour which is very digestible and forms a suitable diet for children and invalids. The green cobs are also eaten boiled.

Closely allied to Maize are the Sorghums, which are largely grown in India and parts of Africa under the names Jowar, Dhurra, Kaffir Corn, &c.

[Observe the succulent stem of the Maize plant, and notice the mode of attachment of the leaves.

[Examine the two kinds of flowers; (1) those with stamens only borne at the top of the plant; and (2) those with pistils only, closely arranged on a pithy column, which

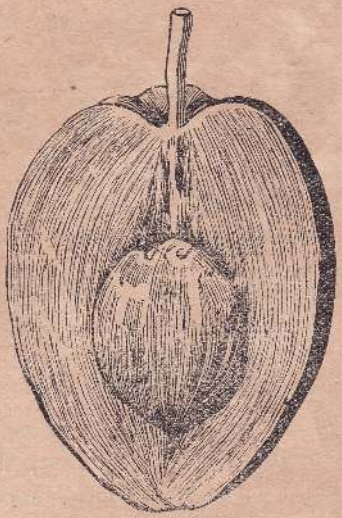
springs between the leaf and the stem, and is enclosed in wrappings called husks.

[Examine the roots and notice that the plant is shallow-rooted.

[Sow seeds of Maize and watch their germination.]

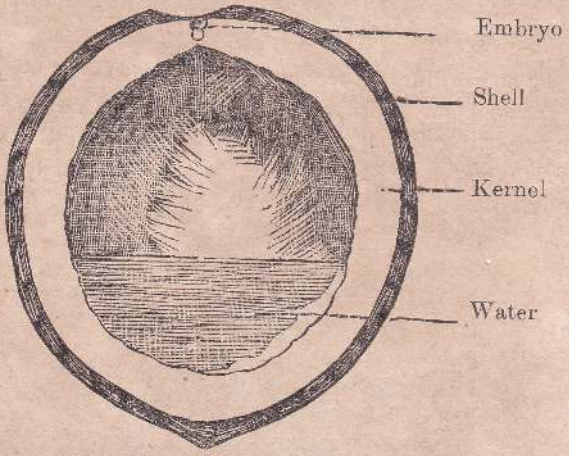
USEFUL PALMS.

Palms are different from other trees, in that they have unbranched stems which, once they are formed, do not add to their girth. Rarely, we come across palms that are branched, e.g., the Doum-palm, and occasionally the Coconut.



Section through Coconut to show Husk and Stone.

The most valuable of all palms is, without doubt, the Coconut, so extensively cultivated for its fruit. The flesh or kernel which gives us oil is the most valuable part of the palm. To obtain oil, the kernel has to be dried in the sun, or over a fire, till the greater part of the moisture is expelled. In this dry condition it is known as "copra." The refuse after the expression of the oil from copra is coconut-cake or "poonac."



Section through husked Coconut.

At one time coconut oil was much used for lighting, and later, in the manufacture of soap and candles: but more recently it has been converted into edible products. Poonac is a valuable cattle food.

The kernel of the mature nut, when cut up fine in the fresh condition and dried by artificial heat, yields the product known as desiccated-coconut, which is used in biscuit-making and confectionery.

The fibre of the husk, known as coir, is employed for making yarn, rope, etc.

The shell, which is close in texture and very hard, makes excellent fuel. The stem yields a good building timber, and from the undeveloped flower spathe is extracted the liquid known as toddy, which in the unfermented state is converted by boiling into crude sugar (jaggery), or, after fermentation, made into the spirit called arrack. The plaited dry leaves are used as a thatch for village houses. So that it may be said that there is no part of this useful tree that really goes to waste.

The Palmyrah palm, though not so valuable as the Coconut, is of great utility to the people who live in dry regions. The timber is very durable, while the fibre, which is found as a network about the leaf-stalks, is used for brush-making, etc. Crude sugar and spirits are obtained from the flower, and from the leaves baskets, mats, fans and various articles for domestic use are manufactured.

The Kitul palm is chiefly valued as a source of jaggery.

The Arecanut palm is valued for its nut, which yields catechu.

The Cane palm is a prickly climber, the long pliable stem of which is split and used in the manufacture of many useful articles, e.g., chairs, baskets, etc.

[Examine the structure of the coconut, and note that it is one of the stone fruits like the Mango. The watery fluid is wrongly called "milk," which is obtained by squeezing the scraped kernel.

[Notice that there are three eyes in the nut, but usually only one hollow chamber. How many chambers are there in the Palmyrah?

[Observe that there are two kinds of flowers in the Coconut—one with stamens only and the other with pistils only. All the flowers found on the branching flower-stalk are enclosed in a large spathe.

[Watch the germination of a coconut.]

CACAO.

The tree from which we get cacao and chocolate is a native of tropical America. It is of moderate size and bears large leaves and tiny flowers. The fruits chiefly occur on the main stem.

These fruits, wrongly called pods, hang on short stalks and are prettily coloured when ripe, being generally red or orange in colour.

The Cacao tree requires a rich soil, good rainfall and a sheltered situation. Hence it is that we find it flourishing only in restricted areas. The tree needs shade, especially during the earlier stages of growth, and begins to bear fruit in about 5 years.

In removing the pods care should be taken not to injure the flowers and small fruit that spring close to them. After the pods are collected in one spot they are cut open and the seeds (about thirty in each pod) taken out. These are first allowed to ferment by putting them in a heap. Fermentation brings about certain changes, as the result of which the seeds turn darker in colour and develop the special flavour which belongs to cacao.

After fermenting, the seeds are washed and slowly dried till they become crisp, when they are ready to be shipped as cacao beans.

To make cacao, the beans are roasted and then ground, after which the fat or oil, called cacao-butter, is partially removed by means of a press, and a dry powder with a small proportion of oil left.

For chocolate the cacao-butter is not extracted, and in the process of grinding, sugar and flavouring agents such as cinnamon and vanilla are added.

Cacao is a very nourishing substance.

Cacao Branch, with Fruit and Flower.

[Procure a specimen of the cacao fruit and examine it. Observe the thick outer shell, and the seeds inside covered with a slimy white substance. This substance on fermenting produces vinegar.

[The teacher should explain the nature of fermentation which is due to the action of ferments or minute vegetable organisms which bring about chemical changes. He should refer to fermentation in toddy, tobacco and other substances.

[Watch the germination of cacao seed.]

TOBACCO.

The Tobacco plant is also a native of Tropical America.

The best Tobacco is produced in Manila, Cuba, Havana, Sumatra and Java, and some of the American States.

The seeds are very tiny and about a teaspoonful will suffice to plant an acre. It is very important to select the seed from the best plants, so that the quality of the crop may be maintained if not improved. In order to do this the flowers should be enclosed in paper bags, so that they may not be cross-fertilised by the pollen from inferior plants. Nurseries must be well prepared, as the seed is so small, and transplanting done very carefully. The seedlings are planted 2 or 3 ft. apart.

Tobacco requires good soil of medium texture, and when the plants are growing the land should be kept clean weeded, the soil stirred and drawn up towards the plants so as to strengthen them. The crop is ready in 6 or 7 months.

The preparation of Tobacco depends on proper fermenting. After the leaves are air-dried they are put into heaps so as to get heated. The heat must be carefully controlled

Tobacco Plant.

and not allowed to rise too high or go too low, so that a leaf of good quality, colour and flavour may result. The fermenting of Tobacco is quite an art, which cannot be acquired by reading, but must be learnt by practical experience. For different purposes the leaves have to be treated in different ways so as to produce a strong or mild Tobacco.

The varieties of Tobacco are many, some being suitable for cigar-making, others for manufacturing cigarettes and pipe-tobacco, and others again for chewing purposes.

The most expensive is the wrapper leaf for the best cigars. These are very fine and silky in texture.

[Examine the flower of Tobacco and notice the resemblance in structure to the flower of the Chili and Brinjal which belong to the same family. The leaf is inclined to be thick and sticky. Merely drying the leaves does not give us tobacco. Fermentation brings out strength, flavour and aroma. Demonstrate this.]

RUBBER.

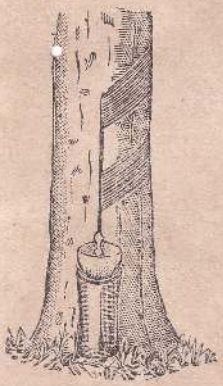
Rubber is obtained from the milky sap or latex of certain trees, of which the best-known are the Hevea, the Castilloa, the Ceara and the Assam rubber trees.

For a long time rubber was a wild product, that is, the supply was procured from trees growing in a wild condition. Even at the present day there is a good deal of wild rubber coming into the market, chiefly from South America and Africa.

Rubber trees are now widely cultivated, and the one grown most extensively is the Hevea, or Para so called from its home in South America.

The tree is propagated by seed which is usually raised in a nursery before planting out.

In about 6 or 7 years the tree is generally fit for tapping, that is, the bark is ready to be cut and the latex collected. Various tools, or rubber knives, are used for this purpose, and the bark is tapped in different ways, but the principles of tapping are the same, viz. (1) to cut only into the cortex of the stem, which is the rubber-bearing region, and avoid injuring the living tissue, or cambium layer, which lies deeper down; (2) to work along one section (a third or a quarter) of the surface at a time, and allow a sufficient interval for the bark to heal and produce new tissue to be again tapped.



Para Rubber.

The latex is caught up in cups placed at the foot of the tree, and the contents of these are collected and conveyed to the factory in buckets. At the factory the latex is treated with a coagulating medium (usually acetic acid), which separates out the rubber.

Finally the rubber is subjected to pressure to expel moisture, and also to smoke in order to dry and preserve it.

The uses of rubber are numerous, and the demand for it for manufacturing purposes is very large.

A great industry has been established in the Eastern Tropics where extensive plantations and factories,

worked under skilled supervision, are turning out rubber of the best quality.

[Observe the flow of "milk," which takes place on cutting the bark of Para or any other latex-yielding tree, and watch the process of coagulation.

[Make a list of trees that yield a milky fluid. Examine a piece of rubber and notice its elastic character.

[How came rubber to be so called?

[The teacher should explain the various uses to which rubber is put.

[Examine the fruit and notice the oily nature of the seed. Notice how the ripe fruit explodes.]

THE BREADFRUIT AND JAK.

The Breadfruit and Jak belong to the same family. When the bark is injured or a twig is broken, a white sticky fluid, resembling rubber latex, pours out.

The Breadfruit is roundish in shape and has a coarse rind. We do not wait till the fruit is ripe to use it, but pluck it when it is nearing maturity. It is cooked like the potato and eaten boiled, fried or curried.

Breadfruit.

The leaves are large and segmented. The flowers, which are very small, are packed close together on a fleshy stalk forming what is known as a catkin, the male flowers on a long stalk and the female flowers on a roundish stalk. With each catkin is associated a leathery bract which falls away as the fruit develops.

The Jak is a bigger tree than the Breadfruit, and though the leaves are smaller the fruit reaches a great size.

Unlike the Breadfruit the Jak can be eaten when ripe, and is relished by some people in spite of its strong odour

and flavour. In the unripe condition it is cooked much in the same way as the Breadfruit.

Both the Breadfruit and Jak, especially the Jak, are common trees in the tropics, and, when grain crops fail for want of rain or other cause, the people look to the fruit as their chief means of sustenance.

The wood of the Breadfruit is of little value, but that of the Jak is much used for house-building and furniture. Jak wood also yields a yellow colouring matter.

The Jak is a native of South India and Malaya and has become almost naturalised in the Island. It is propagated by seed, and is suited to moist and semi-dry districts.

The Breadfruit is a native of the Pacific Islands. The common variety does not produce seed and has therefore to be propagated by suckers from the roots, or by "Gootee" layering.

[Observe that the Jak bears fruit on a main stem and branches, while Breadfruits are generally found on the smaller branches. Notice the difference in the shape of the leaves and the inflorescence. Are the fruits of these trees simple or compound? Notice the bracts associated with both. Cut sections of old roots of the Breadfruit, and try to raise plants from them.]

CASSAVA OR MANIOC.

Cassava or Manioc is now very extensively cultivated for food, though not very long ago people looked upon it with suspicion as a poisonous plant.

Cassava is raised from cuttings which soon grow up into bushes. The plant bears large divided leaves, the segments of which spread out like fingers. The crop is ready in from 8 to 12 months and the yield varies on good land from 8 to 10 tons per acre.

Cassava or Manioc.

Cassava is distinguished as bitter or sweet. The bitter variety does not become soft when boiled, but the sweet kind boils soft, except for the hard core in the centre which must be rejected.

Both varieties contain a certain amount of the poison known as Prussic acid, but the bitter variety is the more

poisonous. Fortunately the poison is easily got rid of by heat, and it is therefore necessary to boil the tubers *thoroughly* before consuming them.

The common form in which the tubers are eaten is after boiling, but they are sometimes sliced and dried for the market. This dry cassava can be pounded, as required, for making flour.

The tubers contain a large proportion of starch, and it is usual to grate them and then subject them to pressure to get rid of the juice. What is left behind is cassava-meal.

The meal is dried by heat in large flat pans to get rid of any juice left behind, and in this form can be made into cakes.

Starch is also prepared from the meal, and this is made into tapioca by heating it on hot plates till the grains swell and burst.

The juice is used for making sauce by boiling it till it thickens into the consistency of treacle.

The manufacture of meal and starch from cassava is carried on extensively in America.

[Study the characters of the plant, foliage and flowers, milky nature, formation of tuberous roots, &c.

[Prepare some starch by grating and washing.

[Try and distinguish the different varieties.]

YAMS AND TANIAS.

The term Yam is used in Ceylon to include both the true Yams or Dioscoreas as well as the tubers of Colocasias and allied plants, which are generally distinguished in the

A Yam.

West Indies and other places as Tanias, Cocoes, Eddoes and Taro.

The plants which produce the true Yams are of a twining habit (twining from right to left instead of as usual from left to right), and extensively cultivated for their tubers which are much esteemed as food.

Yams are propagated by sets or divisions of the tubers, each section containing one or more dormant buds or "eyes" similar to those found in the potato, for, like the potato, the Yam is a swollen under-ground stem and not a swollen root.

The sets are planted two or three feet apart each way and in from 9 to 12 months' time (according to variety) they yield a crop of about 4 or 5 tons.

There are many varieties of yams.

The plants which yield "Tanias" are characterised by large heart-shaped leaves. They are propagated by means of buds which spring up on the sides of the large tubers or heads.

The tubers are ready in from 5 to 10 months.

Section through a Yam.

In the West Indies Yams form the chief article of diet with

the masses, the best varieties (such as the Cush-cush) being even preferred to potatoes.

Yams thrive up to an elevation of 2,500 or 3,000 feet. The tubers may be kept stored in a dry condition under sand for a considerable period.

Tanias are among the oldest cultivated crops of the world. They do best in moist lands containing much organic matter, and thrive up to an elevation of 3,000 feet, and also do well under irrigation in a dry climate.

Tania.

[Note that the Yam is a stem-tuber as distinct from Cassava which is a root-tuber. Trace the eyes or buds. Make divisions of a tuber, plant in damp earth and watch

the development of new plants. Examine the structure of a Yam and Tania, and note the difference. Observe the way in which the Yam twines. Compare this with the method of twining in the Bean.]

THE PLANTAIN.

The Plantain is both a fruit and a vegetable, that is to say, some kinds are eaten as ripe fruit while others are only useful for cooking as a vegetable. The fruit Plantain is generally spoken of as the Banana.

The Plantain Tree.

There are many varieties of Plantain, differing in size, shape and flavour. Many of them are fine table fruit.

The Ash Plantain is reckoned the best vegetable variety.

The Red Plantain is chiefly used for stewing.

Besides being employed in the fresh condition and cooked as a vegetable, the Plantain is also sliced and dried and made into flour, which is highly recommended as an invalid food.

Ripe fruits of the glutinous varieties can be successfully dried like figs.

The plant is propagated by means of suckers or side-shoots that spring up from the parent plant. Suckers about 2 feet high are generally planted 15 by 15 feet or 18 by 18 feet apart according to soil. The first crop may be expected in a year's time.

Too many suckers should not be allowed to spring out of each tree. If left alone a large number will grow up, but two or three only should be encouraged to do so, and that when the mother plant nears its fruiting period.

Fibre of the best quality is extracted from particular species, but a less valuable quality is obtainable from varieties grown for fruit.

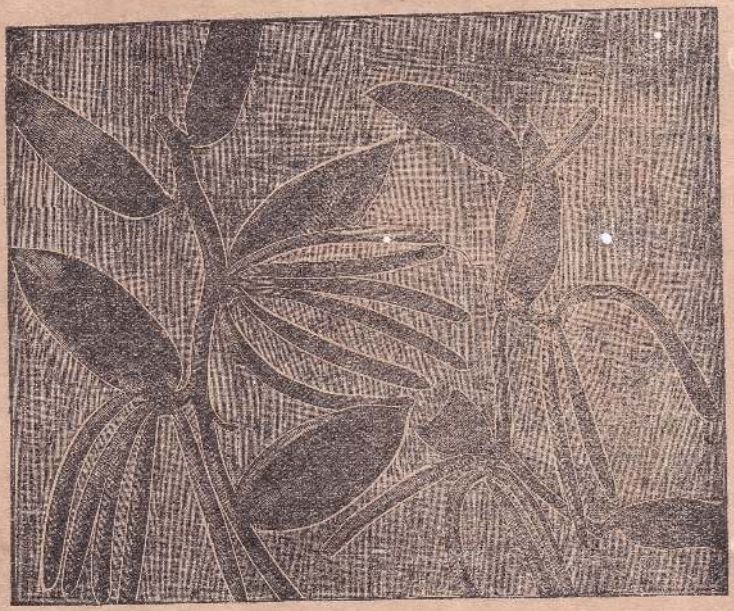
The Plantain is reckoned an exhausting crop, and when grown as a catch crop on new clearings, this fact should be borne in mind, particularly on land which is not specially rich, and manure added to the soil to make up for reduction of fertility.

[Make a section of the stem and notice the cellular tissue of which it is composed. Examine the Plantain flower, notice the fleshy bracts. Study the structure of an individual flower. Compare it with flowers of plants belonging to the same order, e.g., Canna, Ginger. Note the absence of seed in cultivated varieties and its occurrence in wild forms. Observe the development of suckers. Make a list of local varieties. Prepare a sample of Plantain fibre and flour.]

VANILLA.

Vanilla is a climbing orchid which grows wild in the forests of South America. The plant is raised from cuttings and trained upon either live or dead supports.

The leaves are thick and succulent, and the stem sends out peculiar flat fleshy roots which enable the plant to attach itself to the support upon which it grows.



Vanilla.

The flower is so constructed that there is no means of self-fertilisation, that is, the pollen of the flower cannot reach the stigma. Under natural conditions fertilisation is effected by insects or birds, but these cannot be depended upon in a plantation, so it is necessary to fertilise by hand. This is done in a few seconds by children who lift the hood which covers the pollen-mass with a small pointed stick, and then gently apply the pollen-mass to the stigma by pressure of the thumb.

If fertilisation has been properly done, the flower gradually withers and a long thin pod begins to develop ;

if the pressure has been too hard, the flower drops off and there will be no pod.

Though the flowers generally bloom in clusters of from 10 to 20, not more than half a dozen of these should be fertilised if good long pods are required.

In 8 or 9 months, when the pods begin to grow yellow at the tips they should be gathered, and subjected to a process of curing. This consists of plunging them into hot water for half a minute, piling them in a heap to drain away the moisture and then spreading out on blankets laid over racks in the sun. Every evening, and also when it rains, they must be taken in.

When the pods have turned dark brown the curing is finished within doors.

A substance called vanillin, which is the flavouring element in Vanilla, has been produced artificially from clove oil, and this, together with overproduction of the natural article, has made cultivation less profitable.

[Observe the fleshy character of the leaf and the flat succulent roots, characteristic of orchids, which enable the plant to cling on to its host. Compare Vanilla with other orchids.

[If a Vanilla flower is not available, the teacher should explain by means of a diagram the structure of the flower and how fertilisation is effected.

[Note that fermentation is necessary for developing the flavour and odour which give Vanilla beans their value.]

COTTON.

Cotton is closely related to many familiar plants, e.g., the Shoe-flower and Bandakka.

Branch of Cotton showing Flower and Boll.

The chief Cotton-producing countries are India, Egypt, America and the West Indies.

The finest Cotton, as regards length of fibre and fine texture, is that known as Sea Island, which thrives best in the West Indies; but the yield is not high and the plant requires very careful cultivation.

The American long-staple and the Egyptian Cottons come next in value and are followed by Indian Cotton, which has a short staple. The white fluffy part, when it is separated from the seed, is known as *lint*, and this is the valuable product of the plant, because from it all Cotton cloth is made. (Linen is made from the Flax plant.)

From Cotton seed is expressed an oil, which, after special treatment, is largely employed for cooking purposes, instead of Olive oil.

What is left after the oil has been pressed out is called Cotton-cake or poonac, a valuable cattle food.

Cotton does not like much rain, and is best suited to dry localities. It is most important that no rain should fall at the time the crop is maturing, that is about 4 months after planting.

Cleanliness is an important item in the gathered crop, which should be free from dirt and other impurities.

Spinning Cotton has to be distinguished from what is generally spoken of as "stuffing Cotton," the product of the Kapok or Silk Cotton tree.

[Compare the flower of Cotton and Shoe-flower. Examine different types of Cotton; note that some have long fibres, others short; some have free lint, in others the lint is attached to the seed; some have seeds separate from one another, others have their seeds attached together; some have silky fibre, others woolly fibre. Compare Cotton and Kapok. Watch the germination of Cotton seed.]

SPICES.

The most important spices cultivated for the market are Cinnamon, Nutmeg, Cloves, Cardamoms and Pepper.

Cinnamon.

Cinnamon is the prepared bark of the Cinnamon tree, which at the proper season, when wet weather prevails, is "peeled" or barked.

The bark, after being taken out, is scraped smooth and fitted into "quills," in which form we find it in the market.

An oil is prepared from both the bark and the leaves, the bark oil being by far the more valuable product.

Nutmegs are the produce of a handsome tree with dark green foliage, which bears round, pale yellow fruits. These fruits split open when ripe and expose the black-shelled seed with a bright crimson overgrowth called an

Nutmeg.

Aril. This red aril when dried turns brown and is known as Mace.

Clove Flowers and Bud.

Cloves are the dried flower-buds of the Clove tree. The buds are picked when they are pink and become dark brown when dry.

Cardamoms are the fruits of a plant allied to the Plantain and grows in the form

of a bush From the base of the bush, near the roots, long trailing flower-stalks arise, and ultimately bear the capsular fruits which, after careful drying and bleaching, become the Cardamoms of commerce.

Pepper is the fruit of a vine with leaves like those of the Betel-vine, to which it is very closely related. Black pepper consists of the berries dried in their skins. White pepper is prepared by removing the skin either by fermentation or by the action of slaked-lime.

Pepper-vine.

Pepper-vines are grown on dead or living supports, and should not be allowed to attain to any height owing to the difficulty of gathering the crop. The bunches of fruit are collected when they begin to turn red.

Cayenne Pepper is the product of a variety of Chillies with a hot flavour and is not true Pepper.

[Examine specimens of Cinnamon, Nutmeg, Mace, Cloves, Cardamoms and Pepper. The teacher should tell the children how famous Ceylon was for its spices: hence "The Spicy Isle:" also that cinnamon was at one time a Government monopoly.

[The children should know the origin and character of each product, and the uses to which it is put.]

DYE- AND TAN-PRODUCING PLANTS.

At one time all dyes were of vegetable origin, and plants yielding colouring matter were much valued and cultivated for their pigments.

Later on it was discovered that it was possible to obtain colouring matter of various kinds from coal-tar.

Anatto Flowers and Fruit.

The result of this discovery was that cheap artificial dyes came to take the place of vegetable dyes, which consequently became less valuable than before.

Indigo was at one time very extensively grown in Bengal as a source of the blue dye so much used in washing, etc., but its cultivation became restricted when "Synthetic Indigo" was discovered.

Anatto is another dye-plant which is now very little cultivated. The colouring matter is found as a reddish paste adhering to the seed. The dye is soluble in olive oil, and is used to colour butter and cheese yellow.

Brown and yellow dyes are also produced by Turmeric, Jak roots, &c.

Sapan is a thorny tree, in the heart-wood of which is found a red pigment. The tree is frequently met with as a fence plant which, from its spinous nature, serves to keep out cattle.

Orchella Weed is a lichen which yields blue litmus. It occurs only in the wild state.

There are many other uncultivated dye-plants, e.g., Welikaha, Chaya, &c.

Tannin or Tannic Acid is an important agent in the preparation of leather. The bark of certain species of Acacia, known as Wattle, are rich in this substance. There are other wild products which are sources of Tannin, such as the fruits of Aralu and Bulu (known as Myrobolans), the bark of Kadol, Ranawara, &c.

[Make a collection of dyeing and tanning agents. Examine the fruit of Anatto, and notice the red paste on the seed. Make a solution in oil and note the colour.

Extract the dye from Orchella and notice how it changes colour when an acid is added. Look for the red heart-wood in Sapan and prepare an infusion from it.]

OTHER FIBRE-PRODUCING PLANTS.

Reference has already been made to Coconut and Palmyrah, Cotton, Kapok and Flax as fibre producers.

Hemp is obtained from a plant which is also the source of a narcotic drug known as Bhang.

The fibre of Jute cultivated in India is used for the manufacture of sacking, rope, &c.

Sunn-hemp produces a white silky fibre used for making fishing nets.

Jute and Sunn-hemp are obtained from the bark.

Manila Hemp is the product of a species of Plantain and is prepared from the stem.

Among leaf-fibres the most important is Sisal.

Besides these there are other leaf-fibres, such as Mauritius Hemp, Bowstring Hemp, Pine-apple fibre, and the American and African Aloes.

In the tropics there are a large number of uncultivated trees which produce fibre, such as Belipatta.

Kapok Pod.

Lace Bark is obtained from the stem of a West Indian tree, and Bark-cloth is the entire fibrous bark beaten out of the stem of a tropical tree called Riti, and used by certain wild tribes for clothing.

The Warâ tree yields a silky floss which is found within the fruit and also a stem-fibre as well.

It will thus be seen that Fibre may be produced by the husk of a fruit as in the Coconut, by the entire stem as in the Plantain, by the bark only as in Jute, by the fruit-pod as in Cotton, or by the leaf as in Bowstring Hemp.

[Make a list of the different kinds of fibre, and, if possible, collect sampes of each kind. Classify them according to their uses for weaving cloth, for stuffing, for brooms and brushes, for mat-making, basket-weaving, rope, &c.

[Explain how coir is prepared from the husk of the Coconut.

[Get the children to beat out the fibre from a leaf of American or African Aloe or Bowstring Hemp, and wash it clean.

[Examine the fruit of the Warâ and observe how the silky floss helps in the dispersal of the seed.]

OIL-PRODUCING PLANTS.

Vegetable oils may be distinguished as fixed oils and essential oils.

Fixed oils are heavy and greasy.

Essential oils are light and possess a strong odour which is generally pleasant.

Coconut oil is a fixed oil, and the Coconut palm is, without doubt, the most important cultivated oil-producing plant.

There is another palm, called the African Oil Palm which is also a valuable oil-producer, but it is not cultivated to the same extent as the Coconut.

Sesamum or Gingelly is extensively grown in India. The oil as well as the seed is edible, while the refuse cake is an excellent food for milking cows.

Castor is another plant much cultivated in India. The oil is used medicinally as well as for lubricating and other purposes, while the cake or poonac is a valuable manure.

Castor-oil Fruit and Seeds.

Mustard, Rape, Ground-nut and Niger seed are also cultivated for the oil they produce.

Of uncultivated plants there are quite a number which are oil-producers, such as Kokuna, Mee, &c. The seeds of these, where they occur, are collected, and the oil extracted for home use.

The seed of the Margosa or Nim tree, which is hardly cultivated, produces an evil-smelling antiseptic oil, much valued as a cattle medicine.

The principal cultivated plants that yield essential oils are Cinnamon and Citronella, Lemon and Geranium grasses.

Cinnamon oil is distilled from the bark and leaf. Citronella, Lemon and Geranium oils are obtained from the leaves of fragrant grasses. A scented oil is also distilled from the roots of the Cus-Cus grass.

Essential oils are obtained from the Nutmeg, Clove and Cardamoms, and by the distillation of scented flowers for the production of perfumes, such as the Rose.

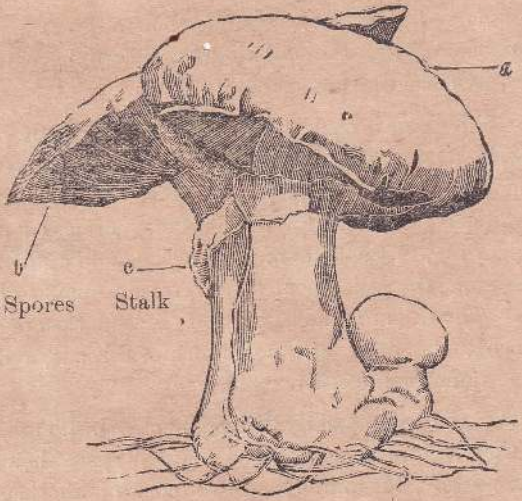
[Note the difference between a heavy fixed oil, such as coconut oil, and a light essential oil like Citronella. Notice the strong odour of essential oils.

[Examine the flower of the cultivated or wild Gingelly. Distinguish between Cinnamon bark and Cinnamon leaf oil, Citronella and Lemon grass oil.

[The teacher should explain the different methods of extracting Coconut oil; also the distillation of Citronella grass oil).

THE MUSHROOM AND ALLIED PLANTS.

The Mushroom belongs to a very low order of plants that do not obtain their food, as ordinary green plants do, from the soil and the air. These derive their nourishment from decaying organic matter in the soil or the dead bark of trees.



Mushroom.

The plant itself consists of a network of threads, which may be found, if looked for in the material on which it grows and feeds. It is only when the plant reaches the seeding stage that it forms the curious umbrella-like structure which is so familiar to us.

The Mushroom is propagated by means of spores, which are very tiny bodies corresponding to seeds. These spores are able to produce new plants, which, as already

explained, grow as threads in the interior of dead wood, manure, leaf-mould or other decaying matter.

The spores are so small that they can only be seen with the aid of a magnifying glass. In the common Mushroom they lie hidden away within the layers or plates found on the under-surface of the fruit-like head.

Some Mushrooms are edible, but a great many are poisonous. Even the edible sorts should be eaten only when perfectly fresh and sound.

Edible Mushrooms are cultivated in specially prepared beds in damp, dark situations; the beds being mainly composed of horse-manure. In this way large crops of Mushrooms are raised for the market. Prepared material for planting, in the form of dry blocks made up of manure containing the Mushroom spores, can be bought of Seedsmen. The beds in which pieces of these blocks are planted soon become filled with a network of threads, and these in due time produce their "fruit."

To the same family belong a class of plants, which, like the Mushroom, do not derive and prepare their food in the usual way, but unlike the Mushroom obtain their nutriment from *living* trees and not from decaying matter. These are the true parasites which, like certain animal parasites, such as bugs and ticks, live and feed on other living bodies. Plants attacked by these parasites become sickly, and eventually die, unless taken in hand and treated in time.

The cultivation of Coffee in Ceylon, so extensively carried on at one time, had to be abandoned owing to a leaf-disease caused by a parasitic fungus. The canker diseases of Cacao and Rubber and Coconuts are also caused by parasitic fungi.

[Find a common Mushroom, and examine it carefully, noting the under-side of the fruiting head where the spores are. Look for the fine threads to be found in the substance from which the Mushroom head grows out.

[Mould or mildew found on damp books and shoes is caused by a similar organism.

[The teacher should explain how easily plant diseases, caused by parasitic fungi, are carried by means of spores, and the importance of growing plants under sanitary conditions.]

INSECT-EATING PLANTS.

We know that the natural food of plants is obtained from the soil and the air, but there are some plants which are able to derive their nourishment by feeding upon insects. To do this they are provided with special means of catching their prey and digesting them.

There is a familiar plant, frequently met with in marshy lands, called the Pitcher Plant. To all appearances it grows like any ordinary plant, with its roots fixed in the soil, and bearing green leaves. This indicates that it is able to obtain its food in the ordinary way, but a closer examination will show that there are special arrangements by which this plant can also capture insects and feed upon their dead bodies.

Hanging at the extremities of the leaves are peculiar hollow bodies which look like pitchers, or vessels for hold-

ing water. These pitchers are provided with lids which are sometimes sealed down, and at other times stand open. The fluid inside them is not rain water or dew that finds its way there from outside, but has entered the pitcher through the body of the plant itself. If a small pitcher is examined before the lid is open, it will be found to contain more

fluid than when the lid is open. This goes to show that the fluid has not been derived from outside.

When the lid of the pitcher has remained open for some time, you will find dead bodies of small insects generally inside it. How have these insects come here? Some people think that the pitcher is a sort of trap, and that when insects enter it the lid shuts down and confines them in: but this is not the case.

Round the edge of the entrance to the pitcher is a smooth collar-like ring with a smooth slippery surface, and insects in search of food fall over this slippery edge and become drowned in the fluid at the bottom. If they attempt to get out by climbing up the inside surface, they find that they are hindered by minute hairs which are directed downwards and so impede their progress.

Dissolved in the fluid in the pitcher are certain juices produced by the plant, and these juices act upon the bodies of the insects in the same way that the digestive fluids in our stomachs act upon the animal food we eat.

Children sometimes drink the liquid found in plant-pitchers thinking it is pure water; but this is not the case, and indeed the liquid is not fit for drinking. There are other insect-eating plants like the Pitcher Plant, but the arrangement for capturing insects is not the same in all. The tiny plant known as Drosera or Sundew, also found in damp situations, bears roundish leaves which have rather stiff reddish hairs arranged round a depression in the centre. When insects alight on the leaves these hairs bend inward and capture them.

[Grow Pitcher and Drosera plants in boxes or pots for the purpose of watching how they capture their prey.

Examine the pitcher carefully and find the ring round the entrance. Observe that it is slippery. Look for hairs inside. The teacher should explain how insects generally enter hollow bodies in search of food. Examine the insects found.

[Procure a specimen of the plant called the Bladderwort found in shallow streams and find outwhat you can about it.]

ALPHABETICAL GLOSSARY OF PLANTS MENTIONED IN THE TEXT.

A.

African Aloe.—*Yucca gloriosa.*
African Oil Palm.—*Elæis guineensis.*
Allamanda.—*A. Cathartica*, S. Wal-ruk-attana.
American Aloe.—*Agave Americana.*
Anatto.—*Bixa Orellana*, S. Rata-kaha.
Antigonon.—*A. leptopus.*
Aralu.—*Terminalia Chebula*, T. Kadukkai.
Arecanut.—*Areca Catechu*, S. Puwak, T. Pâkka.
Arrowroot.—*Maranta arundinacea*, S. Hulankiriya.
Arum Lily.—*Richardia æthiopica.*
Assam Rubber—(Rambong) *Ficus elastica.*

B.

Bamboo.—*Bambusa vulgaris*, S. Una.
Bandakka.—(Ladies' Finger)—*Hibiscus esculentus.*
Banyan.—*Ficus bengalensis.* S. Maha nuga, T. Al.
Bark-cloth Tree.—*Antiaris innoxia.* S. Riti, T. Netavil.
Belipatta.—*Hibiscus tiliaceus.*
Betel.—*Piper Betle*, S. Bulat, T. Vethilai.
Bignonia —*B. Unguis-cati.*
Bitter Gourd.—*Momordica charantia*, S. Karivila, T. Pavakka.
Bladderwort.—*Utricularia reticulata*, S. Nil-monaressa.
Bombax.—*B. malabaricum*, S. Katuimbul, T. Patuttai.
Bougainvillea.—*B. spectabilis.*
Breadfruit.—*Artocarpus incisa*, S. Ratadel, T. Eera-pilakkai.
Bryophyllum.—*B. calycinum*, S. Akkapana.
Bulu.—*Terminalia Belerica*, T. Tandi.

C.

Cacao.—*Theobroma cacao.*
Cactus.—*Opuntia sp.*, S. Katupathok.
Candlenut.—*Aleurites triloba*, S. Tel-kekuna.
Cardamom.—*Elettaria Cardamomum*, S. Ensâl.
Cashew-nut —*Anacardium occidentale*, S. Kaju.
Cassava.—*Manihot utilissima*, S. Mannokka.
Castilloa Rubber.—*C. elastica.*
Castor-oil.—*Ricinus communis*, S. Endaru, T. Sitta manaku.
Casuarina.—*C. Equisitifolia*, S. Kasa, T. Chowkku.
Ceara Rubber.—*Manihot glaziovii.*
Chaya.—*Oldenlandia umbellata*, S. Saya-mul, T. Saya.
Cherry.—*Cerasus vulgaris.*
Cinnamon.—*Cinnamomum zeylanicum*, S. Kurundu, T. Karuva.
Citronella Grass.—*Cymbopogon nardus*, S. Pengiri.
Clove.—*Eugenia caryophyllata*, S. Karâbu.
Coconut.—*Cocos nucifera*, S. Pol, T. Tennai, Kirabu-Kai.
Coleus.—*C. sp.*
Cotton.—*Gossypium sp.*, S. Kapu, T. Pangi.
Couch Grass (Ceylon).—*Panicum repens*, S. Etóra.
Creeping Fig.—*Ficus pumila.*
Croton (Garden).—*Codiæum variegatum.*
Cus-Cus.—*Cymbopogon muricatus*, S. Sevendara, T. Vetti-ver.

D.

Dhall.—*Cajanus indicus*, S. Ratathora, T. Parippu.
Domba.—*Calophylum Inophylum*, T. Punnai.
Doum-palm.—*Hyphæne thebaica.*
Drosera.—*D. indica*, S. Kandulessa.

F.

Flamboyante.—*Poinciana regia*, S. Rata mara.
Flax.—*Linum usitatissimum.*

G.

Gallnut or Ink-nut.—*Terminalia Chebula*, S. Aralu, T. Kadukkai.
Gauva.—*Psidium Guyava*, S. Pera.
Gingelly.—*Sesamum indicum*, S. Tel-tala, T. Ellu.
Ginger.—*Zingiber officinale*, S. Inguru, T. Inji.
Gloriosa.—*G. superba*, S. Niyangala, T. Kuddinchi.
Grape-vine.—*Vitis vinifera*, S. Midi-pala, T. Mudirappalam.
Groundnut —*Arachis hypogœa*, S. Rata-kaju, T. Nela-kadala.
Guinea Grass.—*Panicum maximum*, S. Rata thana.

I.

Indian Corn.—*Zea mays*, S. Bada-iringu.
Indigo.—*Indigofera tinctoria*, S. Nil-avari.
Innala.—*Plectranthus tuberosus.*

J.

Jak.—*Artocarpus integrifolia*, S. Kos, T. Pilakai.
Jute.—*Corchorus capsularis.*

K.

Kadol.—*Rhizophora mucronata*, T. Kandol.
Kapok —*Ceiba pentandra*, S. Imbul, Pulun.
Kapprawalliya.—*Plectranthus aromaticus.*
Kitul.—*Caryota urens*, T. Tippili-pana
Kumbuk.—*Terminalia glabra*, T. Marutu.
Kuruakkan.—*Eleusine coracana*, T. Kaivaru.

L.

Lace-bark Tree.—*Lagetta lintearia.*
Ladies' Finger.—*Hibiscus esculentus*, S. Bandakka, T. Bandakkai.
Lemon Grass.—*Cymbopogon citratus*, S. Sèra, T. Shèra.
Lime.—*Citrus acida*, S. Dehi, T. Dèsi-kai.
Long Bean.—*Vigna sinensis*, S. Mé.
Loranthus.—*L. longiflorus*, S. Pilala.
Lotus.—*Nelumbrium speciosum*, S. Nelun.
Lunumidella.—*Melia dubia*, T. Patiri.

M.

Maize.—*Zea mays*, S. Bada-iringu.
Mango.—*Mangifera indica*, S. Amba, T. Mânga.
Manilla Hemp.—*Musa textilis.*
Manioc.—*Manihot utilissima*, S. Mannokka.
Margosa.—*Azadirachta indica*, S. Kohomba, T. Vempu.
Mauritius Hemp.—*Furcræa gigantea*, S. Gônigas.
Mi.—*Bassia longifolia.*
Mulberry (Indian).—*Morus indica.*
Murunga.—*Moringa pterygosperma*, T. Murunkai.
Mustard.—*Brassica juncea*, S. Aba, T. Kadughê.

N.

Nettle (Ceylon).—*Fleurya interrupta*, S. Kahambiliya.
Niger Seed.—*Guizotia abyssinica.*
Nut-grass.—*Cyperus rotundus*, S. Kalânduru, T. Korai.
Nutmeg.—*Myristica fragrans*, S. Sadikka.

O.

Onion.—*Allium cepa*, S. Loonu, T. Vengayam.
Orange.—*Citrus aurantium*, S. Dodan, T. Dodankai.
Orchella Weed.—*Rocella Montagnei.*

P.

Paddy.—*Oryza sativa*, S. Wee, T. Nellu.
Palmyrah.—*Borassus flabellifer*, S. Tal, T. Panai.
Papaw.—*Carica papaya*, S. Pepol.
Para Rubber.—*Hevea braziliensis.*
Pepper.—*Piper nigrum*, S. Gammiris, T. Molagu.
Pineapple.—*Ananas sativus*, S. Annâsi.
Pitcher Plant.—*Nepenthes distillatoria*, S. Bandura-wel.
Plantain.—*Musa sapientum*, S. Kehel, T. Vâlapalam.
Poinsettia.—*Euphorbia pulcherrima.*
Potato.—*Solanum tuberosum*, S. Arthâpal, T. Kelengu.
Plum.—*Prunus domestica.*
Pumpkin.—*Lagenaria vulgaris*, S. Vattakka.

R.

Radish.—*Raphanus sativus*, S. Râbu.
Ranawara.—*Cassia auriculata*, T. Avarai.
Rape.—*Brassica rapa.*
Red Cotton Tree.—*Bombax malabaricum*, S. Katu-imbul, T. Parutti.
Rice.—*Oryza sativa*, S. Hal, T. Arisi.
Rose.—*Rosa sp.*

S.

Sapan.—*Cæsalpinia sapan*, S. Paténgi.
Satin-wood.—*Chloroxylon swietenia*, S. Buruta, T. Mutirai.
Screw-pine.—*Pandanus fascicularis*, S. Mudu-keyiya, T. Thale.
Sedge.—*Cyperus sp.*
Shoe-flower.—*Hibiscus rosa-sinensis*, S. Sapthu-mal, Wada-mal.

Sisal Hemp.—*Agave sisalana.*

Snake Gourd.—*Trichosanthes anguina*, S. Patôla, T. Podi-vilanga.

Sunn-hemp.—*Crotalaria juncea*, S. Hana.

Sweet Potato.—*Ipomœa Batatas*, S. Batala, T. Velkelengu.

T.

Tannias (Aroid tubers).—*Colocasia sp.*, &c.

Tea.—*Thea sinensis*, S. Thé.

Teak.—*Tectona grandis*, S. Thekka.

Tobacco.—*Nicotiana tabaccum*, S Dunkola, T. Powilé.

Turmeric.—*Curcuma longa*, S. Kaha, T. Manjel.

V.

Vanilla.—*V. planifolia.*

W.

Warâ.—*Calatropis gigantea*, T. Errukum.

Wattle.—*Acacia decurrens.*

Welikaha.—*Memecylon capitellatum*, T. Katti-kaiya.

Y.

Yams.—*Dioscorea sp.*