TEA.

THE OPENING AND MAINTAINING OF A TEA ESTATE.

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Adapted from the Dutch by

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It is extremely difficult to separate the question of the opening of a tea garden from that of its maintenance. It is noticed that they merge in every detail; the measures adopted for the maintenance of gardens will always be directly connected with those used in opening out. A piece of land opened out with care will always be easy to keep clean; the contrary with one that has been opened out on wrong lines. It is, therefore, well understood among planters that it is wrong to spare expenditure at the outset, for the initial outlay is amply rewarded in the future by the lower cost of upkeep and the better growth of the plants. It is then false economy to lay out a tea estate on land superficially opened out, *i.e.*, where the stumps of trees or injurious vegetation has not been removed or only partially removed, where the tillage has been very superficial, where no roads, catch-pits, and terraces have been laid out and where plant-holes have been made in an unsatisfactory manner.

The greatest danger for a tea estate is wash, and faulty opening out is the surest way to encourage it. Within a few years, or even months—even before the plants are fully developed—the humus may disappear, and all work in the future may have to be concentrated upon the improvement of the soil rendered less valuable owing to the initial mistakes. The expenses that recur every year from bad opening out, with the resultant loss, prove considerably heavier than those required to open out on the right lines.

It follows that consideration of the opening out of tea lands will be concerned mainly with the measures to be taken against wash.

Although people desire to lay out a tea estate on virgin forest land, it often occurs that only secondary forest ground is available or plains where only illuk and underwood grow; or old coffee, cinchona or tea gardens have to be re-opened. It goes without saying that in each of these cases the process should vary.

In the opening of heavy virgin forest a beginning is made with the cutting of some roads and paths for the purpose of survey and of facilitating control. Each division of the land to be cultivated is cleared by a separate set of work people. To begin with, the undergrowth is cut and left to dry Then, suitable timber trees are marked; and these are felled, mostly at a height of from 3-4 feet above the ground. Stumps of large, heavy trees are generally very difficult and expensive to do away with, but it is necessary to uproot them as far as possible, in order to obtain a clean

plantation. If such large stumps were allowed to stand, the risk is entailed of root diseases, which may spread to the tea plants. This risk is great, especially on grounds rich in humus. Branches, shrubs and small trees are burnt; they must be stacked in small heaps, for there is loss of humus from the ground where the burning is done. Burning should be done as far as possible, on prospective roads. The large felled trees which are not sawn into timber or sold are laid in the direction of the slope in order to prevent them from rolling and causing damage to the plantation. The wood is cleared by rolling it down into the ravines.

The clearing of secondary forest is naturally simpler and less costly; but, as a rule, the soil in such places is also less good.

Lands with undergrowth and grasses are yet easier to clear; everything is cut and, after drying, burnt. After this the roots and root stocks, etc., are dug out, this process in the case of grasses is essential if it is desired to avoid trouble with them later.

In the conversion of old coffee, cinchona and tea gardens, every growth is at first uprooted, and planting is done anew. It is not generally easy in practice to make the new plants strike root, and then, for some time, reafforestation has to be brought about by means of such Leguminoseae as Leucaena, Tephrosia and Crotalaria. In this way it is possible after some years to open out these lands again in tea.

In Java and in Preanger there occurs such a variety of soils that it is not possible to lay down a general procedure. On flat and very porous lands, as, for example, those that occur on the plateau of Pengalengan, precautions against wash will not be so urgent as on heavy clay soils mixed here and there with 'tjadas' and limestone, of Djampangs for example. Where there is a hard, firm lower layer the danger of earth slips has to be reckoned with. It is undesirable to let too much water be absorbed by the ground; therefore, the quick outflow of water should be provided for.

After the land has been sufficiently cleared, tilling is commenced. It depends wholly on the conditions of the soil whether tilling should be heavy or not. Loose sandy soils and soils that contain heavy humus, such as those of Pengalengan, are easily cultivated; to these it is not always desirable to apply heavy cultivation, since this may strongly aid "dry wash." In clay soils the opposite is the case; these soils are remarkably responsive to heavy tilling.

In opening out, the ground is generally tilled 12-18 inches deep; this is 2-3 mammoty strokes. The roots of grasses and harmful weeds are removed at the same time. Unless this is done with much care, there is risk of the growth of illuk, couch or other grasses which are very difficult to root out. Unremitting supervision is needed to ensure deep tilling and thorough weeding. Any weeds appearing after tilling should be promptly eradicated. It is a mistake to commence tilling when the planting has been done. This certainly raises the cost of upkeep.

On very stony ground, boulders impeding growth must be blasted at any cost. It is desirable to remove any stone, as far as practicable, as part of the process of clearing. Suitable stone may serve in the building of the roads and drains, but if it is brittle, it had better be broken into pieces.

Deep tilling of the ground is necessary in stiff soils in order to enable air and water to penetrate. This causes quicker disintegration of the food reserves. On loose sandy soils the circulation of water and air is, of course, well regulated ; these soils therefore need a less intensive tilling. Humus soils are generally loose.

When a land has been cut open and partly cleared, it becomes very important to plan out a systematic network of roads. This is certainly not easy, and it is wrong to leave the setting out of the roads to inexperienced assistants. The land conditions are so different in the mountains that it is impracticable to give fixed rules for each type of land.

Some main principles can, however, be stated :—

First. —*Roads should never be made to serve as outlet drains as well.* On the contrary they ought to be protected from flowing water by means of special drains *above* the road, while the water that is bound to flow along the road must be led away as quickly as possible into the ravines or outlet drains lying *below* the road. From this it follows that *a network of roads should be set out before the setting out of the drains.*

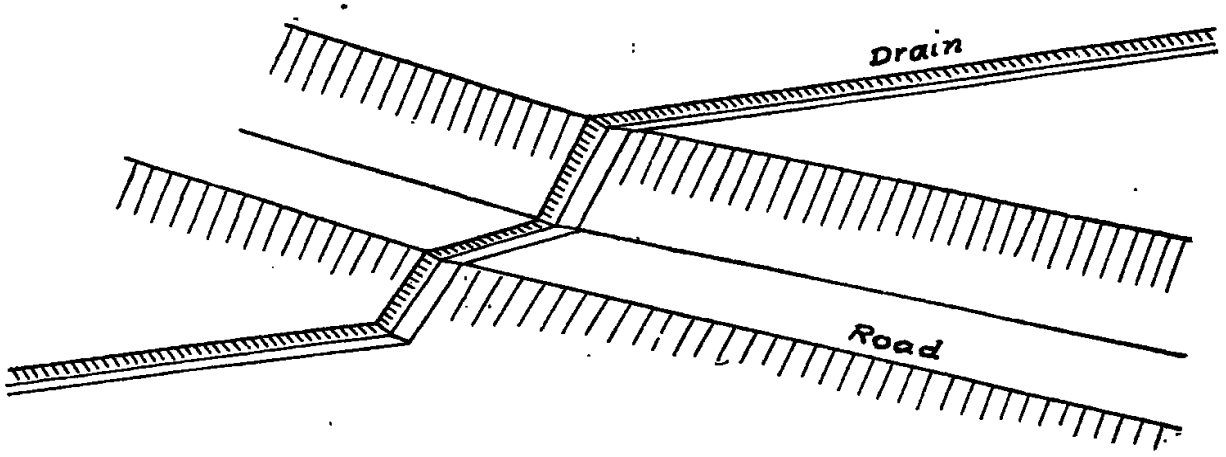

FIG I.—DRAIN CROSSING ROAD.

From this it is seen that roads must be set out first—afterwards the drains.

Second.— It is desirable on mountain land to make the roads not absolutely horizontal, but to give them a slope of, say, at least 1 in 40, so that water may never accumulate. It is best then, if the road runs along a slope, to make it highest at the ridges and thus allow it to slope towards the valleys, so that the drain along the road may be as short as possible.

Third.—When the roads have a long and regular ascent or descent there must be made at distances of not more than 150 to 300 metres, cross drains or culverts in order to free the road drain from any overflow of water.

Fourth.—It is desirable to lay the main roads in a sort of cobweb system, with the factory grounds as centre. It may be necessary to receive the product (tea leaf) several times a day and forward it to the factory. Either hard roads or light narrow rails will be required. This light narrow rail is not very much more expensive than hardened roads and costs much less in upkeep. Ropeways are generally more expensive, but they need not be discussed here

In view of their possible use for narrow rails, the main roads ought not to be too steep: they must preferably be not more than 1 in 30 or 1 in 40. Once the planting is carried out, it will be very difficult to alter the road track; it is advisable to pay attention to this question at the outset.

The main roads serve not only for the transport of the product to the factory, but also for the transport of timber and fire-wood, and therefore it may be recommended that the narrow rails be laid immediately after the clearing. The main roads should also serve later for the transport of manure by cart to the fields.

It is advisable to take into account, beforehand, the direction traffic will circulate. It should be noted that the coolies always choose the shortest road, even though steep. If a short way be found through the plantation, whatever be the hindrance, they make a track.

Where the system of "hectarewegen," or "hundred lines" exists (that is to say gardens divided by roads into portions of 100 by 100 metres or approximately 325 feet x 325 feet, the roads should be so planned as to prevent too much loss of land through the laying of roads. The obvious short cuts must place the pluckers in a position to reach the factory or the receiving sheds quickly.

Along the slopes, parallel roads can be laid out in the same manner as has been said previously for the main roads, *i.e.*, not absolutely horizontal but sloping towards the ravines.

Between the parallel roads steeper connecting roads can be laid with slopes of not more than 1 in 7 to 1 in 10.

It is advisable, after the setting out of these roads with the road tracer, to examine all the tracings, once again, carefully, with the desire to do all the work over again if a better tracing is possible.

For easy traffic it is advisable, to let the roads come together as much as possible on the ridges, thus forming junctions on the ridges.

The system of outlet drains must be set up with reference to the heaviest rainfall to be expected. The rain observations in a neighbouring meteriological station may serve as a basis to some extent. The figure in inches per day does not say *for what duration of time* a heavy shower has fallen. It is clear that, say, a rainfall of 4 inches which is evenly divided over 24 hours will do less harm than a shower of, say, 3 inches that falls within a half hour. While, for example in Holland, in the most rainy months, not more than 2½ to 3 inches, and, at most, 8 inches of rain falls, a shower of 4 to 8 inches per day is no rare occurrence in the mountains of Java, and there occur also showers of even 10 inches. On heights above 4,000 feet, such heavy showers occur very seldom. It goes without saying that such showers can cause extraordinary damage to plantations, and that the absorbing capacity of the ground, aided by catch-pits, is yet insufficient to overcome wash. Besides, it happens that water is absorbed rather slowly and, thus, short heavy showers cannot be absorbed. In heavy showers succeeding long rainy periods, the ground is almost saturated with water and a part of the rain water will flow below, along the slope, and bring on wash thereby.

In order to prevent the occurrence of larger streamlets by the accumulation of descending water, outlet drains must be laid at definite intervals on

the slopes. This is generally known, but the outlet drains are often unsuitable and, unsystematically laid, or are, sometimes wholly omitted. The following may be accepted as general principles :—

First.—That *it is wrong to make drains that are too long*, since at the lower end the flow becomes too heavy and scourings and breakings through arise.

In order to obtain relatively short drains the highest point of the drain must lie on the hill ridges and the drain, on both sides, slope towards the valleys that lie between, at a gradient of 1 in 25 to 1 in 40, or on an average, say 1 in 30, according to the nature of the land.

The relative distance of the secondary drains may be taken at 50-100 feet. The drains are to be taken closer to each other, if:

a. the rainfall is heavy ;
b. the ground is very loose or finely grainy;
c. the land is very steep ;
d. the gardens are kept clean weeded

Second. *Valleys are the natural outlet drains;* therefore the steeper main outlet drains must be laid therein with as few sharp curves as possible.

As an objection to this it is urged that, often, the valleys contain the finest soil. But water travels to the valleys, and, besides, it is often desirable to drain the latter by means of deep main outlet drains. It is known that it is often very difficult to make tea grow in the valleys on account of ground water.

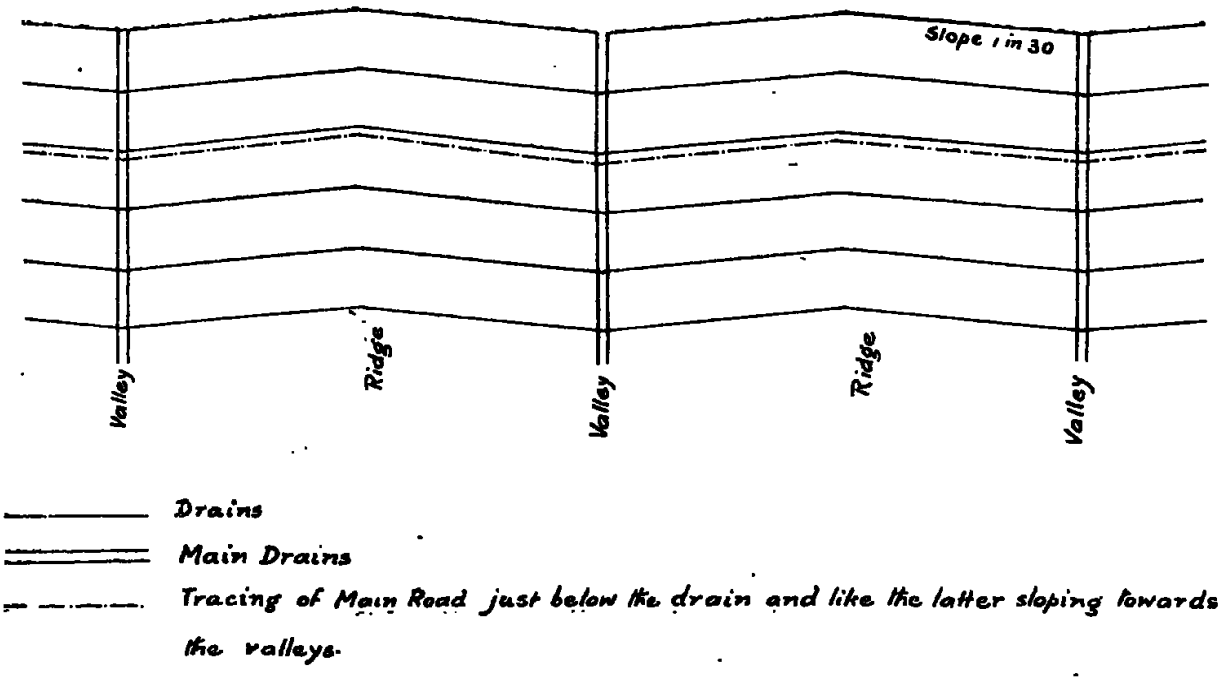

FIG 2.—SYSTEMATIC SETTING OUT OF THE DOUBLE FISH-BONE SYSTEM OF DRAINS.

The main outlet drains, if they are steep, will perhaps be deeply furrowed ; but it is better to localise the wash there than to have the burden of it over the whole land, and as a result lose by degrees the whole top layer.

By means of small dams of wood, bamboo, or yet more preferably, live cuttings of dadap or such-like plants, and by planting the sides with various grasses, the scouring is overcome to some extent.

Where a sufficient number of valleys does not exist on a long mountain ridge, in order not to make the secondary drains too long (never more than 300-600 feet), main outlet drains should be provided at regular distances. It follows that a kind of *double fishbone system*, of the nature of the old tapping cuts of rubber trees, is desirable.

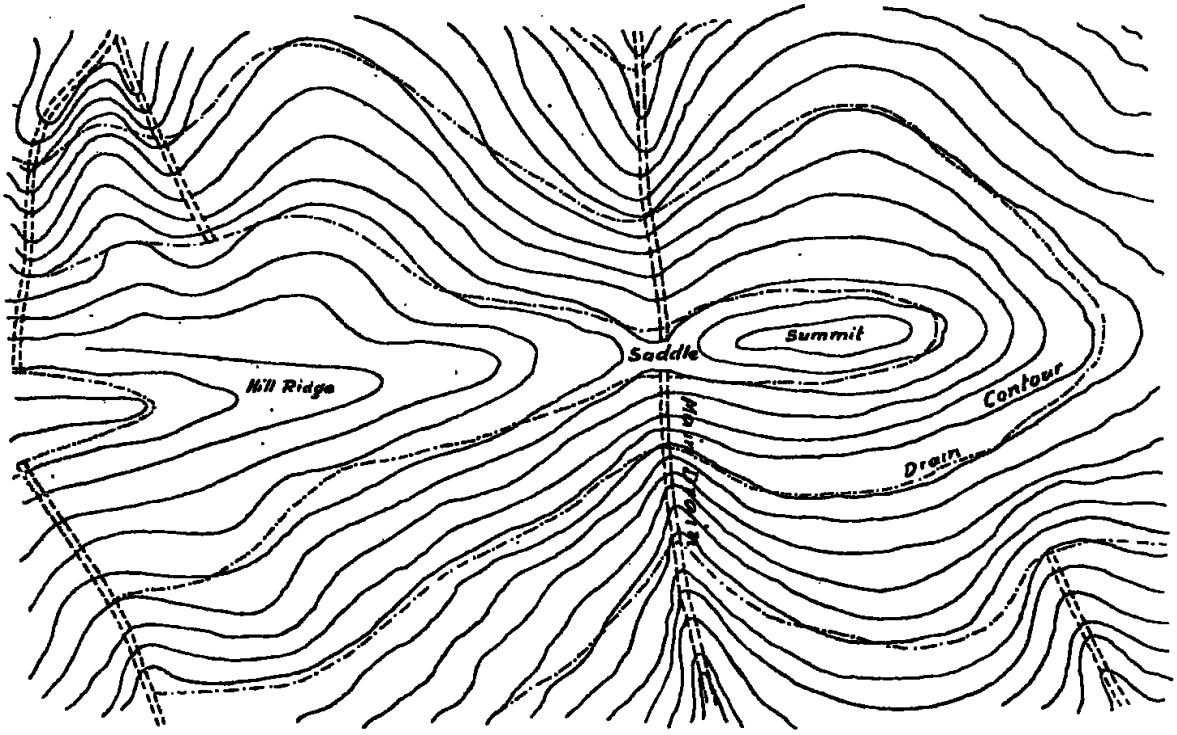

FIG 3.—MAP SHOWING SITUATION OF DRAINS.

On older estates there is a bad system of leading off the water of the valleys by outlet drains. This divides up the water, which, comes by zig-zag drains, right into the valleys, growing into heavy streams and deeply furrowing the drains.

Another system consists in *a sort of rhomboid form of roads* on the slopes. In the first place the roads become denuded and by degrees, unserviceable for communication, and in the second place these are too steep for outlet drains and cause erosion. Heavy denudation occurs especially on the cross-ways.

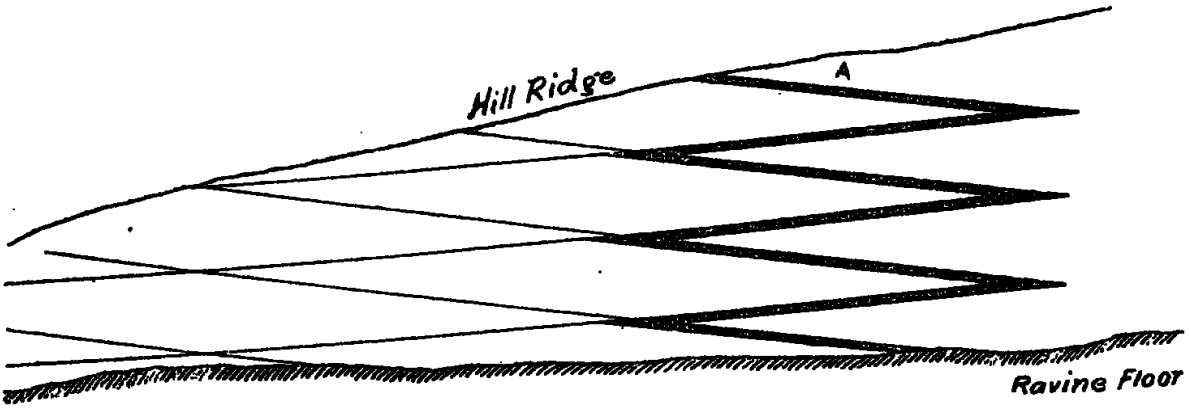

FIG 4.—DRAINS AND ROADS ACCORDING TO RHOMBOID SYSTEM.
(Wrong System)
The thick lines show the long Zig-zag course water has to flow from A

As has been already remarked regarding roads, the road system should be held strictly separate from the outlet drain system.

Yet another system that I have seen on paper, but not in practice, is the making of main outlet drains with a gradient of 1 in 25 to 1 in 40 sloping towards the ravines, and of steep secondary outlet drains. This system seems to me to be absolutely wrong, for according to it, all over in the gardens, steep drains that are difficult to maintain are brought into existence, while in the main outlet drain, on account of the low velocity of flow, a great volume of water accumulates. If such a main outlet drain gives way, then the damage can be very considerable.

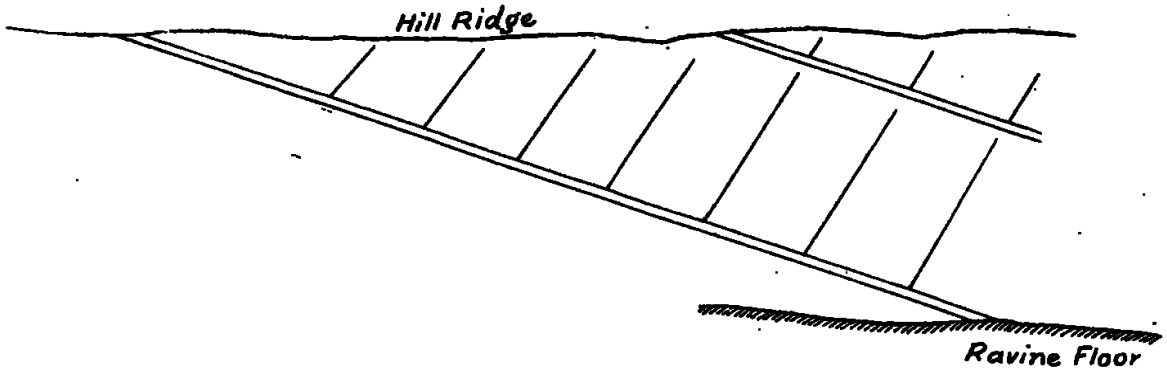

FIG 5.—MAIN DRAINS WITH SLIGHT SLOPE WITH SMALL STEEP FEEDING DRAINS.
(Wrong System)

The main outlet drains in the valleys cannot break through, since they always follow the lowest portion of the land.

The breaking of smaller drains can also cause damage. *They must therefore be regularly kept clean.* Since very heavy showers fall only a few times in the year, it is a good system, after each abnormally heavy shower, to set all the permanent workers on the cleaning of the outlet drains. Keeping drains in repair is very much easier if both sides of the drains are planted with grass. Planting the lower edge prevents breaking through and planting the upper edge prevents sand accumulating too quickly and the crumbling of the sides. Exceptionally suitable for this is the "Veti-vert" (*Andropogon muricatus* Retz). This grass grows easily and forms not only a thick hedge, but has, besides, an enormously wide-spread root-system that holds the ground together. This network of roots spreads underneath the floor of the outlet drain and forms with the ground a tough whole. Thereby the drains are well protected. The roots also prevent the crumbling of the ground during the dry season, which the planters of British-India appropriately call "dry wash."

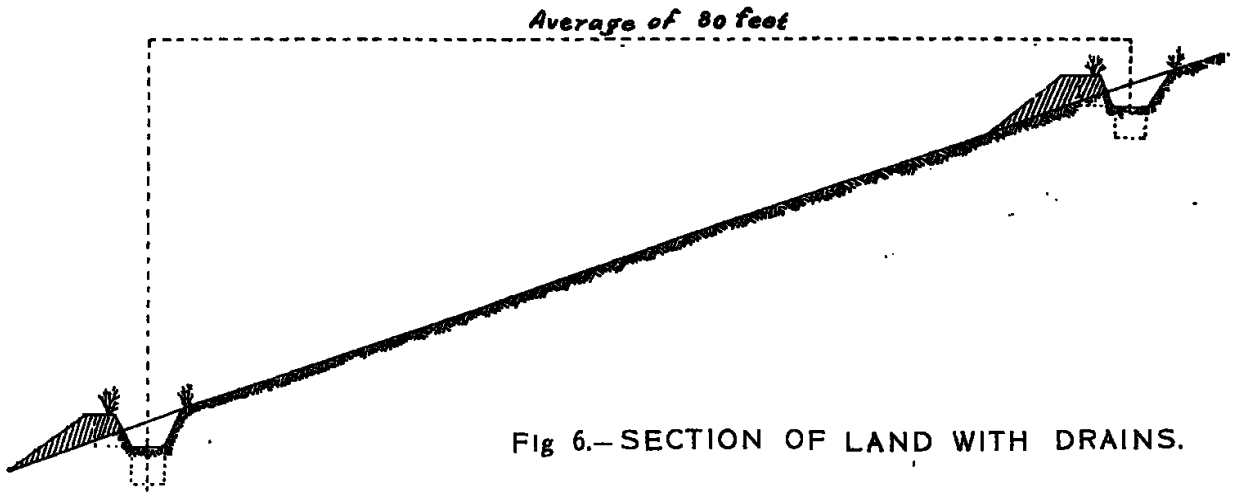

FIG 6.—SECTION OF LAND WITH DRAINS.

Other plants may be used but none have the wide-spread root-system of "Veti-vert," which is also suitable for planting on steep sides of roads. It seldom if ever produces seed, and never spreads in the tea garden.

In *very flat lands*, such as occur in the lower tracts, water outlet is often very difficult because the land allows too small a slope in the drains and therefore the slope has to be obtained by making the drains deeper down-stream. These should also be carefully set out with a level.

In these cases, draining is not required so much for dealing with wash as for lowering the ground water level. It is well known that ground water has a very prejudicial effect on plants if their roots reach it. Ground water is especially injurious if it is stagnant, *i.e.* if there are no outlet drains in the neighbourhood. If ground water is regularly drained away then it seems to be less injurious. Very deep main outlet canals with a large number of tributary canals exist in such tracts.

One of the most useful inventions for mountain cultivation is certainly the system of catch-pits. Their advantages for improving the soil will not be discussed here, but rather their value in counteracting wash.

In the first place, a catch-pit holds a certain quantity of water during a heavy shower of rain, so that water has time to permeate the ground, and, in the second place, the pit catches up the soil that is washed away, which can be restored to the ground when the pit is deepened.

It is important to make the catch-pits at least 18 inches deep. The breadth is generally only one mammoty stroke, but it is better, if there be room for it, to make the pits two or three mammoty strokes wide.

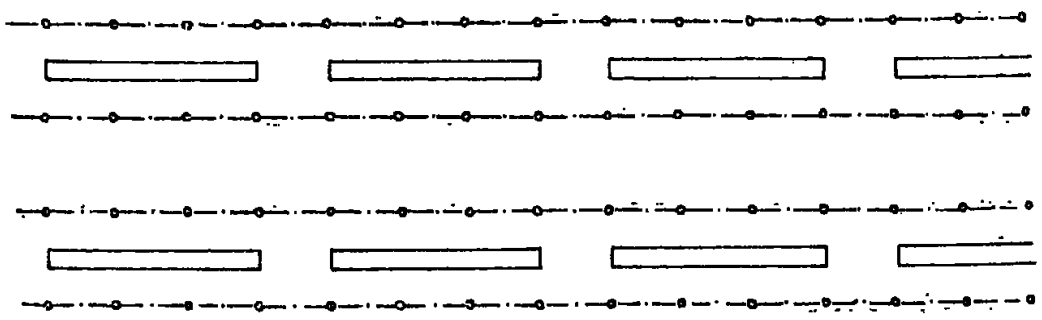

Fig 7.—LONG CATCH-PITS IN ALTERNATE ROWS.

Pits.—6 inches long, 16 inches deep, 9 feet long, about 465 per acre.
Contents.—2,760 Cubic feet per acre, equal to a shower of 0·75 inch.

Such deep and wide pits are, however (especially in hard ground), very

costly, hence their construction is often put off too long, and people are generally satisfied with shallow catch-pits, of one mammoty stroke's breadth.

As has already been said, one cannot allow the soil to absorb too much water if there is a hard impervious layer under the top layer. In such cases it is better to omit catch-pits.

It is best to make catch-pits not longer than, say, 10 feet since the plant rows do not always run horizontal. A pit that is not horizontal overflows at the lower edge and causes wash there.

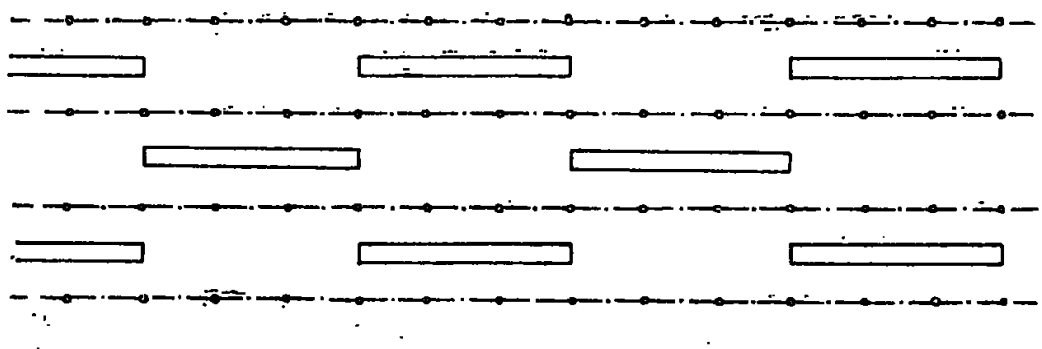

Fig 8.—LONG CATCH-PITS—ALTERNATE SYSTEM.

Pits.—About 605 per acre.

Contents.—3,630 Cubic feet per acre, equal to a shower of 1 inch.

On older estates short pits of 3-6 feet are made in each row at equi-distant intervals, but alternating in the rows.

At present, longer pits are made, of 10-15 feet in length in alternate rows with but very small intervening spaces. If the terraces, however, are not absolutely horizontal, the terrace that has no pits may be converted into a flowing aqueduct.

On the advantages of the making of terraces opinion is fairly divided. Much depends on the nature of the land and on the rainfall. If terraces and catch-pits be made, then the ground is made to absorb much more water than it normally would do.

It is advisable to examine whether this large quantity of water is good for the growth of the cultivated plants and will not lead to lack of air in the ground. Water must be allowed to drain away. Where the land slopes gently and the rains are not heavy, catch-pits alone, or in combination with horizontal hedges of, say, Leguminoseæ, are quite sufficient, if the ground be porous and can therefore absorb much rain. A good system is one row with long catch-pits and the other with a hedge of Leguminoseæ.

On steeper lands terraces and catch-pits are undoubtedly of great use.

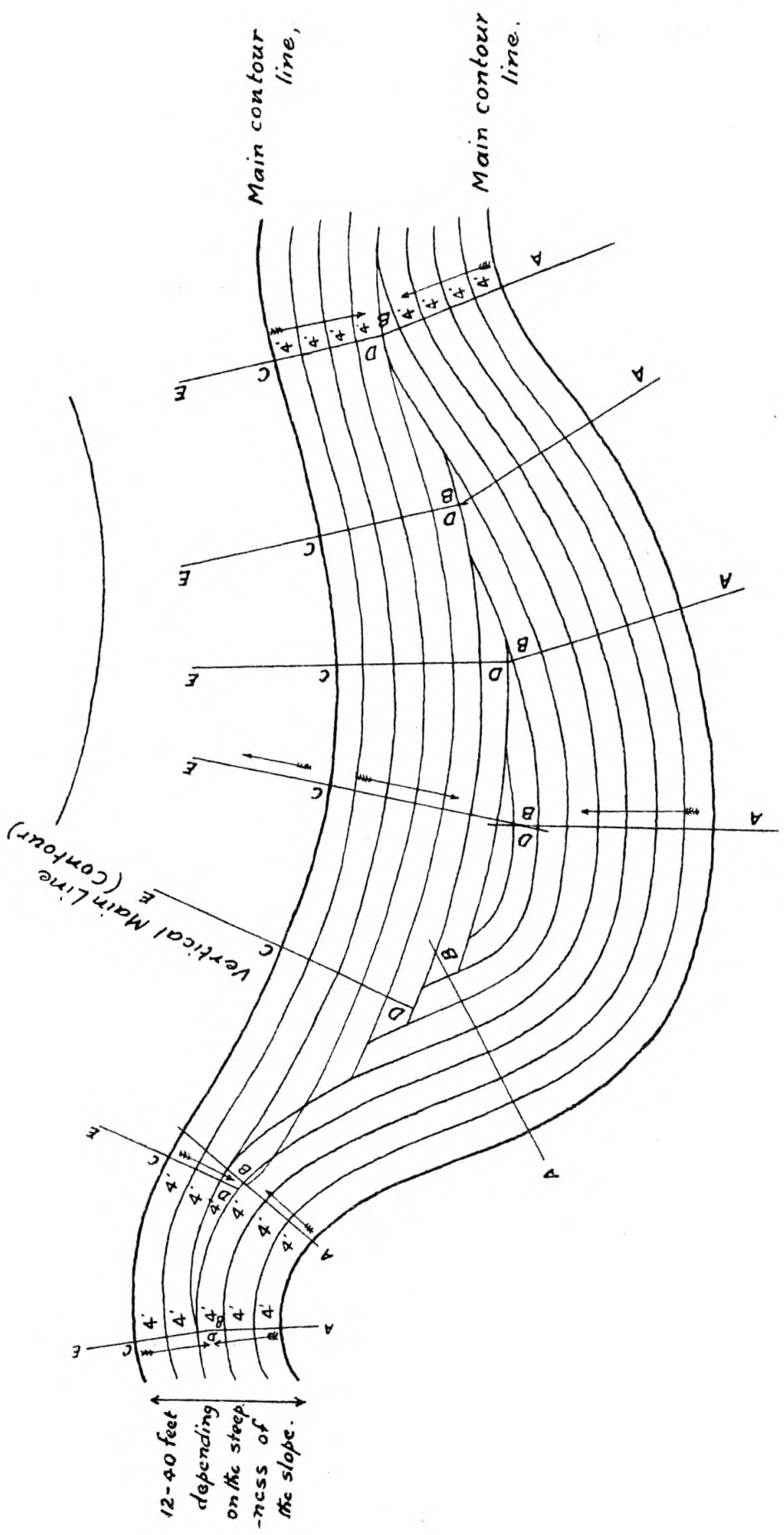

FIG 9.—PLAN OF A METHOD FOR TERRACING OR CONTOUR PLANTING.

Distances Between rows of plants are set out from A to B, from C to D and from C to E—**Not from A to C.**

There are two kinds of terraces, namely the individual terraces wherein around each tree a nearly square, flat surface is made, and long terraces which follow contours of the land.

The first kind is fit for crops with wide planting distances, such as rubber, coffee, etc , the second kind for narrow planting distances, for tea, cacao, etc.

In order to work well, the long terraces must be set out very carefully and therefore the alignments should not lie too far from each other.

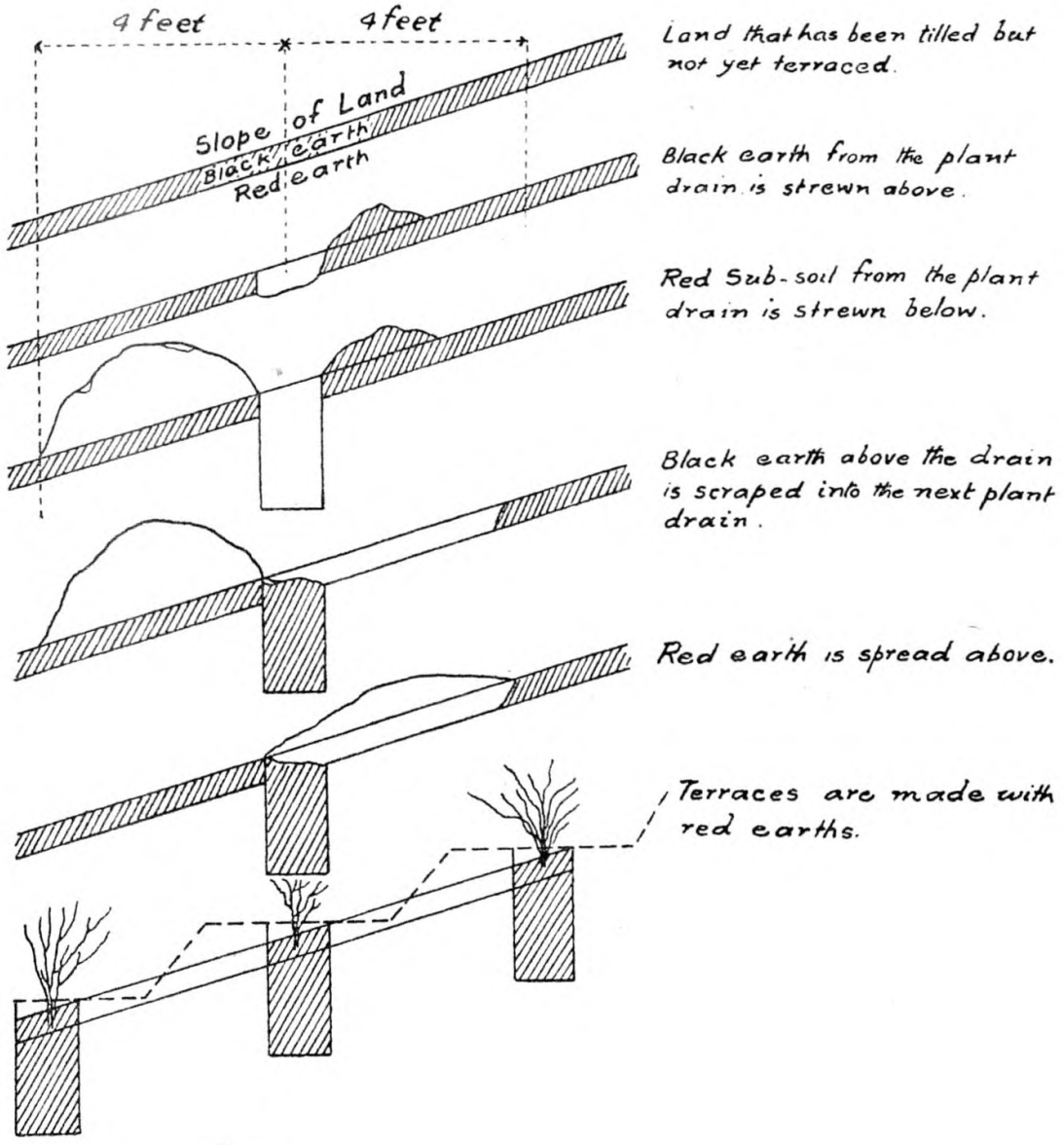

Fig 10.—PROTECTING THE FERTILE TOP SOIL BY MEANS OF TERRACES.

This levelling is done with the road-tracer. The setting out of these lines is certainly not easy. It is best to set out at first arbitrarily, at not too distant intervals, a number of horizontal main lines in order to obtain thereby a survey of the lie of the land, and then draw lines perpendicular to these. On these then the common distances of the rows are set out, and from that again the horizontal plant-lines, and on these the common distance of the plants themselves.

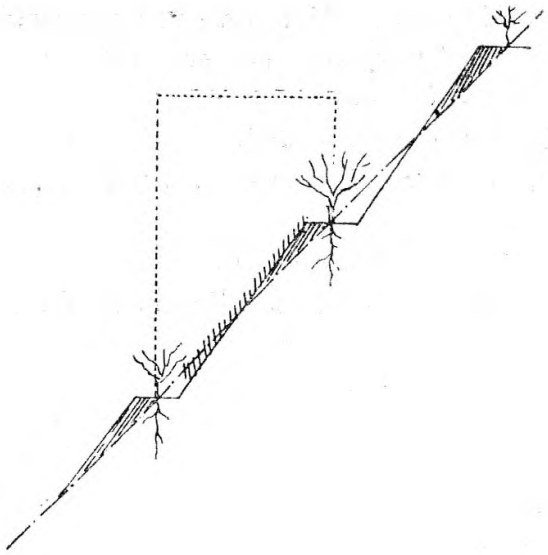

Fig. 11.—TERRACES ON VERY STEEP LAND
Here catch-pits are impracticable.

One of the greatest objections urged against terracing is that the young plants are planted out in the less fertile sub-soil, as these are planted somewhat behind on the terrace.

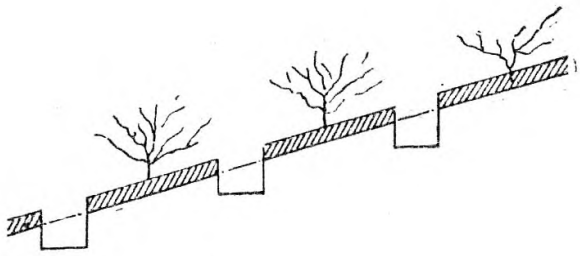

Fig 12.—WIDE CATCH-PITS WITHOUT TERRACES.

This is, however, easily prevented by, for example, *digging long deep trenches* along the lines of planting, and filling these trenches with fertile top-soil, which is thereby also preserved from wash. Also, the ground can be tilled so deep that loose fine soil is secured even at the back of the terrace.

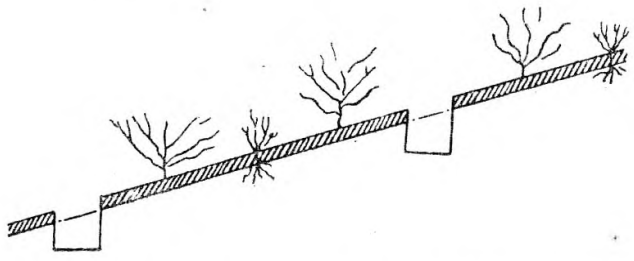

Fig 13.—WIDE CATCH-PITS IN ALTERNATE ROWS.
Interplanted with hedges of Leguminosae.

Heer E. van Laump's method on Montaja has been to dig pits 3 feet deep and 3 feet wide with dividing walls also 3 feet broad. After these pits have been exposed some days to the air, they are closed up with the earth of the dividing walls, which therefore turn into pits. Later, these too are closed up, and so, the whole ground is cultivated to the depth of 3 feet.

The objection against the Montaja method is its enormous expense. With the present scarcity of coolies it will hardly ever be possible to have sufficient labour for extensive opening out according to this system.

Another objection is that in an infertile sub-soil the plantation is thrown back a couple of years.

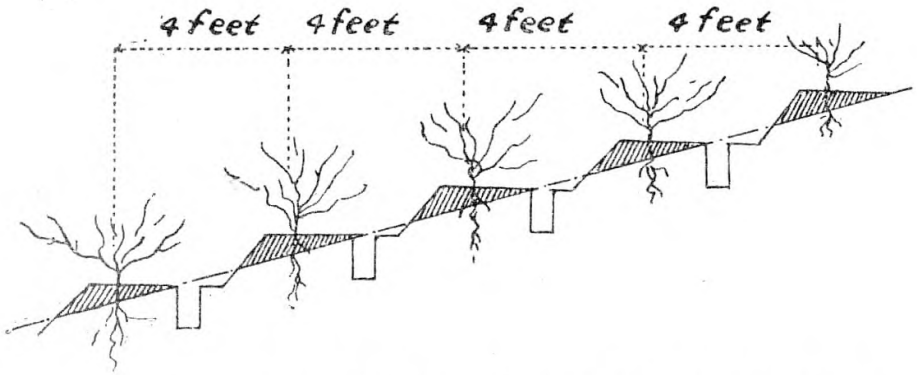

Fig 14.—TERRACES AND CATCH-PITS ON MODERATELY SLOPING LAND.

For the rejuvenation of long cultivated soils it is certainly a good system, but it is a question whether it is also profitable and whether the little humus which remains may not be dissipated. Experiments have shown that this system cannot always be recommended in every case and that on loose sandy soils it may give bad results.

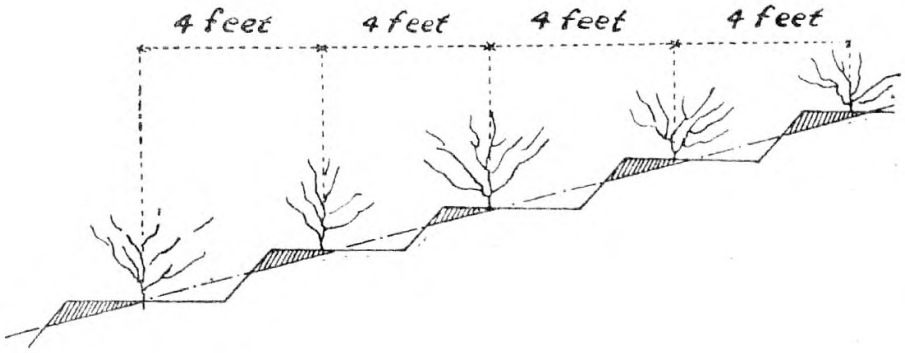

Fig. 15.—TERRACES ALONE.

Terraces can be formed by laying down weeds in lines between the rows. The earth that is washed away is held up by the weeds and so, by degrees, self-formed terraces are made. If the catch-pits are dug later, and the earth from them is spread above the weeds, this formation is accelerated.

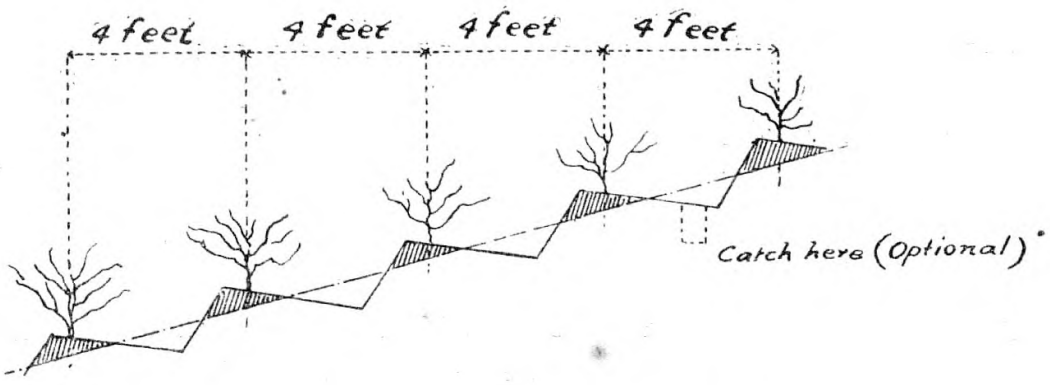

Fig. 16.—TERRACES SLOPING BACKWARD.
With or without Catch-pits.

In the narrow space allowed at present between the rows of tea plants there is hardly room for both terraces and pits. With a spacing of less than 4 ft. there should be either pits alone or terraces alone. Some planters make covered terraces on steep slopes, without catch-pits, while on more even land they make catch-pits without terraces. Where stones occur, these are arranged to make parapets or the sides of terraces.

We come now to a very important question, namely, cover planting of steep sides of terraces.

This can hardly be done if the gardens are cleared of all weeds, for, in digging them up, the cover plants will also be destroyed every time.

For cover planting many kinds of plants are used but it is recommended that preference be given to such Leguminoseæ as indigofera, tephrosia, clitoria. etc., since these bring nitrogen to the soil at the same time.

As a rule on many kinds of soil, especially clayey and stiff soils, the planting of Leguminoseæ immediately after clearing, is recommended. On this subject reference can be made to the special paper by Dr. Bernard on Green Manures.

Clitoria makes a specially strong hedge which, however, must often be cut. The stems that are cut should be laid behind the trunks so as to form with it a close hedge.

A system that has been successfully used is to let the usual weeds (consisting of hundreds of different kinds) remain on steep terrace sides, but regularly to cut them short. In this process, the grasses are got rid of Grasses appear to cause a poisoning of the soil and should not be tolerated in the neighbourhood of cultivated plants,

A very great factor in the determining of a system of cover planting is the labour question. Planters should ask themselves: "Can I keep the cover plants regularly cut short?" Where there is no regular labour supply, covered terraces may cause very much trouble by the gardens becoming "dirty."

The even portions of the terraces must naturally be kept as clean as possible and tilled a few times a year. For nursery beds terraces are surrounded by small drains in order to protect the seeds or small plants from being washed away. These drains and all beds may be given a slope of, say, 1 in 30 or, in 40, and the small drains then allowed to discharge their water into main drains.

This would not be such a bad system for the gardens themselves if one could at least be certain of being able to have the little drains regularly kept open by cutting down the weeds on their sides and emptying them of the earth that has been washed into it.

Fertile soil can be brought to the gardens from the unplanted valleys and scattered there. This has often given incredibly good results, but it is enormously expensive. In British India this top-dressing of old gardens is practised.

Finally it should be remarked that even the best system of the lay-out of gardens cannot counteract wash if the outlet drains are not regularly deepened and the terraces not regularly repaired. Special attention has to be paid to repair after heavy downpours.

In the upkeep of tea gardens in maturity, the measures adopted when opening out are repeated, *viz.*, tilling in order to make the soil loose again, mending of the roads, ditches, terraces and outlet drains, and especially weeding, which is done in various ways.

Generally weeding is done at intervals of 1½ to 2 months, according to the rapidity of the growth of the weeds. Most planters in Java are not supporters of clean weeding as this aids wash. It should be recommended only on land where the growth of weeds is so vigorous that the development of the plants of the main crop are hindered by them, and where the control of injurious weeds, especially illuk, is too difficult. Clean weeding is the best method to be recommended where illuk exists.

The system of weeding that gives good results, especially on loose forest ground rich in humus, is selective weeding, whereby all bad weeds are eliminated and the good ones retained. This system is more difficult, and requires specially strict control, but it is better than clean weeding because, from the good weeds that are retained, a return is made to the humus of the soil, and at the same time the prejudicial influence of grasses which have always to be done away with is eliminated. Besides, in the so-called "dirty" gardens, the good weeds give the advantage of shade to the ground.

After pruning (generally about every 1½—2 years) tilling takes place; it is then easy to till the tea rows. The ground is dug up as deep as possible with the "mammoty" (generally with the "mammoty fork"), the ditches are emptied or deepened, terraces and drains are put in order, manures are used as required, gaps are interplanted and Leguminosæ are planted as desired. In short all measures for aerating the ground are applied, whereby water easily percolates into the lower layer of the ground, and metabolism takes place freely, so that new quantities of food stores are made available to the plants.

All the working methods spoken of above are very expensive; if however they are applied with care, gardens will be found satisfactory and their increased yields will cover the expenses incurred. Besides, with intensive preparation, the maintenance of gardens, as has already been stated, is rendered easier, and the cost of upkeep is lowered.