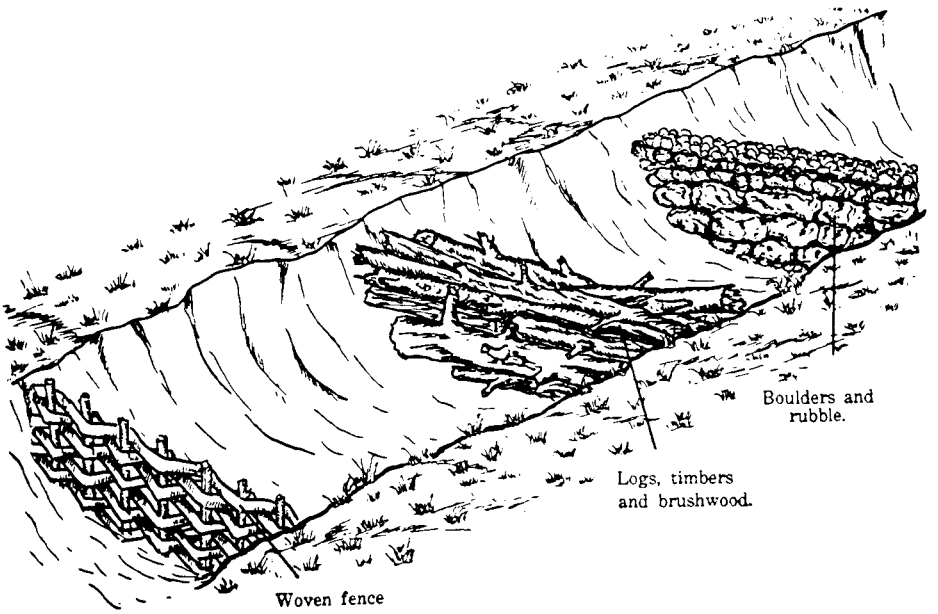
MINISTRY OF AGRICULTURE,
FEDERATION OF MALAYA.

Agricultural Leaflet No. 39

SOIL CONSERVATION
AND
EROSION CONTROL



Reprinted in November, 1969.

Published by and Obtainable from
The Ministry of Agriculture & Co-operative, Malaysia.

SOIL CONSERVATION AND EROSION CONTROL

Introduction

In Malaya, the soil under natural forest is protected from hot sun and beating rain. Leaf litter and rotting vegetation enrich the surface with organic matter and with plant food brought up from depth by the tree roots. Heavy rainfall is broken by the tree canopy and floor litter, and readily penetrates the porous, well structured soil surface. Rainwater soaks deep into the land which is rendered absorbent by the ramifying mass of tree roots. The trees transpire some of the rainfall and the rest percolates slowly and harmlessly down to the streams and rivers. Soil fertility remains good indefinitely.

Indiscriminate clearing and cultivation of slopes removes this protection and if conservation methods are not adopted, the result is erosion, i.e., the washing away down the slopes of fertile topsoil, exposing infertile lower layers. In time the result is impoverishment of the land, falling crop yields and poverty to the cultivator and country. Severe erosion can render the land totally unproductive for many decades.

Causes of Soil Erosion

Clearing and burning in preparation for cropping exposes the soil directly to the weather. Direct sunlight raises soil temperature and speeds up decay of soil organic matter. Termites attack timber and tree roots. Because of this fall in organic matter the soil loses much of its friable, absorbent structure and the surface becomes less permeable to water. Heavy rain falls directly on to the soil, puddling the surface, which becomes incapable of absorbing water rapidly. On sloping land much of the rain is forced to run downhill over the surface, washing particles of fertile topsoil down with it, silting up the valleys and streams below.

Types of Erosion

Sheet Erosion

Rain falling directly on the bare sloping soil pulverizes the surface, loosening particles of topsoil. These loosened soil particles are picked up by surplus surface run-off water and are carried away down the slope. The soil is removed in more or less uniform thin layers. The finer soil particles that contain most of the plant nutrients are removed first by sheet erosion and soluble plant foods are carried away in solution at the same time. This type of erosion is very widespread and serious in Malaya and is particularly insidious because the damage is not easy to see and is usually not recognised by the farmer.

Rill Erosion

Surface water running downhill rapidly concentrates into Small streamlets, cutting broad, shallow channels or rills in the topsoil. They are usually from 1 to 3 in. deep and from several inches to 2 or 3 ft. wide. This type accompanies sheet erosion and, like it, is very widespread and serious in Malaya.

Gully Erosion

On long slopes numerous rills converge to form fast-flowing streams which cut into the soil, forming deep, narrow, steep-sided channels known as gullies. Many Malayan soils resist gullying because of tightly packed and lateritic hardpan formations in the subsoil layers. Deeper and more fertile granitic soils do gully, however, and numerous examples of gullies 2 to 4 ft. or more deep and 1 to 1½ ft. wide exist on slopes cultivated with tobacco and other annual crops.

Landslips

On steep slopes, where land becomes saturated with water to great depth, whole blocks of land may slide downhill, uprooting trees and burying others. The results are spectacular, but this type of erosion is not very serious in Malaya, being confined mainly to very steep, terraced rubber lands and to steep forest areas in the mountains, and is more often associated with mining and road-cutting operations.

Soil Conservation Rules for the Cultivation of Slopes

Slopes steeper than 1 in 3 (18½°) should not be cleared but left under natural vegetation, because measures sufficient to control erosion on such steep slopes would normally be uneconomic. No restrictions are normally necessary for slopes below a gradient of 1 in 10 (5¾°). Recommendations for slopes between these extremes are given in Table I and illustrated in Figs 1-3.

Table I

Factor	Slope Gradient	
	1 in 10 to 1 in 5 ($5\frac{3}{4}°$ to $11\frac{1}{4}°$)	1 in 5 to 1 in 3 ($11\frac{1}{4}°$ to $18\frac{1}{2}°$)
1. Method of clearing:— A. Felling & burning. B. Felling (no burn or light burn) or poisoning. C. Selective felling or poisoning.	A, B and C	B and C only
2. Method of establishing covers:- A. Catch crops. B. Cover crops. C. Natural vegetation, selective weeding.	A, B and C	B and C only
3. Crops to be grown:— A. Manila hemp. B. Rubber. C. Tea. D. Oil Palm. E. Fruit Trees. F. Cacao.	A, B, C, D, E and F	B, C, D, E and F. A on very fertile soils with mulching.
4. Subsequent cultivation:— A. Slashing. B. Selective weeding. C. Clean weeding.	A and B only	A and B only
5. Mechanical methods:— A. Protecting major streams. B. Protecting gullies and drains. C. Contour bunds and drains, and silt pits. D. Contour planting. E. Terracing.	A, B and C where applicable. D the rule	A, B and C where applicable. D and E the rule.

Methods of Erosion Control

Erosion control methods aim:—

(a) To reduce the harmful effects of direct sunlight and beating rain.

(b) To encourage maximum penetration of rainwater into the soil.

(c) To direct surface run-off water slowly and harmlessly down the slope.

Stream, Gully and Drain Outlet Protection

This should receive first attention on all slopes. Vegetation, natural or planted, should be retained on all stream banks and encouraged to grow in the bed of the waterway, if possible. Water flow should be checked and soil retained by filling gullies with felled timber and other rubbish. Gully bottoms should be grassed by dibbling divisions of *Axonopus affinis* or other quick growing vigorous spreading grass. Check dams of brushwood, timber, boulders or concrete may be necessary to stabilize steep, fast flowing streams. Drain outlets should be protected by piping or with stone or wood (Fig 4).

Covers

The prime need on all sloping land is a dense ground cover. Fellin should aim at laying the trees parallel with the contours and burning should be kept to the minimum necessary to allow access. Soft leafy growths in the natural vegetation should be retained and encouraged, while harmful plants, especially lalang and bracken, should be destroyed. On land newly cleared from jungle, selective weeding may be adequate, but where suitable growths in the natural vegetation are insufficient, cover should be planted. Land cleared from lalang or after annual crops will normally require a cover crop to be planted. The leguminous creepers *Centrosema pubescens*, *Calopogonium muconoides* and *Pueraria phaseoloides* have proved best in Malaya. The bushes *Tephrosia candida* and *Flemingia congesta* are sometimes preferred on flat land as being less competitive. Mixed covers of two or more species have proved best. Three mixtures of cover crop seed are given below in order of preference :—

(a) 5 parts *Calopogonium muconoides*
4 " *Centrosema pubescens*
1 " *Pueraria phaseoloides*

(b) 4 parts *Centrosema pubescens*
1 " *Pueraria phaseoloides*

(c) 1 Part *Centrosema pubescens*
1 " *Calopogonium muconoides*

Five lb. seed of one of the above mixtures is sufficient for one acre. Sow in cultivated drills 6 feet apart and not closer than 6 feet to the permanent crop. Manure the drills with Christmas Island rock phosphate at 4 oz. per yard.

To hasten germination it is an advantage to treat the seed with hot water before sowing. Place seed in a bucket and pour over it water that has been heated to 75°C (165°F) using just sufficient to cover the seed. If no thermometer is available 2 pints boiling water mixed with 1 pint cold water give the correct temperature. When the water has cooled add more cold water and leave 12 hours. The treatment of seed with root nodule culture obtainable from the Rubber Research Institute of Malaya also aids rapid establishement. Full instructions on use are issued with the nodule culture. For best results plant in damp soil when showery weather is expected. Selective weeding along the drills may be necessary to aid initial establishment and broadcast dressings of Christmas Island rock phosphate may be required to maintain good growth.

Contour Planting

Together with the maintenance of covers, contour planting is an essential minimum protection against erosion. It acts mainly by preserving the inter-row covers in continuous level strips on the contour, so that strip weeding where practised does not form bare sloping channels down which water can run and erode. It also lends itself more easily to terracing and other forms intensive mechanical control measures.

Method

An average slope is selected and planting intervals are marked by guide pegs along a line running directly up and down the slope. Then, starting at the top, contour lines are pegged out with short pegs to indicate the planting points. A road tracer is most convenient for this, but on small areas a simply constructed levelling triangle or hurdle is quite suitable and can be made by any handyman (Fig. 5)

The levelling triangle is placed with leg A against the guide peg and when the instrument is correctly levelled, a peg is driven in where leg B meets the ground. Second and subsequent points are found using the preceding point as the guide, reversing the instrument each time to cancel out small errors.

As the slope varies across a hillside, the contour lines converge on steeper slopes and widen on gentle slopes. Should the contour lines converge to less than half the chosen interval, one contour should be stopped. Should they widen to more than 1½ times the chosen width, an extra contour (a "blind" contour) should be introduced between the regular contours.

Terracing

Some form of terracing is normally considered essential above a gradient of 1 in 5 (11¼°) under Malayan conditions and is desirable even below this.

Bench Terracing

This is the most intensive form of terracing and consists of transforming steep land into a series of level or nearly level strips running across the slope, each separated by an almost vertical retaining wall of earth, rock or concrete, protected by vegetation. These have been used for centuries in countries where dense population makes it essential to cultivate steep slopes. In Malaya bench terraces are only applicable to very small areas such as for vegetable growing in Cameron Highlands.

The vertical interval between bench terraces should be the minimum possible to obtain a bench wide enough to cultivate and should be chosen so that the area to be dug out equals the area to be filled, (Fig. 6). For instance, on a 24° slope, a vertical interval of 5 ft. with a retaining wall slope 1 in 2 would give a bench approximately 10½ ft. wide. The bench should be sloped from front to back at about 1 in 12, and longitudinally at 1 in 400, so that surplus water drains slowly along the back of each terrace to protected outlets. Dense vegetation should be encouraged on the retaining wall to stabilize it and the front edge should be grassed.

Terracing for Tree Crops

This type of terracing is widely applicable in Malaya. Contour lines are pegged out as described under Contour Planting and a continuous bench from 3 to 5 ft. wide excavated along the contour. The spoil is thrown to the front of the bench and the surface sloped back into the hill. Small stops or dams should be left or made every 20 to 30 ft. along the terrace to obstruct lateral water flow, to encourage water penetration and prevent overtopping where slight irregularities would result in water build-up. Intervals between terraces depend upon the crop and the slope; 30 ft. measured along the ground is suitable for moderate slopes, reduced to 20 ft. or less on steeper slopes. (Fig. 7).

Planting Platforms

These are sufficient on gentle slopes below 1 in 5 (11¼°) A platform is excavated at each planting point, sloped back into the hill, and can be cut irrespective of the planting system. They serve to retain water on the bare soil in the ring-weeded patch round each plant.

Contour Bunds

These are bunds built on contour by scraping surface soil from either side and stabilizing with vegetation. Stops should be made along the length of the bund to control lateral water flow. They are used largely to check erosion on old established square-planted areas where other measures cannot be adopted. (Fig. 9).

Silt Pits

Silt pits should be dug on contour athwart incipient gullies to catch silt washed downhill. They are normally dug in short lengths 6 to 20 ft. long with a cross section 1 x 1 ft. to 2 x 2 ft. Spoil is thrown to form a bund along the outer edge of the pits which need to be cleaned out annually, preferably before the main rains. Silt pits are expensive to maintain and for this reason contour bunds are usually to be preferred. Futhermore, they have been found to encourage the growth of bracken *(Gleichenia)*, a most undesirable cover (Fig. 8).

Contour Hedges

Contour hedges are strips of plants usually planted to fix bunds or outer edges of terraces and athwart waterways to check flow. Tufted grasses growing naturally in the vicinity are most suitable, e.g. *Themeda villosa.* The commonly grown citronella grass is another. Other useful plants include. *Flemingia congesta,* of value in robusta coffee; Napier grass, *Pennisetum purpureum* and *Vetiver* grass, *Vetiveria zizanoides.* Pineapples also are of value when close planted.

Contour Drains

These are dug across the slope to divert water laterally and prevent damage to land and crops below. They should have a cross-section sufficient to carry the maximum expected flow and a slope of not more than 1 in 400 to prevent scouring and erosion of the channel. Outlets should be protected where necessary.

Mulching

This is the covering of bare soil with a layer of cut vegetation, usually several inches thick. Mulch protects the surface against the direct impact of rain and sun, keeps the surface cool and moist, increases soil organic matter, encourages superficial rooting of crops and increases surface porosity, all of which tend to reduce run-off and retard erosion.

Soil Conservation For Special Crops

ANNUAL AND SHORT-TERM CROPS

I Conservation measures for gentle slopes are:-

(a) Construction of beds on contour with small stops between to retain water and encourage percolation.

(b) Construction of contour drains to remove excess rainfall.

(c) Mulching bare soil with cut vegetation.

(d) Retention of uncultivated strips of land on contour on which dense natural vegetation is encouraged.

II On steep land complete bench terracing as described above.

HIGHLAND TEA

Tea is a special case, as terracing has been found to encourage landslips. Measures advised are:—

(a) Retention of ground cover by selective weeding.

(b) Lay prunings in lines on contour.

(c) Construction of contour drains.

(d) Planting contour hedges of dense bushes or grasses

Summary

POINTS OF IMPORTANCE TO REMEMBER

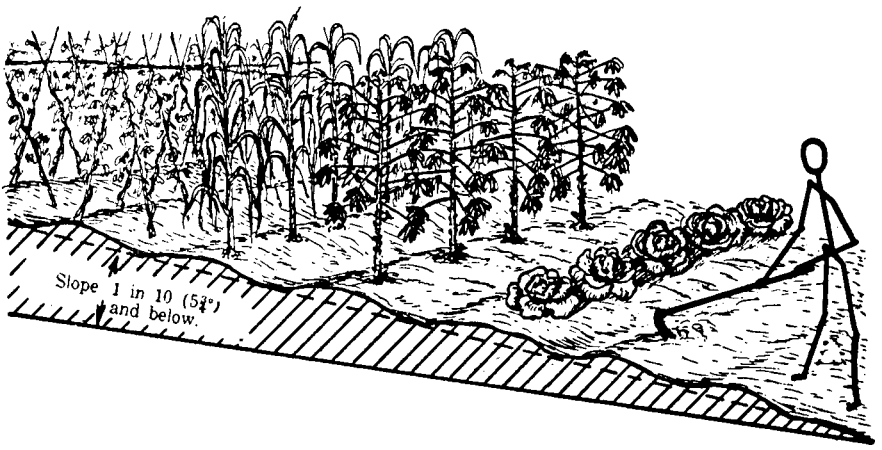
Do not clear land too soon. Always aim to expose the land for the shortest possible time.

Sow covers immediately after clearing.

Always make stops along level terraces, to check lateral water flow.

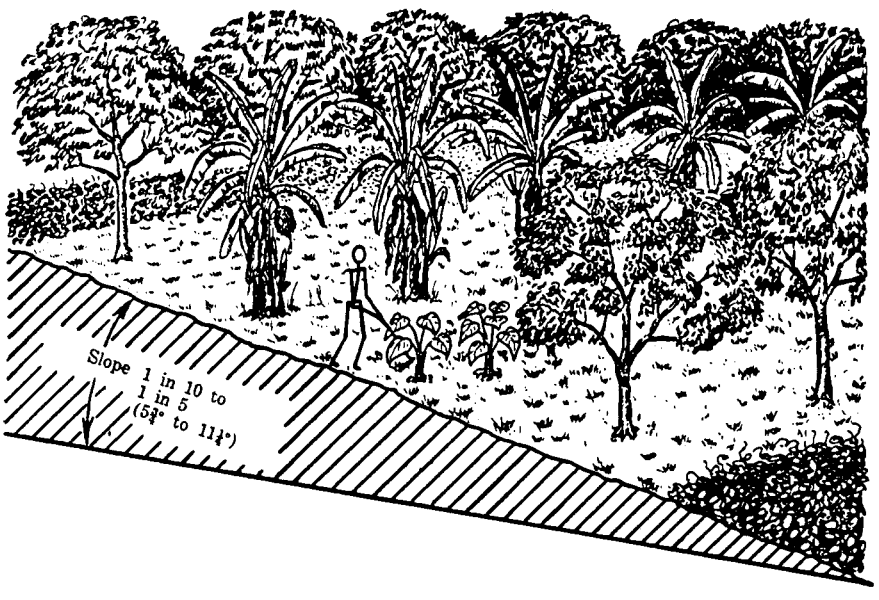
Protect existing streams and gullies first, before starting other measures.

FIG. 1



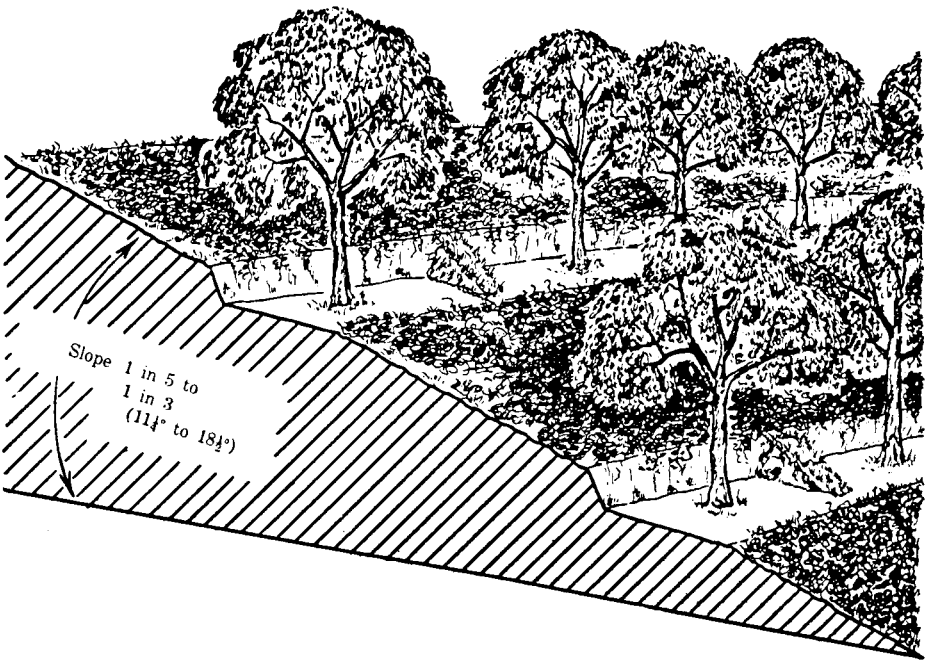
Slope 1 in 10 and below. Suitable for all crops.

FIG. 2



Slope 1 in 10 to 1 in 5. Permanent crops on contour and catch crops

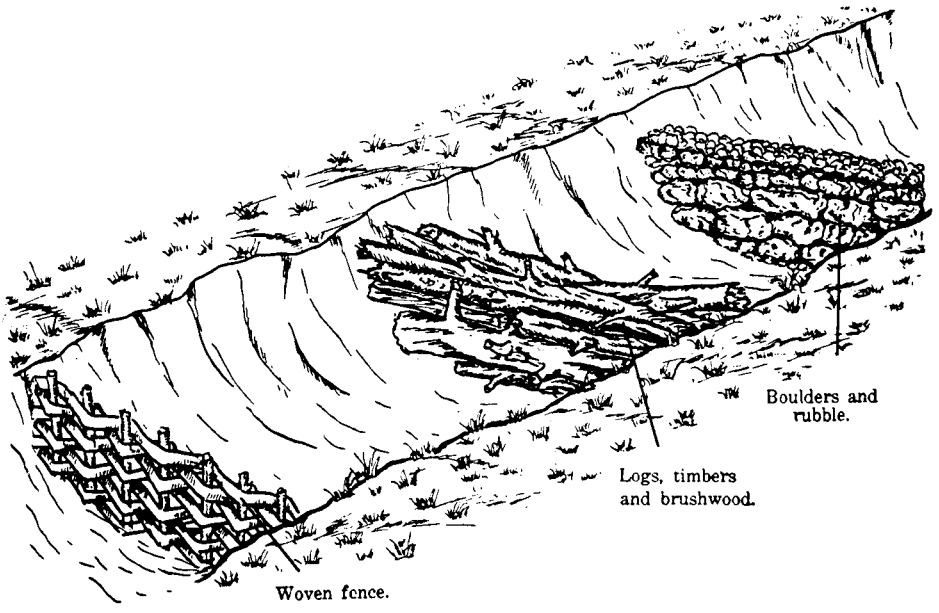
FIG. 3



Slope 1 in 5 to 1 in 3. Terraced permanent crops with covers.

FIG. 4

(a) Check dams in gullies and streams.



(b) Protected drain outlets.

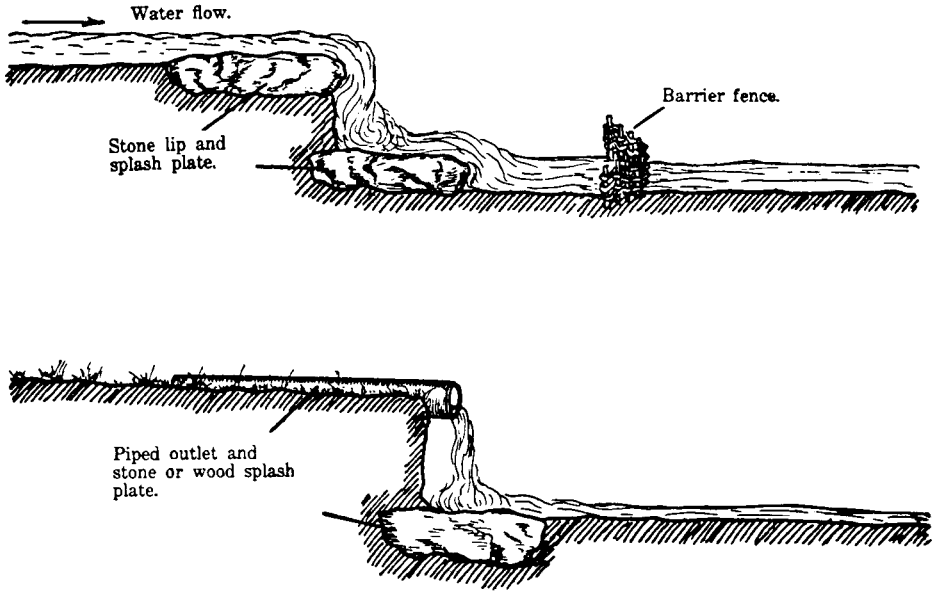
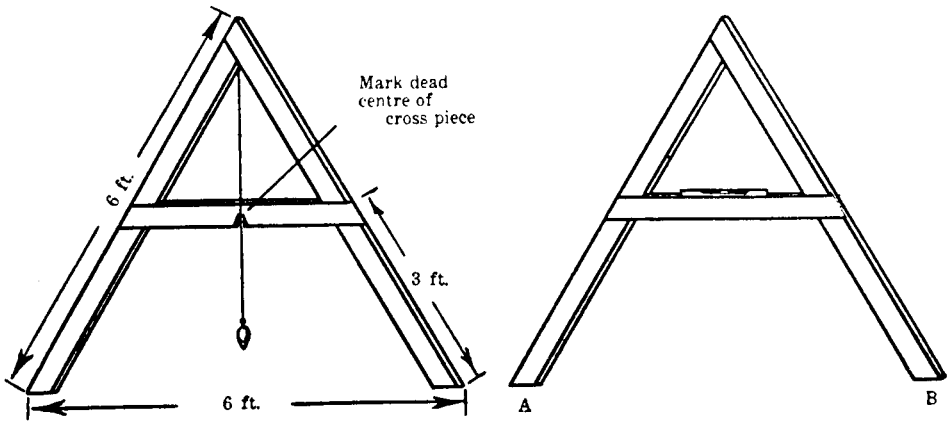
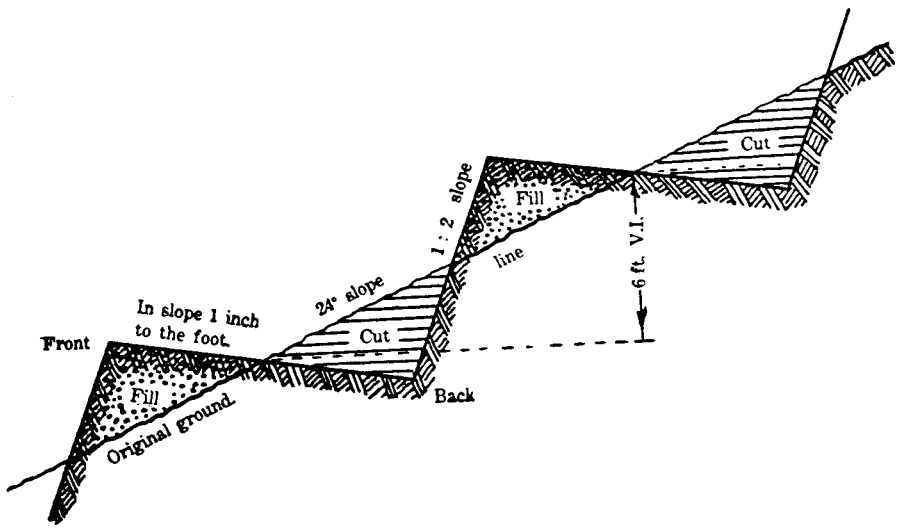


FIG. 5



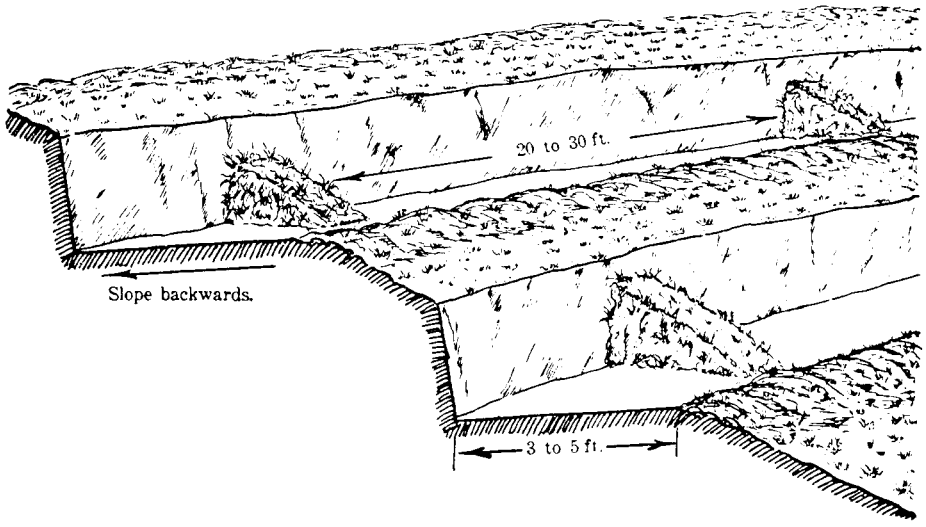
Levelling Triangle.

FIN. 6



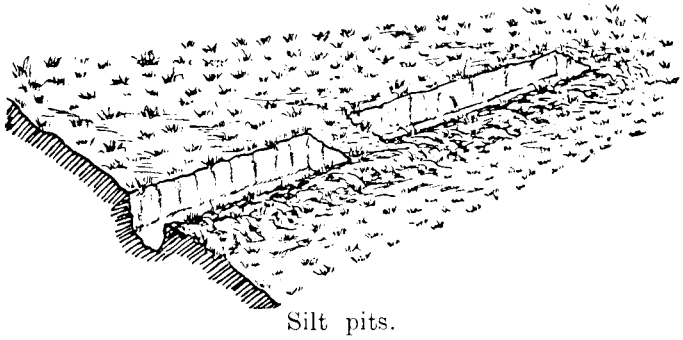
Bench Terraces.

FIG. 7



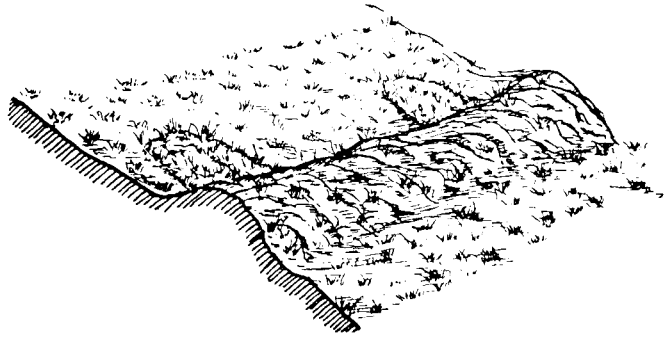
Terrace for tree crops.

FIG. 8



Silt pits.

FIG. 9



Contour bunds.

For further advice, apply to:—

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