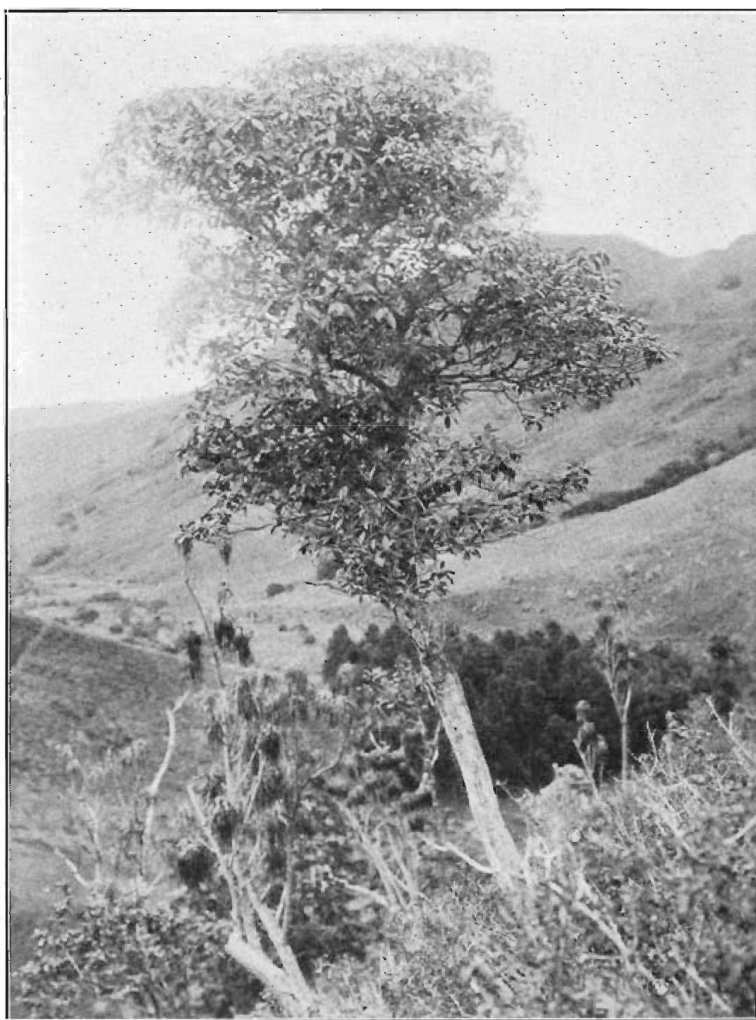


# A MANUAL FOR TREE PLANTERS IN THE HAWAIIAN ISLANDS



AN OPPORTUNITY FOR TREE PLANTING

Agricultural Extension Service  
University of Hawaii, Honolulu, T. H.  
FREDERICK G. KRAUSS, DIRECTOR

Coöperative Extension Work in Agriculture and Home Economics,  
University of Hawaii and United States Department of Agri-  
culture Coöperating. Acts of May 8 and June 30, 1914.

# UNIVERSITY OF HAWAII

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“O ka waiwai o ka aina ua hoopakele ia e na kumulaau.”

“The wealth of the land is preserved by trees.”



Photo by 11th Photo Section, Air Corps, United States Army.

Fig. 2. Typical Waste Land. Once forested, then over-grazed by cattle and now planted to pineapples. The irregular scars in the grass areas in the foreground are earth scars caused by wind erosion. Such waste land can be made to produce an income by planting the right kinds of trees on it.



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# A Manual for Tree Planting in the Hawaiian Islands

By THEODORE C. ZSCHOKKE, Extension Forester

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## INTRODUCTION

The Manual for Tree Planters is divided into three sections. The first is historical and briefly reviews forest conditions, both past and present, in order that landowners may feel encouraged to plant trees in waste places and on bare slopes that once were forested. The second section deals with saving the soil, because much of the tree planting and other reclamation work would have been unnecessary in former agricultural or grazing lands, if soil losses had been prevented. Control measures are suggested, and references are given to publications which discuss soil erosion more fully than is possible in this bulletin. In the third section are considered the different purposes for planting trees, such as for the control of erosion, and for use as woodlots and windbreaks. Trees suitable for planting in different sites are listed, and information regarding the uses of each tree is given. It is expected that circulars about new trees will be issued whenever there are enough trees available for landowners. The third section also contains general planting instructions.

## FOREST HISTORY

The forest conditions in the Hawaiian Islands at the time of their discovery can be estimated very closely by the records of the early settlers and by the testimony of people now living who remember what happened on Molokai and in other regions. In addition, the presence of many broken stone adzes and tree trunks on treeless slopes is evidence that forests once flourished there.

Along the coast there were hala\* (also called screw pine and pandan) milo, kamani, and false kamani or Indian almond. Along streams in the lowlands grew coconuts, bread fruit, hau, and a number of other trees. The dry plains and rocky spurs were practically treeless with occasional wiliwili trees. Very probably the Hawaiian forests began at what is now the lowest occurrence of red clay on the rocky ridges.

In those days there were none of the common shade or ornamental trees and shrubs; no guava, papaya, mango, avocado, cactus, lantana, klu, algaroba, koa haole, cockle burs, pamakani, gorse, Hilo grass, or a host of weeds. Only the dry coastal and

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\* See Notes on Trees for scientific names.

leeward regions of all Islands and the central plain of Oahu and Maui were more or less treeless. The Islands of Molokai, Lanai and Kahoolawe were forested, and on all Islands the uluhe fern was an ornamental fern of the forest and not the pest that it is now.

The sandalwood trade did not destroy the forests or exterminate the sandalwood, because only those trees were cut which were large enough to have the scented wood. The harm of the sandalwood trade lay in the fact that it accustomed the Hawaiian chiefs to easy money, and when the wood became scarcer, they turned to cattle raising for their cash. The cattle roamed in large numbers in the lowlands and, then, as the food disappeared, they went higher and higher up the mountains eating off the ground cover, loosening the soil and interfering so much with normal forest conditions that the trees died. What the cattle could not reach the goats destroyed. In regions below the line of daily mist, when the forests on top of the ridge were destroyed, the soil dried up and was blown away leaving bare rock or hard subsoil. As a result, but little rain soaked into the soil and in a short time the seepage down the cliffs stopped, thus killing more vegetation. Finally, because the springs at the foot of the mountains dried up, people were forced to abandon their taro fields and settlements. Once the soil was gone, it was difficult for trees to come back; and they never will return as long as goats and cattle are on the land. When the koa and other forest trees disappeared, one of two things happened; either undesirable plants occupied the ground, or the soil disappeared, being blown away by trade winds, or washed away by the heavy rains. Where there was enough moisture, the uluhe fern (sometimes called staghorn) spread rapidly. Elsewhere, Hilo grass prevented the tree seedlings from growing; and in dryer places guava, lantana or klu covered the ground.

In brief, the treeless red clay slopes that are now waste land were not always without forest cover, and there is no reason why they should not be planted to worth while trees or to fodder plants if the region is suitable for grazing.

The need for forest protection was recognized by Dr. Hillebrand in 1856; and later on, reforestation was begun with the object of increasing the supply of underground water. In the course of time, two agencies carried on extensive tree planting projects. The first was the Board of Agriculture and Forestry, which, through the Territorial Forester, has been planting trees on the very extensive area of treeless public land that is in urgent need of reforestation if the underground water supply of the Islands is to meet the demand for irrigation water. The need for this work is serious, and the appropriations of the Territorial Forester are limited, yet he has been able to furnish advice and thousands of trees to such landowners as applied to him.

Another agency interested in reforestation work is the Hawaiian Sugar Planters' Association. Its foresters have introduced



hundreds of kinds of trees and have made trial plantings in different sites. As a result, the sugar plantations have set out trees on many of their mountain lands. The Bishop Estate and many landowners on all of the Islands have also done much tree planting.

The third agency interested in tree planting is the Agricultural Extension Service of the University of Hawaii. The Territorial Forester, the Hawaiian Sugar Planters' Association, and the Agricultural Extension Service have three distinct lines of work. The first is concentrating his efforts on the public lands in forest reserves. The second is busy on lands owned by sugar plantations, while the Agricultural Extension Service confines its efforts to encouraging tree planting on waste private land in agricultural regions outside of forest reserves. The Territorial Forester coöperates in this work by furnishing trees free to landowners who have agreed to plant them in accordance with the recommendations of the Agricultural Extension Service. The smallest as well as the largest landowners or farmers may call upon the Agricultural Extension Service and its County Extension Agents for suggestions or help in caring for waste land.

As a result of the past tree planting projects, it is possible to see how well trees will grow in a variety of sites. Prospective tree planters would do well to study these examples and thus profit by the experience of others. It is the policy of the Agricultural Extension Service to consider the needs and wishes of the landowner; and every effort will be made to find trees or forage plants that will meet his requirements, and which will grow on the land available. Enough is known about introduced trees to recommend trees suitable for planting in nearly all sites and which at the same time are suitable for many purposes, such as for the control of erosion and gullies, for use as windbreaks, firewood, fence posts, cattle fodder and bee pasture, and for the production of nuts and tanbark.

## SECTION 2

### GUARDING SOIL FERTILITY

*Introduction.* Hardly anyone will dispute the statement that land should be put to its best, permanent use. Landowners may be undecided as to what is the best use; consequently land is used wrongly or left idle because the owner does not know of anything better to do with it. The object of this section is to show landowners how they may protect their land from misuse, and to induce them to change their tax-eating waste lands into income producing woodlots.

*Agricultural Land.* Agricultural land has been defined as "that land which for a long term of years will produce profitable crops by proper farming methods." There are three parts to this definition and if any part does not apply to a given tract of land, then that land is not agricultural land.

*Grazing Land.* Land that is too steep or too rocky to plow or that has thin soil may be grazing land. It also includes agricultural land which is of too small an area to cultivate or is too far from markets to make farming profitable. The introduction of new crops, the use of better agricultural methods, or the building of roads, may change this class of grazing land into agricultural land.

*Waste Land.* Waste land is land with an area too small to be worth fencing for grazing, or else is so steep or dry that stock grazing on it will start erosion. Although many small landowners have waste land, only a few have done more than plant a wind-break or raise some trees for firewood. A landowner should set for himself the goal of having a well-developed farm, namely, one in which all waste land is fully stocked with useful trees.

*Loss of Soil Fertility.* The value of agricultural land depends upon the fertility of the top soil. When this fertility is lost, the soil is said to be thin, poor or worn out. The loss of soil fertility is due to one of two preventable causes: either failure to return to the soil the plant foods removed by cropping the land, or to the disappearance of the top soil itself. This latter process is called soil erosion, and in the Hawaiian Islands it occurs in three forms, namely: sheet erosion, gullying, and wind erosion. Sheet erosion results from rain removing the fertile top soil over the entire field. Gullying is caused by rain water running downhill in channels, and wind erosion is caused by the steady trade winds blowing away soil particles on exposed slopes. All of these forms of erosion are preventable. They can be stopped in the early stages, but if left alone they will totally destroy the land. The renewing of soil fertility by the rotation of crops and by the use of green manures and fertilizers, which, because they are well established methods among up-to-date farmers, need not be considered here. The prevention of erosion will be taken up because the harm of erosion and the ways of preventing it are so little understood that it is generally neglected. The chief cause of erosion, according to Dr. J. Russell Smith, author of "Tree Crops, a Permanent Agriculture," is the custom of using on hillsides and on sloping land the same farming methods that have proved valuable on the level lands of the valleys. Many landowners and tenants, both here and on the mainland, act as though they believe that any land is agricultural land if they can climb it with a plow and mule and not fall off. The fact that such land is abandoned as worthless after a few crops should convince even the most optimistic that such land should never have been plowed in the first place. The protection of the top soil cannot be too strongly emphasized. It is the first few inches at the top and not the miles of rock below that make farm land valuable. The landowner should carefully study land similar to his and decide for himself whether his intended use of the land will prove to be the best use. There are entirely too many eroded slopes which were plowed downhill for a few years and then abandoned as worthless. It would be far more sensible for a

person to harvest mangoes by cutting off the fruit-bearing branches ; for the tree, in time, can grow new limbs, but the land cannot get a new layer of top soil in the lifetime of the owner or of his grandson even. In other words, the careless cultivation of slopes for one or two years, will rob the land of the fertility that nature accumulated through centuries, and which man cannot replace, except at great expense and after years of effort.

*Sheet Erosion.* Sheet erosion is often unnoticed, but it does much harm by removing the fine particles in the top soil and with it

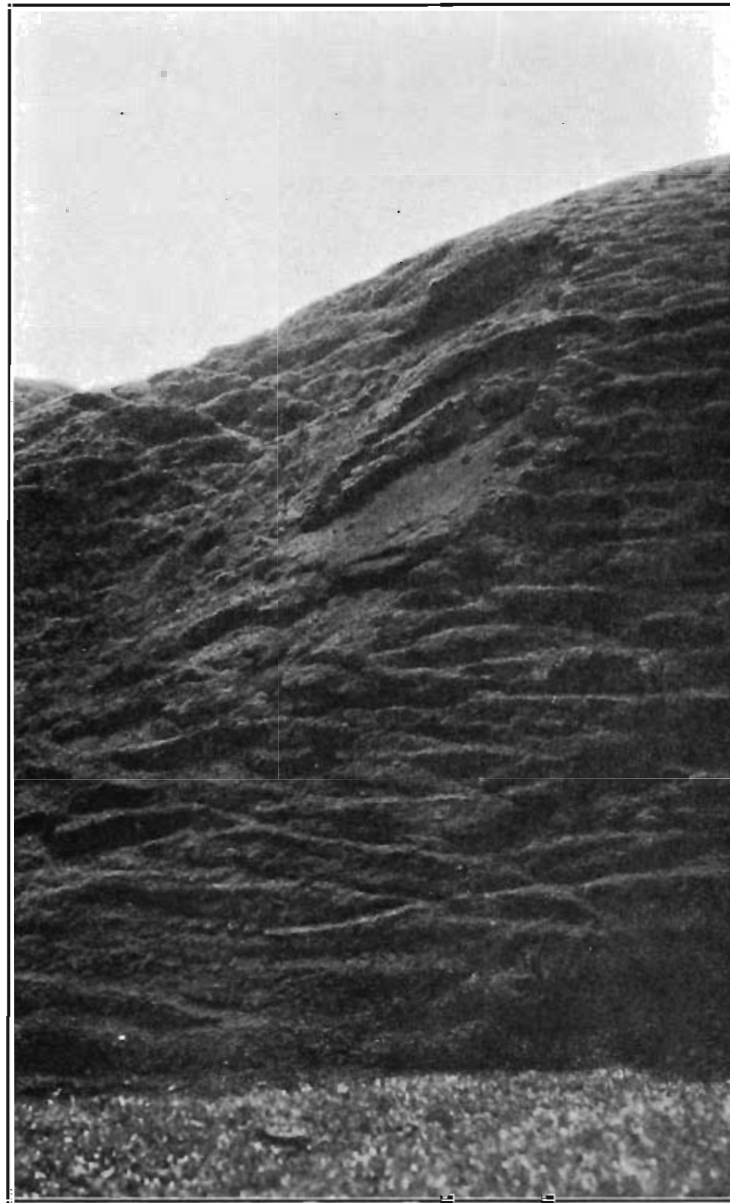


Fig. No. 3—Waste Land. Sheet erosion on the entire area and wind erosion started at the criss-cross trails on an over-grazed steep slope. Tree planting will save the soil. (Photo by Territorial Forester.)

the fertilizers applied by the farmer. The quantity removed at any one time depends upon the fineness of the soil, the steepness of the slope, the nature of the soil cover, and upon the severity of the rain. The loss is permanent because the soil is removed faster than the weathering of the subsoil can make new soil.

*Methods of Preventing Sheet Erosion.* The simplest way to prevent sheet erosion is to cover the land with a dense mat of grass. This method should be used on areas that are lying fallow. An attempt has been made to plow sloping land on a contour, that is, around the hill and not up and down the slope. This method is excellent as long as the subsoil is loose enough to soak up all the rain water as it falls. However, on moderate slopes with the usual clay subsoil of the Hawaiian agricultural lands, this method leads to disastrous land slides or severe gullying. The better way is to plow around the hillside giving the furrow a three percent grade. It is important that drainage ditches should be provided at intervals to lead away the rain water flowing along the furrows. The narrow ridge terrace is used on all sugar cane plantations, but for pineapples and other crops the broad-base terrace probably is preferable, if the soil is deep enough to permit its being used. For details, the landowner should read Farmers' Bulletin No. 1386 on "Terracing Farm Lands." A copy may be secured from the Office of Information, U. S. Department of Agriculture, Washington, D. C.

It should be clear that plowing furrows down a slope is all wrong if the fertile top soil is to be kept in place. It is unfortunate that this practice is still so common, especially on rented land; but as long as the landowners permit such waste, either through ignorance, indifference or vaguely worded leases, there is no reason to condemn the tenants who commit the waste. Suggestions as to the proper wording of leases to prevent waste can be obtained from the County Extension Agent.

*Erosion by Gullies.* Gullies sometimes follow serious sheet erosion, especially on steep slopes; but they usually begin in furrows plowed downhill, in wheel ruts and cattle trails, and in natural depressions along which rain water flows and forms a channel. At present, the most common source of such gullies is in or below pineapple fields where the accumulated drainage water from the fields rushes down steep slopes, forming new gullies, which at times destroy considerable grazing land or invade the pineapple fields.

*Control of Gullies.* Farmers' Bulletin No. 1234 of the United States Department of Agriculture explains fully how gullies may be controlled, and landowners intending to do any of this work should secure this publication from the Office of Information, U. S. Department of Agriculture, Washington, D. C., or from the County Extension Agent.

Brush dams at frequent intervals will control small gullies on moderate slopes. Posts are set firmly, and hog wire fencing or

brush, or both, are piled behind the posts and held in place by cross bars. The point where the dam touches the bank should be protected by brush fastened to the slope. It is important that the dam be made lowest in the middle. In large gullies the dams should be low, about four feet high, and made of stone. When the gully is filled in to the top of the dam another can be made, but unless there is a substantial dam that will not rot out, this practice is not wise where freshets occur. The water falling over the top of any dam should be prevented from undermining the foundation. A layer of brush or a stone floor at the base of the dam will prevent undermining, and neglect of this precaution is the reason for the failure of many dams.

The upper ends of gullies, where the water from the slope pours in, are points that must be protected. Live posts of koa haole, tall enough to reach to the top of the gully, should be set firmly and brush should be packed tightly behind them and held in place by cross bars. As in other dams, undermining must be prevented. These structures must be put in wherever water enters the gully, if the owner wants to keep the gully from extending further into his land.

*Young Gullies in Pastures.* Wheel ruts, cattle trails and natural depressions can easily develop into gullies. The wheel ruts should be filled in, or else the water should be diverted every few feet. Outlets for water two or three feet wide and deep enough to intercept the water should be put in at short intervals in cattle trails. Narrow outlets are useless as they are easily filled up by trampling. Depressions which might develop into gullies should be planted to grass and protected with low brush barriers. Alahee is excellent for this purpose.

*Wind Erosion.* The exposed treeless slopes are very apt to contain earth scars caused by wind erosion. Any breaks in the soil cover, such as those caused by cattle trails, uprooted trees, or by the death of plants during a dry season, give the steady trade winds a chance to blow away particles of dry soil. The surface soil and then the subsoil is blown away, until in a short time a bank is formed which dries out for a distance of several feet, killing the grass at the edge. Each year the wind scours deeper into the subsoil, and the under-cut sides cave in, until the scar covers acres of ground. In fact, the scar will grow until a change in the slope breaks the force of the wind.

*Control of Erosion by Planting.* In pasture and agricultural lands, earth scars and shallow gullies can be held in check by planting forage grasses and shrubs. The coarse grasses used for green manuring in pineapple fields will spread over scars if moisture conditions are right. Where these coarse grasses would be objectionable, the low and hardy carpet grass (*Paspalum compressum*) makes a good soil cover and pasturage, too. Buffalo grass (*Stenotaphrum americanum*) is another excellent grass for use in regions where the koa thrives.

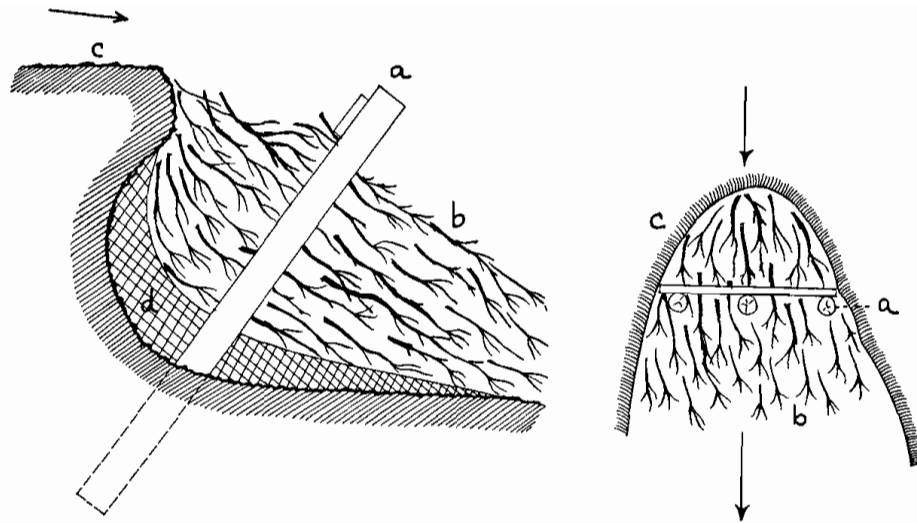


Fig. No. 4—How to Control Gullies. Brush piled into the head of a gulley to prevent further caving of the bank. (a) Posts and cross bar to hold brush in place; (b) brush; (c) surface of ground; (d) fine brush or grass.

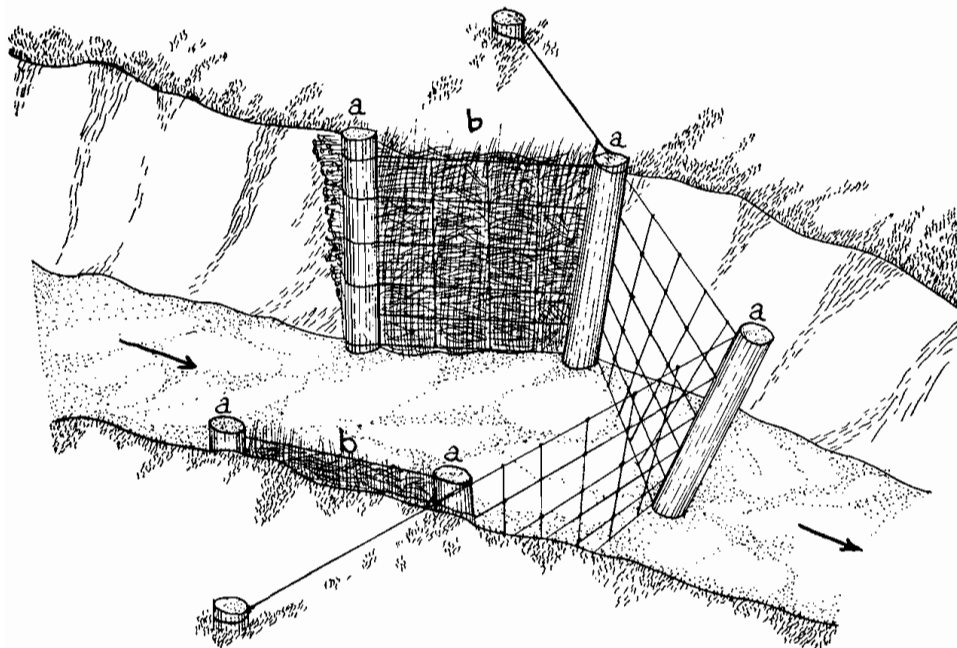


Fig. No. 5—Woven Wire Dam in a Gulley. The dam is intended to catch rubbish and then it will hold dirt. Brush may be piled against it. (a) post; (b) brush piled against the bank to prevent washing around the dam.



Fig. No. 6—An eroded and gullied slope showing holes for trees.  
Photographed in November, 1926, by The Bishop Estate.

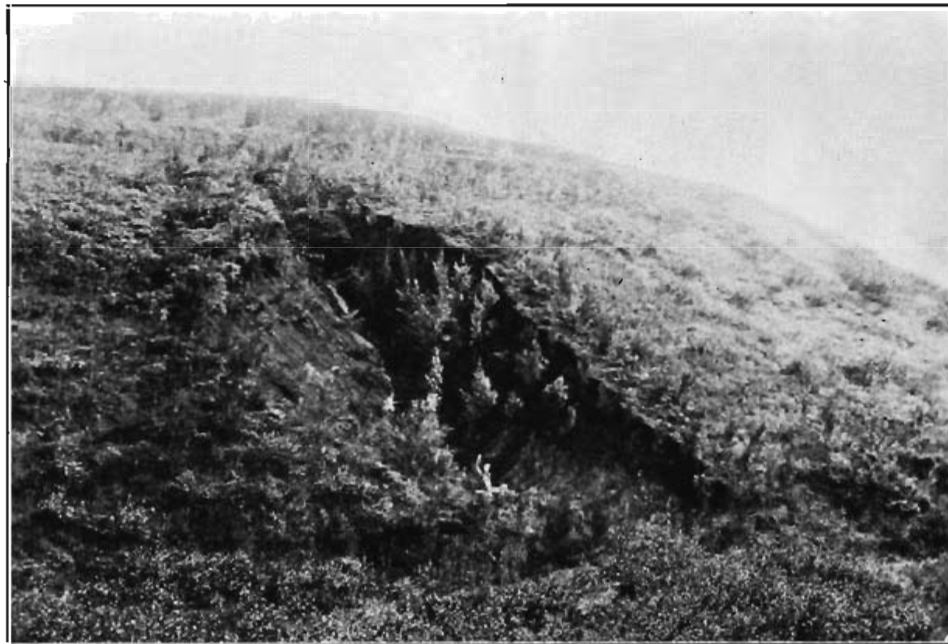


Fig. No. 7—The same slope as in Fig. No. 6 photographed in November, 1929. The salt marsh ironwood trees are beginning to send up root sprouts. The trees are 4 to 10 feet high.

If a windbreak is needed for the grass, the alahee is a hardy shrub, which is not attacked by cattle and which will grow readily in dry places. Further information regarding forage grasses and fodder plants may be secured from the County Extension Agent.

Trees recommended for dry earth scars are: saltmarsh ironwood, to be planted on the scar; and lowland ironwood and silk oak, to be planted around the scar. The selection of trees for planting in or around gullies will depend upon the wishes of the landowner.

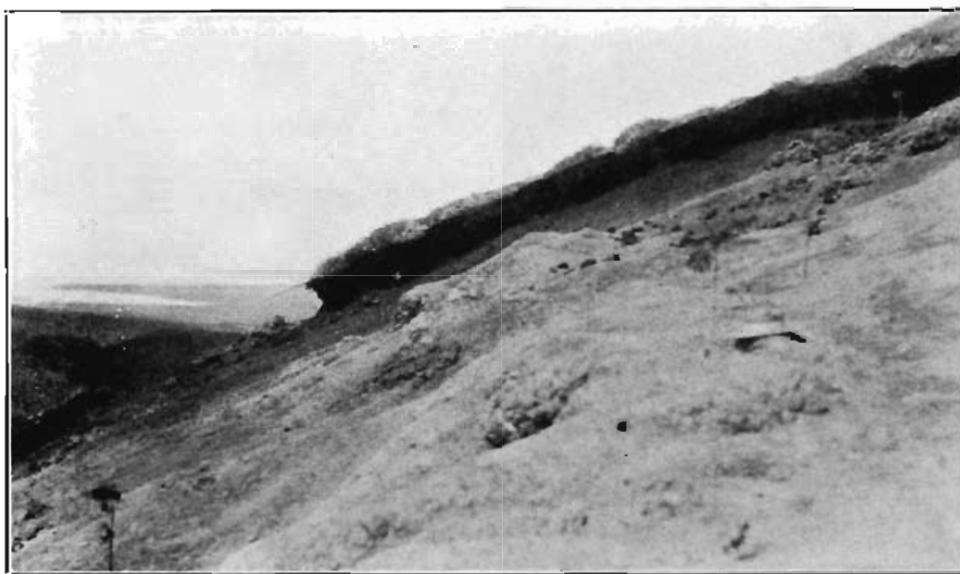


Fig. No. 8—Example of wind erosion on a grassy slope. Note undercut bank and exposed subsoil. Seedling trees planted under the direction of the Hawaiian Sugar Planters' Association. (Photo from H. S. P. A. collection.)

### SECTION 3

#### THE UTILIZATION OF WASTE LAND THROUGH TREE PLANTING

*Introduction.* The use that may be made of waste land will depend upon local conditions. In a grazing region, the wind scars and areas of sheet erosion should be planted to hardy grasses that spread by runners. Landowners having this problem should consult the County Extension Agent or read the circular on forage grasses.

There are many bits of waste land that are suitable for fruit trees, and upon which the landowner should consider raising enough fruit for home use, especially if the agricultural portion of his farm is fully cultivated. Fruit trees on waste land where they will receive little or no attention, cannot compete with trees that are properly cared for; hence the only fruit trees to receive attention in this section are a few that are adaptable to waste land.



As a rule, therefore, the trees recommended for planting on waste land are: those for windbreaks; those suitable to form a woodlot; and those used to hold soil in place, as in wind scars and gullies.

*Windbreaks.* The pioneer farmers of the prairie region in the States did not prosper until they had done three things, namely, developed a proper method of cultivating the soil (dry farming), found suitable crop plants for their land, and planted windbreaks. At present, these prairie farmers are raising splendid crops, the best of which come from the sheltered side of windbreaks. There is no question about the beneficial effects of windbreaks. The only point about which there is any disagreement is the choice of trees. The usual windbreak in this Territory consists of four rows of trees, the two rows on the windward side being lowland ironwood, and the two other rows being swamp mahogany. Both of these trees will grow on almost any kind of soil. They do not produce root sprouts, they endure wind and drought and make rapid growth. The objection advanced against using these trees for windbreaks is that their roots interfere with the crops. This is a valid objection, but the benefit of the windbreak more than offsets the harm done by the roots of the trees. This damage can be largely prevented by digging a trench two to three feet deep between the field and the trees. It should be remembered that windbreaks need a reasonable amount of room for their roots, and that one way to secure this space is to use the land next to the windbreak as a farm road.

It is the general practice to plant windbreaks as a protection from the strong trade winds, but it would be well if landowners, especially banana growers, also planted windbreaks to shelter their crops from the violent Kona storms. Only a few of these storms are destructive; yet they are a serious risk, as they can destroy an entire banana plantation in a very short time.

In regions having a moist climate, it is not wise to plant sugar cane to the leeward of a windbreak, as cane in such places is more severely attacked by eye spot than cane exposed to the drying effect of the trade winds.

*Benefits of Windbreaks.* In the Hawaiian Islands, the chief benefit of a windbreak is to shelter the crop from the force of the wind. There is a narrow strip just to the leeward of the windbreak that has an eddy; and for a distance equal to about twenty times the height of the trees in the windbreak, there is a calm belt beyond which the effect of the wind is felt more and more as the distance from the windbreak increases.

Another effect of a windbreak is the decrease in evaporation from the field because of the lowered wind velocity.

The planting of windbreaks as a shelter to the home and to farm buildings should be considered also. In windy situations, the escape from the strong winds will be a relief. By putting the windbreak far enough from the house, the landowner can get the benefit of the cooling wind without its force.

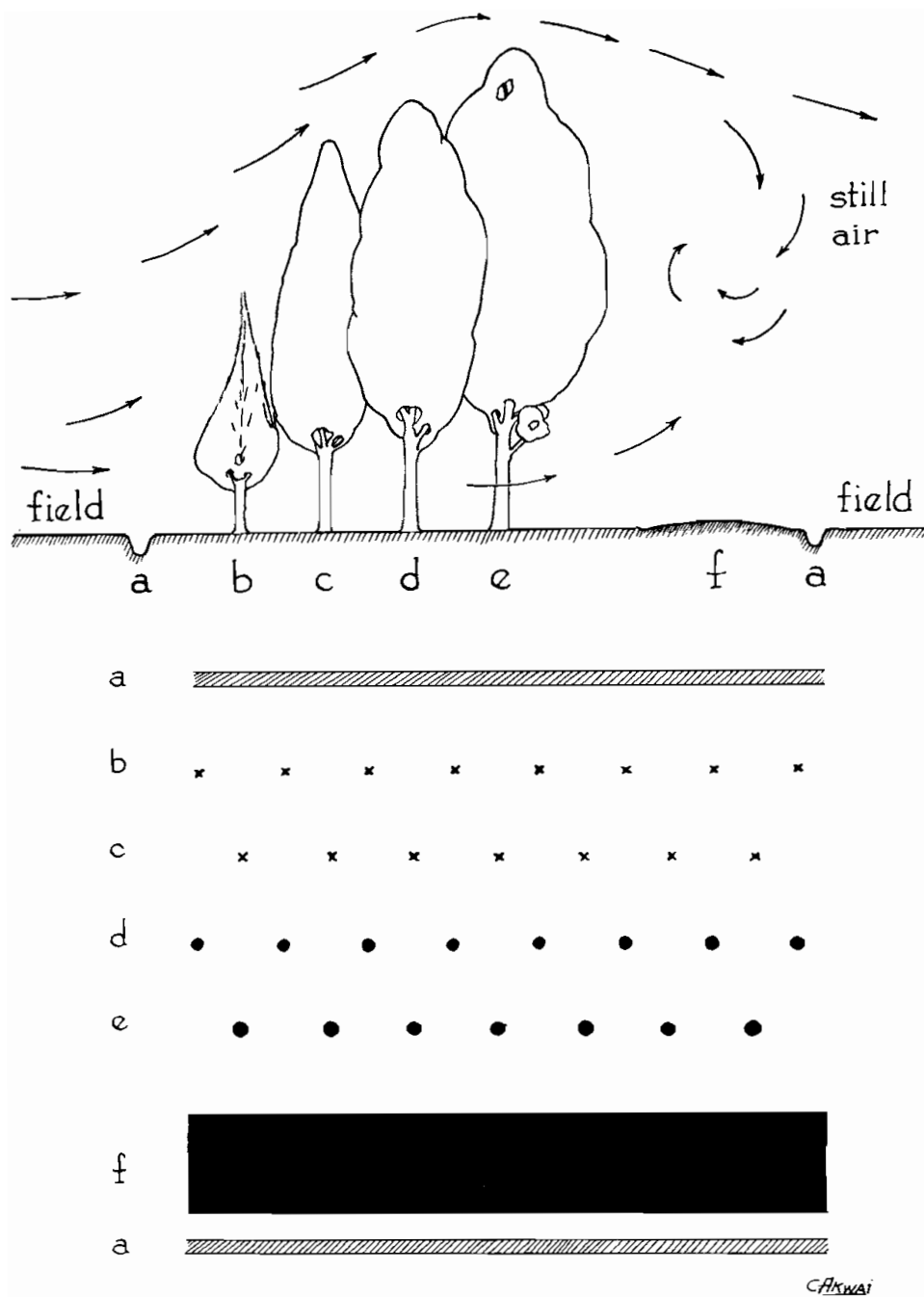


Fig. No. 9—Diagram of a Windbreak. a. Trench two to three feet deep to keep tree roots out of the field. b. Topped lowland ironwoods to form a hedge. c. Lowland ironwood (*Casuarina equisetifolia*). d. and e. Swamp mahogany (*Eucalyptus robusta*). f. Farm road.

*A Windbreak for the Beach.* The windbreak on a beach is made of lowland ironwood trees planted in two or more rows, the rows being six feet apart and the trees four or six feet apart in the row. The trees of the second row should be staggered, that is, planted opposite the spaces between the trees of the first row. If three or more rows are planted, the trees in the outside (windward) rows should be cut off four feet from the ground when three inches in diameter, in order to form a hedge, thus making a better windbreak close to the ground. If a hedge resistant to salt spray is desired, a shrub called *Conocarpus erecta* can be planted in the shelter of the windbreak. Hau, sea grape or pandan can also be used as a shelter behind which other trees or shrubs may be planted.

*Windbreaks for Dry Sites.* Experience has shown that the lowland ironwood and swamp mahogany are the best combination of trees for windbreaks in dry places. The ironwood is planted in the two windward rows, and in exposed situations the swamp mahogany may be set out a year later, though this is not essential.

*Shelter Belts.* If there is waste land available, the windbreak can consist of two rows of ironwood; and in their lee as many other rows of trees can be set out as seem desirable, thus forming a source of supply for firewood and fence posts. It is not wise to fell a row of trees in the windbreak for firewood or other purposes, unless the windbreak is over four rows wide. Felling a tree here and there in the windbreak for firewood is another matter, and in the case of eucalyptus trees with tall bare trunks is actually helpful, as the sprouting stump makes a larger screen against the wind.

*Trees for Windbreaks.*

Lowland ironwood, in all sites.

Swamp mahogany, in all sites except the beach.

Silk oak, in lantana and guava sites (it is often used, but black butt is preferable.)

Black butt, brush box, and lemon scented gum, in guava sites.

*Shade for Stock.* It often is desirable in a hot, dry region to plant trees for shade in the pasture. To insure quicker results the waste water from a trough should be piped to the trees, if this is practicable. At any rate, the trees must be protected by a fence, and only evergreen trees should be selected. On the windward side of the Islands, the true kamani and the banyans are excellent for this purpose. In dry regions there are no widespreading trees that will do as they shed their leaves. In a sandy site, athel or tamarisk, opiuma, and ironwood are suitable. Elsewhere thornless algaroba is about the only widespreading lowland tree that will endure wind and drought. Swamp mahogany and ironwoods can be used to form a small grove, with silk oak in the lee of the trees, if moisture conditions are favorable. If the overflow from a trough is available, then banyans should be planted, as these make dense shade and are widespreading. Kukui trees in gulches often

are used for shade, but only those that are open to the wind are suitable for stock.

Shelter belts or groves in pastures should prove desirable both as shelter for stock during a rainy spell and also as a source of posts for line and paddock fences.

*The Farm Woodlot.* On the mainland, the farm woodlot is of great importance to the farmer. It furnishes firewood, fence posts and poles for his own use. In the winter he can use his team in hauling out railroad ties, posts, and even saw logs. It is a convenient source of cash always available in an emergency. In the Hawaiian Islands, the landowner should start a woodlot on his waste land and raise his own firewood, fence posts, and poles for corrals. If he so desires, he can plant trees whose nuts or fruit can be sold, or, he can raise trees for tanbark, for poles, piling and for saw logs. It is very poor economy to pay fifty cents for imported fence posts when the landowner can raise his own, and thus get an income from his waste land.

*Kinds of Waste Land.* For the convenience of landowners, the ordinary non-agricultural lands are here named after some characteristic or after the common plant or tree found on them. The lack or abundance of moisture in the soil is the factor which determines the choice of trees in each site and, as this also affects the other vegetation, it is safe to judge the local moisture conditions and the suitability of the site for a given tree by the thriftiness, as well as by the variety of shrub growing there. The klu site merges into the lantana site and this in turn blends with the guava site. The three shrubs often occur together, but the typical klu site is much drier and usually has poorer soil than the lantana site.

*Trees for Waste Land.* The following notes on trees and shrubs suitable for different sites also show the uses which can be made of them. Details regarding the plants named in these notes are given at the end of this bulletin.

*Beach Site.* The beach site includes the sandy area beyond the high water mark. It usually is treeless and dry and is exposed to wind and to salty spray. The following trees and plants are recommended for planting near the coast:

*Firewood:* athel, ironwood.

*Fodder:* Australian saltbush, Bermuda grass.

*Shade:* athel, *Barringtonia asiatica*,\* coconut, hala, hau,\* Indian almond,\* ironwood (lowland), kamani,\* milo,\* noronhia.

*Shrubs:* *Conocarpus erecta* (for hedge), sea grape.

*Windbreak:* athel, lowland ironwood.

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\* These trees are also ornamental because of their flowers.

*Salt Marsh Site.* The salt marsh site is marked by salt-loving plants, such as the fleshy "pickle weed." The trees listed will grow on mounds or high ground in or beside the swamp. The only tree in Hawaii that will grow in salt water is the mangrove. The following trees are recommended:

*Firewood:* mangrove, salt marsh ironwood.

*Posts:* looking glass tree.

*Shade:* *Barringtonia asiatica*,\* coconut, hala, hau,\* Indian almond,\* kamani,\* *Lagunaria patersonii*, looking glass tree, milo,\* salt marsh ironwood, sea grape.

*Tanbark:* mangrove. This tree grows on land which is under water at high tide.

*Lowland Fresh Water Swamp Site.* As a rule, this site has too much water for rice, taro or lotus. The trees listed will grow on mounds or high ground in or at the edge of the swamp. The following trees are recommended for planting in this site:

*Firewood:* swamp mahogany.

*Piling:* turpentine tree.

*Posts:* bald cypress, paper bark,\* turpentine tree.

*Shade:* bald cypress, three *Erythrina* species, namely, tiger's claw,\* *E. fusca*\* and cock's comb,\* hala, hau,\* Indian almond,\* kamani,\* milo,\* paper bark,\* swamp mahogany, turpentine tree.

*The Klu Site.* The klu site occurs on the lee side of mountains wherever it is very dry. Near the coast and in valleys the kiawe tree flourishes, and on the rocky ridges the klu is associated with low lantana in the better soil, and with cactus in the rocky places. Only a few trees and shrubs will grow without irrigation in this site and among these are the following:

*Firewood:* koa haole, kiawe, salt marsh ironwood.

*Fodder:* Australian salt bush, ben tree, koa haole, kiawe, klu (thornless).

*Ornamental Shrubs:* *Acacia arabica*, mock orange, pride of Barbados.

*Shade:* *Acacia arabica* (low tree) *Acacia catechu*, three *Erythrina* species, namely, wiliwili,\* *E. caffra*,\* and *E. abysinnica*,\* lowland ironwood, swamp mahogany.

*Soil Binder:* Alahee, Australian salt bush, salt marsh ironwood.

*Lantana Site.* The lantana site is dry and occurs at the base of ridges. Some klu is found here, but in the gullies and elsewhere stunted guava is growing. This site is usually at a slightly higher

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\* These trees are also ornamental because of their flowers.

elevation than the klu site and a larger variety of trees and shrubs will thrive here, among which the following are suggested for planting:

*Firewood*: koa haole, lemon scented gum, salt marsh ironwood, swamp mahogany.

*Fodder*: Australian salt bush, ben, koa haole.

*Posts*: brush box, lemon scented gum, paper bark.

*Shade*: brush box, three *Erythrina* species, namely, tiger's claw,\* *Erythrina caffra*,\* *E. abyssinnica*,\* lemon scented gum, lowland ironwood, salt marsh ironwood, paper bark,\* silk oak,\* swamp mahogany.

*Soil Binder*: Alahee, koa haole, salt marsh ironwood.

*Tanbark*: Opiuma.

*The Guava Site*. The guava site projects into the lantana site in the bottom of gulches and higher up the gulches it contains thrifty kukui trees. Everywhere in this site the guava is associated with a luxuriant growth of lantana. At the upper limit, it is associated with koa, but as this usually is in the forest reserve region, this land hardly concerns the average landowner. A large number of trees and shrubs will grow here and the best of these are listed below:

*Firewood*: black wattle, blue gum, madre cacao, longleaf ironwood, salt marsh ironwood, swamp mahogany.

*Fodder*: ben tree, koa haole.

*Fruit and Nut*: avocado, cashew, jujube, kukui, macadamia.

*Ornamental Trees and Shrubs*: Cook pine, white cordia,\* dumbeya,\* ruddy ironwood, sandalwood, silk oak.

*Posts and Lumber*: ash, Australian red cedar, balsa, black butt, brush box, Jamaica yokewood,\* paper bark,\* silk oak,\* turpentine tree.

*Posts*: black butt, brush box, *Eucalyptus crebra*, lemon scented gum, madre cacao,\* paper bark,\* turpentine tree.

*Tanbark*: black wattle.

*Windbreak*: black butt, lowland ironwood, swamp mahogany.

*Mountain Slopes 3000 to 7000 Feet*. Elevation is a factor that must be considered on Maui and Hawaii, because there are many landowners on the slopes of the high mountains who may want to plant trees at an elevation of 3000 feet or more. The mamani tree, if protected from cattle, is one of the best trees for posts in the higher or moister sites. Black locust is suitable for waste land among the settlements. Black wattle will thrive so vigorously as

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\* These trees are also ornamental because of their flowers.

to invade cultivated lands. The blue gum and probably other eucalyptus trees will serve for firewood. Redwood and Japanese cedar, planted by the Bishop Estate at 3000 feet, are growing splendidly in South Kona, Hawaii. The following are suggestions for tree planting on the higher slopes:

*Firewood*: black wattle,\* blue gum, swamp mahogany.

*Poles and Lumber*: in rainy districts, ash, Japanese cedar, paper bark,\* redwood.

*Posts*: black butt, black locust,\* brush box, mamani,\* turpentine tree, redwood in moist places.

## THE KIAWE OR ALGAROBA

*The Kiawe as a Shade Tree.* The kiawe is limited to the dry valleys and lower slopes of the leeward sides of the Islands. In very dry sites, it is a low, bushy tree that is leafless part of the time, and, because of the dryness of the site, it is likely to be spiny and have inferior pods. The trees are much larger in the valleys and do not shed their leaves. As a shade tree, the kiawe is often the only tree available, and large trees around a house are valuable. As the kiawe is likely to be uprooted during a violent storm, especially after the ground has been soaked by a long continued rain, the shade trees should be protected by a layer of rocks around the tree. A low mound fifteen to twenty feet in diameter and not over two feet high at the center will so weight the roots that the tree will stand. To prevent storms from breaking the large limbs, the tree should be pruned every few years.

Wherever kiawe is planted for shade, the thornless variety should be used. Thornless trees occur in many places; but if none are found locally, the Agricultural Extension Service can secure averaged sized pods from thornless trees. Because many of the seeds may not come true, it would be advisable to plant a dozen seedlings in one spot, and then save the best and transplant or destroy the others.

Before leaving the subject of kiawe shade trees, it is necessary to add a caution to the householder. Clothes lines should not be located near kiawe trees, as the falling flowers make an indelible stain upon any laundry they touch.

*Variation in Kiawe Pods.* Every stock raiser knows the value of kiawe or algaroba pods for stock feed. He gratefully accepts whatever pods fall to the ground, little realizing that he can do a great deal toward increasing the number, size and quality of the pods produced by the grove. A single blossom may produce from one to a dozen pods, and though such fruitful flowers may occur on any tree, they are very abundant on only a small number of trees. The trees also vary as to the size, shape and food value of

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\* These trees are also ornamental because of their flowers.

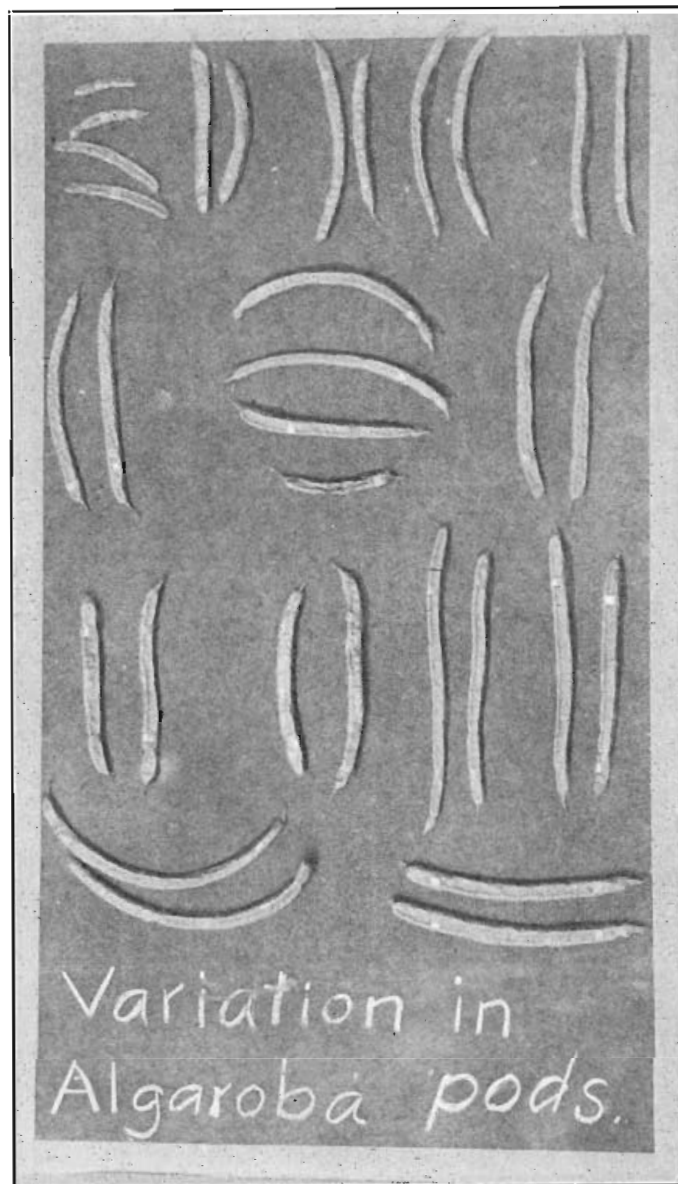


Fig. No. 10—Variation in Kiawe Pods. Top row: Small, thin, worthless pods. The last one is not eaten by stock. Second row: These pods are too thin to be worth picking or keeping for stock feed. Third row: Plump, short pods, average pods and long, thin pods. Good enough for stock feed but not in the prize-winning class. Bottom: Crescent pod; 40 to the pound. The straight pod has won several first prizes at the Territorial Fairs; 30 to the pound.

Note: Some of the large pods are from thornless trees.



the pods which they bear. The pods on one tree may be only three inches long; and on another tree they may be three times as long, but so thin and narrow as to be worthless as stock feed. Other pods are so unpalatable that cattle leave them on the ground, while under adjacent trees the cattle eat the pods as soon as they fall. Even hogs show a marked preference for some pods and reject others. Chickens greedily eat plump, thin-skinned pods but leave most of the other kinds alone.

*Improvement of the Kiaue Grove.* The owner of a grove of kiaue trees should study the trees and mark those having undesirable pods, in order that these trees may be felled for fuel or posts. If he fells his trees without consideration for the quality of the pods, he probably will decrease the proportion of desirable trees. It may be wise in some cases to plant seeds from productive trees and protect the seedlings by piles of brush or tops from poor trees.

#### TREE PLANTING INSTRUCTIONS

There can be no comparison between the methods and cost of planting on the mainland and those developed in the Hawaiian Islands. Each is successful in its own field and each would prove unsuitable if applied outside of its region. This explanation is necessary in order to prevent misunderstandings when cost and other tree-planting data in one region are compared with similar data in the other.

*Clearing Off Brush and Grass.* Often it is well to leave brush as a windbreak for the young trees and, therefore, instead of clearing off all the brush, it is better to cut lanes about five feet wide. In grass land the grass should be dug up by the roots, leaving a bare, circular space so large that the wind cannot blow standing grass over the young tree. For example, if the grass is eighteen inches high, the clearing should be four feet in diameter. Some tree planters find it advisable to raise their trees in paper pots 6 or 8 inches deep and let the trees grow tall and then topping them at a height of a foot. The tree forms a sturdy trunk and before planting it, the top is allowed to grow till the tree is over two feet high. It is then able to keep above the grass and most of the brush. The advantage of this method is that it cuts down the cost of clearing the land and makes weeding unnecessary.

*Digging Holes.* The young tree should be given the best possible start by being planted in pulverized soil in a properly made hole. In loose, fertile, black soil almost any kind of hole will do, but in dry sites or on earth scars, a large, properly made hole is absolutely necessary for success. In guava and lantana sites the holes should be a foot deep; and in order to get this depth with a mattock, a patch two to three feet square should be dug up. Holes on earth scars, in windy places, and in klu sites should be deeper. On steep slopes the laborers are very apt to pull down the hillside

and make a small platform of loose soil on the surface which will wash away during a storm. In such situations a trench a foot or more deep and two feet long should be dug and the subsoil should be removed. The top soil on the slope should then be dug down, filling the trench, and then the subsoil should be loosened. There are two advantages in using this method; the hole is made deep enough and is filled with top soil, and there is little danger of the soil being washed away during a storm.

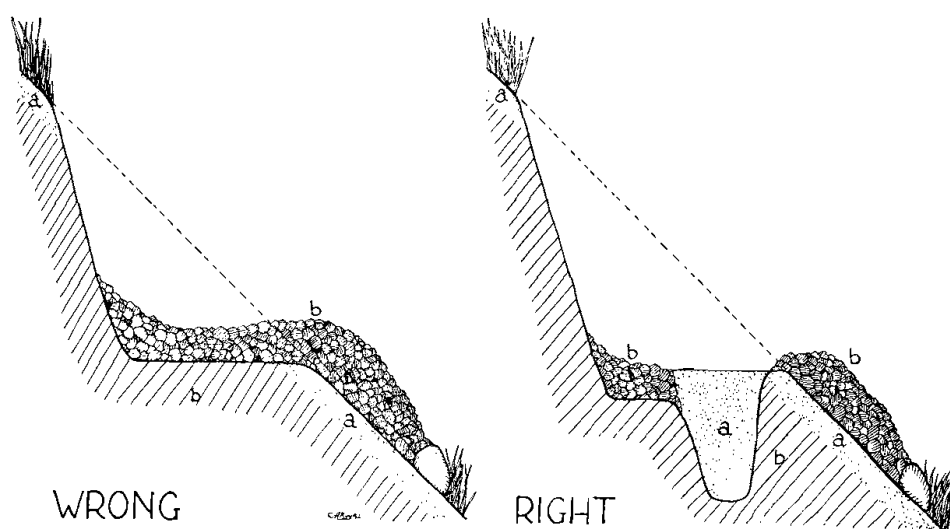


Fig. No. 11—The Wrong and the Right Way to Dig Holes for Tree Planting on Slopes. (a) Top soil. (b) Subsoil.

*Cost of Holes.* In an hour one man can dig ten holes 12 to 18 inches deep in guava or lantana slopes. If the subsoil is very dry, as in earth scars, then he cannot dig more than six holes per hour. In tall grass that must first be mown, the rate is five per hour. If labor is forty cents an hour, then holes will cost six to ten cents each in dry sites and about half that much where the soil is loose, as is the case in the lantana slopes. This does not include the cost of cutting brush.

*Blasting Holes for Trees.* Digging holes in the hard subsoil of scars is a laborious task. Better results can be secured in *dry* subsoil by using dynamite. If the clay subsoil is wet, dynamite cannot be used because it will compress the clay instead of shattering it. Details regarding the use of explosives may be secured from the local dealers in dynamite, as the powder companies have issued booklets on the use of explosives on farms. In these, subsoiling, blasting stumps, digging ditches, and filling shallow gullies are discussed.

*Fertilizers.* It may be a good plan to drop a handful of fertilizer into the bottom of a hole a foot deep instead of spending money in making a deeper hole. Whether this method is better will depend upon the nature of the subsoil. If it can be readily penetrated by

roots, then a little fertilizer will stimulate tree growth. If the subsoil is hard and apt to be dry, then a deeper hole will hold more water, which will induce growth.

*Plowing.* Tree growth will be much more rapid in plowed land than in unplowed land, therefore, where it is possible to do so, trees for windbreaks and shelter belts should be planted in the middle of a plowed strip, the holes for the roots being dug in the bottom of the furrows. It is a mistake to set the trees on top of the plowed ground and pile dirt around them. Good results can be obtained by planting trees in pineapple fields that are about to be abandoned.

*Spacing of Holes.* The spacing of holes will depend upon the use that is to be made of the wood or tree. Close spacing, say 6 ft. by 6 ft., is necessary if poles are needed and 25 ft. by 25 ft. or more if nut or fruit trees are planted. Close spacing is recommended on scars and in gullies where quick results are desired and also where posts, poles, and saw logs are wanted. By thinning out the trees it will be possible to get each of these products, whereas if trees for saw logs were planted eighteen feet apart they would be too short and too full of limbs to be worth anything for lumber.

#### NUMBER OF TREES PER ACRE

Spacing	No. of Trees	Spacing	No. of Trees
2 ft. x 3 ft.	7,260	10 ft. x 10 ft.	435
3 ft. x 3 ft.	4,840	12 ft. x 12 ft.	302
3 ft. x 4 ft.	3,630	15 ft. x 15 ft.	200
4 ft. x 4 ft.	2,722	18 ft. x 18 ft.	135
4 ft. x 6 ft.	1,815	20 ft. x 20 ft.	110
6 ft. x 6 ft.	1,210	22 ft. x 22 ft.	90
6 ft. x 8 ft.	907	25 ft. x 25 ft.	70
8 ft. x 8 ft.	680	30 ft. x 30 ft.	50

The number of trees needed to plant an acre, if other spacings are used, can be found by referring to the following figures: If trees are set one foot apart in the rows and the rows are spaced 6, 8, or 10 feet apart there will be 7,260, 5,445 and 4,356 trees per acre. If it is desired to plant trees 6 ft. by 12 ft., then divide by 12 the number of trees per acre when the rows are 6 ft. apart; for example:  $7,260 \div 12 = 605$ .

*Cost of Tree Planting.* If the young trees should cost only a few cents, it would be economical to plant the tree as cheaply as possible. However, when trees cost the government fifteen cents to raise, and if by the time they are delivered at the planting site this cost has risen to twenty cents, it is false economy to plant these trees in small holes. A few more cents spent in digging large holes will make a great difference to the tree and may mark the difference between success and failure. Because of the expensiveness of

planting material that is furnished to landowners and farmers, they should not agree to do any tree planting unless able and willing to give the trees a fair start.

By using holes a foot deep in a dry, lantana region the percentage of failure has been less than five per cent. In a much better site the percentage of failure jumped to over twenty-five per cent when some laborers, without supervision, planted trees in soil that had merely been loosened with a mattock. An inspection of the trees that died showed that they had been planted under such conditions, and enough of the living trees were examined to show that they had been planted in properly dug holes. The cost to consider is not only the first cost of planting but also that of replacing dead trees and of weeding trees whose growth has been checked because of poor holes or careless planting.

*Planting Material.* The planting material that should be used will depend upon the site and upon the tree or shrub being set out. Seeds, cuttings, rooted cuttings, bare root seedlings or transplants, and transplants with a ball of earth, constitute the planting material. Of these, the last is the one most widely used in reforestation work in the Hawaiian Islands, and the landowner should make up his mind to use this material wherever possible. Where other planting material can be used it will be so stated; otherwise potted plants should be used.

*Cuttings.* Cuttings are more effective than potted plants in some cases. This is particularly true of tamarisk or athel and madre cacao. Cuttings are useful in the control of erosion, because they will serve as stakes to form a light brush dam across small gullies. The cutting should be of firm wood generally a year old. Its lower end should be cut slanting with a sharp knife, and great care should be taken not to bruise the lower end. Thrusting cuttings into the ground tears the bark and greatly increases the percentage of failures besides producing inferior plants. It is just as necessary for a cutting to have good loose soil in which to start as it is for a transplanted tree. The cutting should be planted on a slant and should be pointed toward the wind. If it is planted at right angles to the wind the cutting will be worked loose by the wind blowing against the young shoot.

Cuttings of fleshy stemmed plants such as cactus, poinsettia, plumeria, and cereus should be allowed to form a callus at the cut end before being planted, as they are likely to rot if placed in wet soil when freshly cut. Such cuttings require a well drained soil.

*Planting Instructions.* In planting trees, a trench mattock will prove to be a great convenience. When the hole is ready, the following points should be observed in planting trees: In the first place, the tree planter must realize that the roots of young trees are just as delicate and require as much care in handling and setting out as the roots of other plants. The potted plants should be watered before they are removed from the tins. Never leave

the can around the roots because the iron, even after it rusts, acts as a barrier to the roots and the tree fails to grow as it should. It is a mistake to assume that this iron will act as as fertilizer, because plants do not need this kind of iron. Care must be taken to disturb the earth around the roots as little as possible, but long roots that have developed in old stock should be stretched out gently and, if necessary, the hole should be deepened to accommodate these roots. The trees will respond to such attentions as these.

The best soil obtainable should be put in the bottom of the hole and around the roots. Fine soil should be packed firmly around the roots, and the subsoil should be put in last, on top, where it is not in the way of the roots. The soil must be packed firmly around the lower roots before the hole is filled; otherwise the bottom roots may not be in contact with the soil and, therefore, they would be useless.

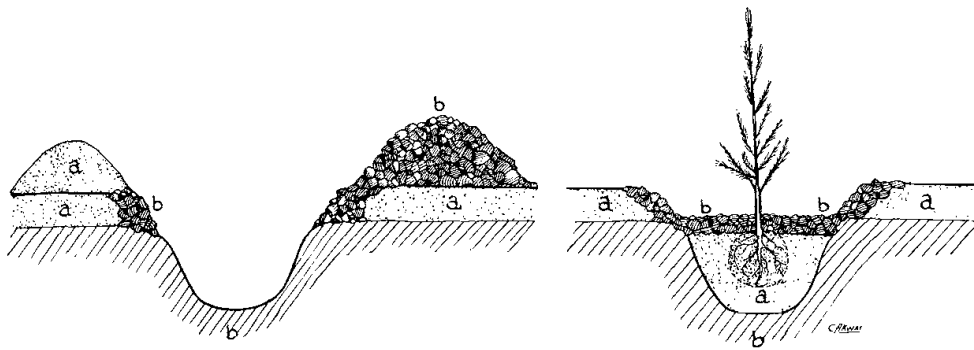


Fig. No. 12—(a) A properly made hole with the top soil at one side and the subsoil at the other side. (b) The proper way to plant a tree in a DRY, WINDY place. Several inches of top soil in the bottom of the hole, the roots in their original ball of earth and more top soil packed around the roots. A three-inch layer of subsoil to help anchor the tree. The tree is planted six inches below the general ground level.

The tree planter should see to it that the ball of earth around the roots is not resting on the hard subsoil at the bottom of the hole. It is the loose soil in the bottom of the hole and not merely the depth of the hole that is important. Therefore, the hole should be dug deeper if necessary, in order to have three or four inches of loose soil in the bottom. The drier the site or the more severe the struggle for existence, the more important it is to give the young tree the best possible start. It may be wise to use one or two cents worth of fertilizer in the bottom of the hole, in order to get quick and sure results, instead of coming back later to free the tree from weeds or to plant a new tree because the first was unable to survive.

In very dry regions, it is necessary to have the hole so deep that the roots when planted are six inches below the surface of the soil, as this will prevent rapid drying out of the soil around the roots.

In very windy situations it is necessary to set the tree far enough below the ground surface that the soil in the filled hole

comes two or three inches higher than the root collar of the tree. This will help hold the tree in place and will give the roots a chance to get a firm hold in the ground. If this is not done, the trees will be loose in the soil and there is danger that the roots will be twisted off. The following trees have been banked up for two or three inches in windy sites with distinct benefit to the trees: silk oak, ash, all ironwoods, macadamia, brush box, practically all

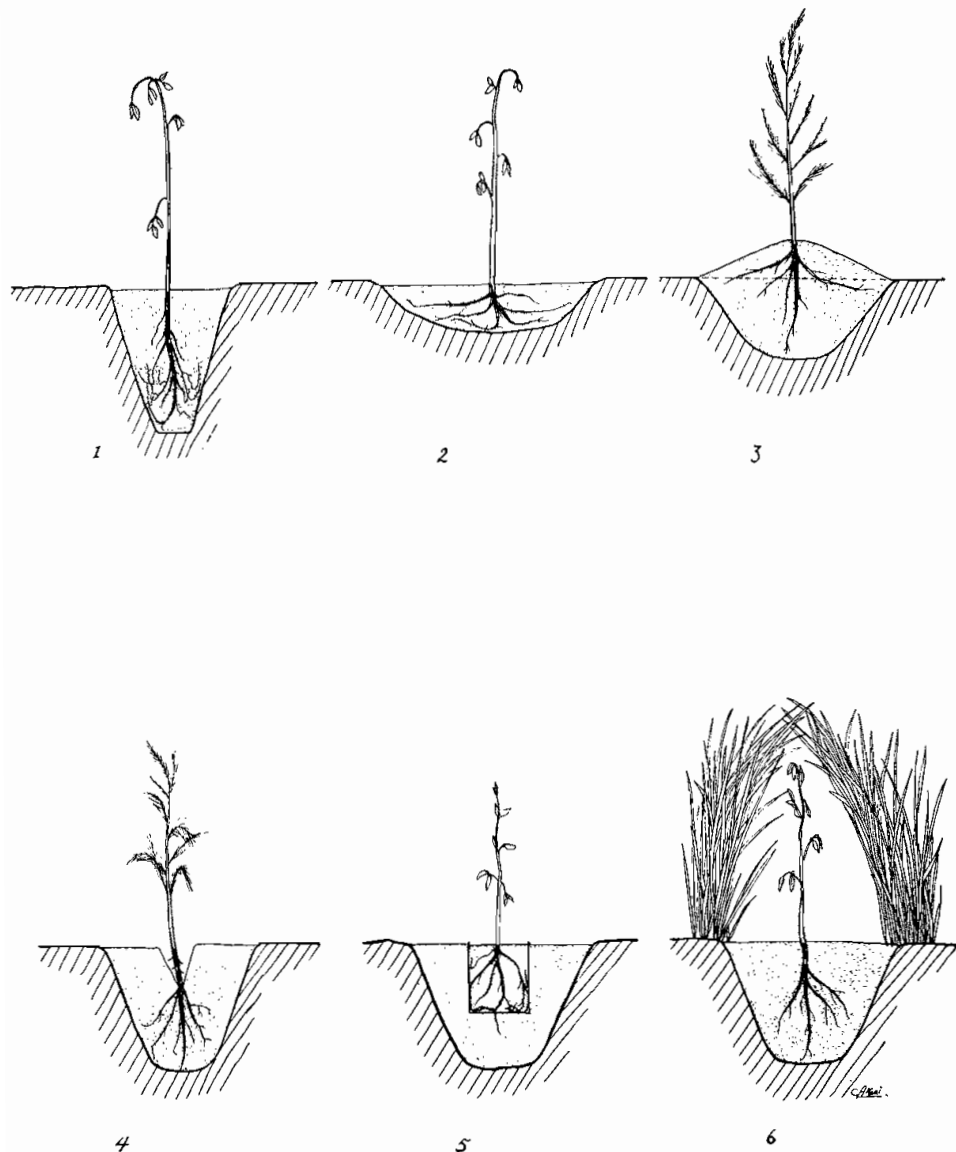


Fig. No. 13.—Why Trees Die. (1) Narrow hole. Soil not packed around roots thus leaving air spaces. Roots crowded and bent upward. (2) Roots on top of the ground, therefore, unable to get water in a dry spell. (3) Tree in a shallow hole and mound. The soil is easily washed away in rainy weather thus exposing the roots to the hot sun. (4) Tree in a windy place not banked up with soil hence the wind is able to twist the tree and break the roots. (5) This is a good hole but the can was not removed when the tree was planted. The roots are unable to spread properly. (6) Tree killed by the shade of the grass. No clearing was made, the tree was not weeded, or it is a slow growing species not suited for the site where it was planted.

leguminous trees, and any tree that sprouts readily from the stump. In sheltered or wet situations, this procedure probably would injure the seedlings.

*Bare Root Planting.* Where the cost of transportation is high, or if for any reason it is not possible to use potted plants, the bare root method may be used. If possible, on the day before planting, the plants should have two thirds of each leaf cut off, thus reducing the evaporation of water through the leaves. On the next day the plants should be dug up, disturbing the roots as little as possible. The roots should be dipped into a batter of clay and thoroughly coated, as this will prevent the root hairs from drying out. The young trees should then be packed in moist moss and kept in a shady place till planted. The roots must not be exposed to the sun or wind; moreover, the practice of taking half a dozen trees out of the planting bucket and planting them one by one is unwise, as the last trees set out have been exposed to drying and to damage from unnecessary handling. There also is considerable time lost in looking for the handful of seedlings whenever they are put down. Some trees cannot survive the bare root method of planting, and all suffer and many die in a dry site where potted plants would survive. Even greater care is needed in setting out bare root seedlings than in handling seedlings with a ball of earth.

*Precautions for Beach Planting.* Because of the spray and wind, the landowner should set out shrubs or trees for windbreaks or as shelters for other plants, or else he should make burlap screens to protect the young plants.

If the surface vegetation on a sand dune is destroyed for any reason, one should plant beach grasses or vines on the spot to bind the soil before the wind undermines the slope and starts moving the sand dune. Brush barriers parallel to the slope will help the plants to get a start.

*Precautions in Planting in Swamps.* Most trees found in swamps are growing on mounds or on high land at the edge of the water; and suitable mounds must be made if tree planting in such areas is to succeed. The question of draining swamps by means of ditches, dynamited subsoil, or tile drains is not within the scope of this bulletin. It is claimed that trees with tap roots that penetrate the subsoil, will start underground drainage in a wet site.

*Planting in Wind Scars.* Holes should be dug in scars at points where the young tree will be protected from dirt sliding down the slope, or where the water will not wash it out of the hole. If trees are planted on a steep scar, work should begin at the top, as otherwise the trees planted at the bottom will be buried or broken by the dirt sliding down during the planting operations.

The best tree to use in wind scars is the salt marsh ironwood which sends up many root sprouts and can endure wind and drought. If thought best, the native shrub alahce can be planted

in rows to act as a windbreak for grass. Cattle will not eat alahee but they eat ironwood readily.

When the shrubs or trees are several feet high, Bermuda grass or some other hardy grass that spreads by runners can be planted to help hold the soil.

The scar should be surrounded by a belt of trees, which should be started about six feet from the edge of the scar and should consist of four to eight rows of trees spaced not over ten feet apart. The purpose of this belt is to make such dense shade that the sprouts of the salt marsh ironwood cannot go beyond the scar. The selection of trees for this belt depends upon the dryness of the site. Lowland ironwood, silk oak, and swamp mahogany should be the trees most frequently used.

*Planting in Gullies.* Deep gullies need brush for their control, and it may be necessary to plant shrubs or trees to furnish this material. Koa haole stakes will take root readily and are ideal for the stakes of brush dams, provided that the koa haole will not become a pest in fields. The madre cacao serves almost as well for stakes in the guava regions, and it does not spread as the koa haole does.

Any tree suited to the locality can be planted in or near gullies, but those best suited for the bare slopes are the trees recommended for dry places. The belt of trees around gullies can be used as a woodlot, and if the patches of land between gullies are too narrow and irregular for farming or grazing, they certainly should be planted to trees.

## COOPERATION

The government is ready to help landowners save their top soil from erosion. The information of its experiment stations is for the use of the general public, and the Agricultural Extension Service is working to bring this information to the landowners and to cultivators of the soil. If the County Extension Agent is unable to answer questions offhand he will find out the answer, for he is expected to give the cultivators of the land the latest information available.

In return for this service the landowner or cultivator of the land is expected to cooperate to the extent of keeping simple cost records (which he should do for his own advantage), and by signing and abiding by a clearly stated agreement which places the co-operator under no obligation and requires nothing but what any progressive tree planter would do. The sole purpose of the agreement is to have a business-like record of projects and to emphasize the fact that trees will not grow except as the result of intelligent effort on the part of the tree planter.

## COST AND GROWTH RECORDS

It is a great satisfaction to know just how much it costs to raise things on the farm, in fact, it is impossible to figure profits



unless there are cost records. A simple record of time spent in making the woodlot and caring for it will be enough to show the value of the wood that is raised on the farm. Records such as those outlined below will prove to others just how much the woodlot is worth and will help the owner get a better price for the woodlot, if the farm is rented or sold.

The first cost of a grove should include the cost of a fence to keep out livestock, the cost of cutting lanes through brush, digging up grass, digging holes, hauling trees and planting them. Later expenses will include weeding around trees, replanting fail-spots and thinning. All cooperators will be expected to keep such records, in as much as they will be of value, not only to themselves, but also to others who may be thinking of planting trees. The County Extension Agent will assist the landowner in preparing a simple form of cost records.

*Fencing.* Spacing of posts, number and kind of posts, number of wires, time and cost.

*Clearing Brush Land.* Kind and height of brush, width of lane, total length of lanes cleared, time and cost.

*Clearing Grass.* Kind and height of grass, spacing and width of cleared spots, time and cost.

*Digging Holes.* Kind of soil, depth, spacing and number of holes dug, time and cost.

*Planting Trees.* Cost of hauling, later care and planting, number of each kind of trees set out, time and cost.

*Weeding.* Most trees will need no further attention, but it is well to inspect the plot occasionally and make sure that no grass or shrub can touch the young tree or is over it. Kind of tree, number, time and cost.

*Planting Fail-Spots.* This includes clearing ground, digging holes and planting trees. Number of trees of each kind set out, time and cost.

*Thinning.* Some trees will need thinning out in a few years. The record should show kind of tree thinned, time and cost of thinning and hauling, value of the material for fuel or other purposes.

*Harvesting.* The cost of felling and preparing the product and hauling should be carefully kept, together with the number of each kind of tree felled and the number of poles, posts and the amount of firewood or other product obtained from each species, and the value of each kind of product.

*Growth Records.* For the first few years, the landowner should make a record of the height of the hundred best trees of each kind. Later, diameter measurements at 4½ feet from the ground

(breast height) of the best trees should be made. It is merely necessary to measure enough of the best trees to get an idea of the average growth of the larger trees. It is not necessary to pay any attention to dwarfs and small trees that have failed to keep up in the race for space in the grove. In large groves, it is necessary to know how many large trees there are on an average acre, and if this is done carefully the owner will have a fair idea as to what his woodlot is doing.

*Reports.* In order to have a record of failures, it will be necessary to go over the woodlot six months after planting the trees and report on the number of each kind of tree that failed to live. If there are a large number of dead trees, the owner should try to find the cause for the failures, in order to prevent a repetition of this loss.

### SAMPLE OF AN AGREEMENT TO PLANT TREES

The County Extension Agent and the Extension Forester of the Agricultural Extension Service, University of Hawaii, will furnish advice and instructions, and the Board of Agriculture and Forestry of the Territory of Hawaii will furnish trees to landowners on the following conditions:

(1) The landowner shall order the trees at least three months in advance of the time that he will need them.

(2) He shall prepare the ground for trees in a manner recommended by the County Extension Agent.

(3) He shall exclude all livestock from the area in which trees are planted until the trees are large enough not to be damaged by stock.

(4) He shall keep a record of costs of planting and tending trees and of the value and quantity of material secured from the trees planted under this agreement.

(5) He shall permit the County Extension Agent and persons conducted by him to visit the area where the trees are planted, when it can be done without injury to crops.

I hereby agree to the terms stated above and will need the following trees on or near.....(Date)

.....(Name)

.....(Post Office)

### LIST OF TREES NEEDED

(Make three copies. Keep one and send two to the County Extension Agent.)

## THE HOME GROUNDS

The home grounds deserve attention. The homes of pioneers in many communities are characterized by sun-scorched and wind-swept yards. That is one of the unavoidable costs of pioneering. Unfortunately, there is so much urgent work waiting to be done that the farmer has but little time or energy for planting trees; yet it is a mistake to put off tree planting. A sun-heated house is not restful; neither does a bare, scorched yard soothe the nerves, hence the absolute necessity for tree planting in the home grounds. Furthermore, such planting pays not only in comfort and satisfaction, but also in cash, as anyone who has tried to sell or let treeless premises has learned.

It is a mistake to plant trees or shrubs, no matter how beautiful they may be, if they are not suited for the site. A shade-loving plant will need much attention and even then will not thrive if planted in a dry, hot situation. Of course, one can do wonders with water and ample time to devote to gardening. The following suggestions are intended for those who must carry the water which will start the trees and shrubs and for those whose time and strength are too precious to waste on plants which are not adapted to the locality.

*Home Grounds in the Kiawe District.* Presumably some of the original kiawe trees are available for shade; if not, some thornless kiawe trees should be planted as explained elsewhere in this bulletin.\*

There are many trees which shed their leaves during the hot season, and there is no objection to planting these trees if they can be watered easily. The following, however, are recommended because they are not leafless in the dry season:

If water is available: mango, kamani.

If water is scarce: lowland ironwood, athel, date palms, tamarind, opiuma, thornless kiawe, swamp mahogany.

Consult "Notes on Trees" in the last pages of this bulletin for details about trees. Because most of these are slow growing, it may be well to plant some monkey-pods for quick shade, which may be felled when the other shade trees become useful. A tree of very rapid growth and recommended for quick results is the red or the white agati, or sesban. It blooms in two years and dies in ten, but in the meantime other trees and shrubs have grown large enough to take its place. This tree requires water and sheds its leaves but its rapid growth makes it useful as a space filler for the first planting in a yard. The following shrubs are recommended because of their drought resistance: mock orange, pride of Barbados (both red and yellow), carissa (very spiny but with edible fruit), thornless klu, thornless cacti, oleander, sea grape.

*Watering Plants.* Plants should be watered in the evening or late afternoon, for then there is less loss of water from evapora-

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\* See page 23.

tion and there is no danger of sun-scalded leaves. Trees and shrubs that are watered by hand often suffer from drought because the roots are accustomed to getting water at the surface. If possible, short pieces of pipe should be set into the ground so as to reach from the surface to the roots; then the water can be poured down the pipes. If post holes can be dug near the tree and filled with gravel, the water will soak through the gravel to the roots below. If this is done, the tree or shrub will not be injured by a short dry spell because its roots will not be entirely dependent on surface moisture.

*Home Grounds in Windy, Red Clay Sites.* The suggestions which follow should not be regarded as being infallible. It happens once in a while that two trees, for no apparent reason, differ greatly in size although they are of the same species and age. Nevertheless, the behavior of trees and shrubs in the neighborhood is a good guide when deciding on what to plant on a vacant lot. In addition to personal observation, people who intend to beautify the home grounds may secure valuable suggestions from the local forest nurseryman.

The following trees and shrubs are recommended for planting in dry, lantana sites, assuming that little or no water can be had for irrigation: *Acacia catechu*, *Albizia lebbek*, Arizona cypress, Bermuda juniper, Christmas berry, *Erythrina abyssinica* and *E. caffra*, (both have showy, red flowers), *Eucalyptus robusta* (pink flowered variety), kiawe, thornless klu, kou, lowland ironwood, mock orange, oleander, pomegranate, pride of Barbados, silk oak and St. Thomas tree. Practically all vines need water and shelter from wind. There is a red-fruited passion vine that thrives in dry places and both the red and the yellow Sodom apple are low shrubs for out of the way corners. The leaves are too spiny for planting as a border or hedge.

*Bee Pasture.* The standard tree for honey is the kiawe, which blooms between March and June and later, depending on the distribution of rains. The klu and some wild plants furnish a little honey, but there are no honey-producing plants in the kiawe section to keep the bees busy all year long. Logwood and divi divi are good nectar-producing trees, but they bloom when the kiawe does and, therefore, do not extend the length of the producing season. Certain shrubs of the genus *Vitex* will grow in klu regions. Anyone interested should give these shrubs a trial as well as certain eucalyptus trees which will bloom later than the kiawe. These include swamp mahogany, red gum, *Eucalyptus leucoxylon*, *E. siderophloia* and *E. corynocalyx*.

In the guava and Java plum regions there are no masses of trees for bee pasture, but there are a number that can be planted for the purpose. Chief among these are: *Cordia alba*, two dom-beya species, several eucalyptus trees and, in the higher localities, acacias and black locust. Of all these, *Cordia alba* is the most prolific bloomer, as it has a fresh crop of flowers whenever heavy

rains end a short drought. The prolific honey-producing plants of California are not found here, perhaps because attempts to introduce them in the past have failed. Until more work has been done on the subject, the beekeeper should improve his bee pasture by planting well-known trees.

*Information Given Freely.* The following notes on trees give some data about the plants and trees mentioned in this bulletin. If information is wanted regarding these or any other trees or plants, the public is urged to write to the Agricultural Extension Service, University of Hawaii, Honolulu, or to the local County Extension Agent.

## NOTES ON TREES

*AGATI* also called sesbania. *Agati grandiflora*.

Home: West Indies. Site: Lantana and guava.

Uses: This is a rapidly growing ornamental tree. The tree dies after ten years, but in the meantime the slower growing permanent trees will have established themselves. The showy pink or white flowers are used in salads.

Objections: None.

*ALAHÉE.* *Dodonea viscosa*.

Home: Polynesia and East Indies. Site: Dry sites 200 ft. to 2,000 ft. above sea level.

Uses: Soil binder and windbreak in earth scars and gullies, especially in pastures, as it is not eaten by stock.

Planting notes: Because of the tap root, this shrub should not be held too long in the nursery.

Objections: This shrub may occupy the ground to the exclusion of other plants in abandoned pastures.

*ASH* (Southwestern). *Fraxinus* sp.

Home: Texas and Northern Mexico. Site: Lantana and guava-covered slopes.

Uses: Tool handles, farm machinery and wagons.

Planting notes: None.

Objections: None. (Beetles attack wood, and it rots easily if left out in the weather.)

*ATHEL* (also called tamarisk). *Tamarix* sp.

Home: Atlas Mts. to Arabia. Site: Sandy soil, especially in stream beds. It will not thrive in wet clay.

Uses: Soil binder, fuel, windbreak, shade.

Planting notes: Cuttings should be set in the ground where the tree is to grow. It will not stand transplanting. (See paragraph on cuttings, page 28.)

Objections: None.

*AUSTRALIAN RED CEDAR.* (This tree is not a conifer).  
*Cedrela australis*.

Home: Australia. Site: Moist, well-drained, sheltered sites that are not exposed to strong trade winds.

Uses: Wood looks like cigar-box wood. Valuable for interior work, cedar chests, surf-boards and cabinet work. This tree is recommended for saw logs.

Objections: None.

*AUSTRALIAN SALT BUSH. Atriplex semibaccata.*

Home: Australian deserts. Site: Dry land near sea level. Does well near the coast in klu-covered areas.

Uses: Soil binder and stock feed.

Planting notes: Seeds should be sown in seed spots at the beginning of the wet season. Seeds probably can be secured on each island.

Objections: None.

*BALSA. Ochroma lagopus.*

Home: Central and South America. Site: Moist, well-drained soil sheltered from wind; that is, in guava-covered gulches.

Uses: The wood is lighter than cork and is used for surf-boards, fish-net floats and in boats and aeroplanes. The best wood comes from five-year-old rapidly grown trees. Trees of slow growth have heavier wood.

Planting notes: The young trees need partial or no shade but must be protected from wind. It should do well as an associate of Australian red cedar, and may be removed when the red cedar needs more room.

Objections: None.

*BALD CYPRESS* also called southern cypress. *Taxodium distichum.*

Home: South Atlantic and Gulf States. Site: Fresh-water swamps.

Use: Durable posts and lumber.

Planting notes: This tree should be planted on raised land in or near fresh-water swamps near sea level. It does not endure strong trade winds.

Objections: None.

*BEACH MORNING GLORY* also called pohuehue. *Ipomea pes-capre.*

Home: All tropics. Site: Sandy beaches.

Uses: Soil binder, especially on sand dunes.

Planting notes: None.

Objections: It climbs upon and smothers other plants.

*BEN* also called horse-radish tree. *Moringa oleifera.*

Home: India, East Indies, Philippines and New Guinea. Site: Klu, lantana and guava regions. It prefers a sandy, well-watered soil but grows almost anywhere below 600 feet.

Uses: *Vegetable*: The young twigs and the half-grown pods make a delicious vegetable. The leaves are treated like

spinach or any other greens. The pods are sliced and cooked with stew or alone. The root is grated and used as horse-radish.

*Stock Feed*: The branches up to an inch in diameter are eaten by hogs. Cattle and horses eat the leaves and break down the trees to get them. Chickens eat the flowers, leaves and seeds.

*Oil*: The ben seed is very rich in an oil which does not turn rancid. It is used in making salves and in extracting perfume from flowers. Before petroleum became so common the oil was used for light. The oil is widely used as a salad oil, though its value as a food has not been determined.

*Wood*: The wood is of no value except that the young branches are eaten by stock.

*Planting notes*: This is a fast-growing tree and should be planted before the tap root gets too long. Cuttings two inches in diameter and four feet long can be set out at the beginning of the wet season. All young trees should be protected from stock. This tree should be set out as a forage tree because in moist regions it can be lopped and fed to stock at any season. In very dry regions, it is leafless for a while and then bursts into full leaf with the first rain before grass and other forage has recovered from the dry season.

*BERMUDA GRASS. Cynodon dactylon.*

*Home*: Cosmopolitan. *Site*: Dry regions near the coast and elsewhere.

*Uses*: A common lawn grass, but it is being replaced in shady spots by buffalo grass. A pasture grass. It can be planted in the lee of trees or shrubs on earth scars. It is also good for lining gullies to hold soil.

*Planting notes*: The grass is propagated by runners, which should not be allowed to dry in the least before they are planted.

*Objections*: None.

*BLACKBUTT (see Eucalyptus).*

*BLACK WATTLE. Acacia decurrens.*

*Home*: Australia. *Site*: Guava slopes 1,000 to 5,000 feet elevation.

*Uses*: Tanbark, firewood, temporary fence posts (6 to 8 years) and windbreaks. The tanbark of selected varieties is very valuable, but as these are not known in Hawaii only the ordinary tree can be planted, though even this is valuable for tanbark. The wood should be used for fuel when the tanbark is removed. As the tree does not live much more than 15 years, it will be necessary to fell the trees before the end of that time. A ten-year rotation is recommended.

As a low windbreak in California this tree is preferable to eucalyptus, but it has not been tried in Hawaii for this purpose.

Planting notes: Once planted, a grove will not need any replanting because the stumps and roots send up sprouts.

Objections: The tree has many root sprouts. Because it dies when 15 to 25 years old, a grove of these trees must be felled and removed to prevent its becoming a fire hazard. This objection is overcome if the trees are cut according to a definite plan.

*BRUSH BOX* also called vinegar tree. *Tristania conferta*.

Home: Australia. Site: Guava and Java plum-covered slopes, and better lantana sites.

Uses: Valuable for fence posts, poles and fuel. Heartwood posts last 40 years in dry sites and probably half that long in sites where koa and uluhe thrive. The posts should be soaked four weeks in water and then seasoned in the shade.

Planting notes: Trees intended for posts should be planted not over eight feet apart. As the trees grow rapidly it is more economical to dig large holes and give the trees a good start in brush land or in tall grass than to return later and weed the trees.

Objections: The logs check and warp badly in the sun. The farmer will find it better to use his trees for fence posts and poles and, possibly, as hewn ties. The wood dulls tools and is difficult to saw.

*BUFFALO GRASS*. *Stenotaphrum secundatum*.

Home: Cosmopolitan.

Site: Shade and moisture-loving grass. Can also endure considerable dryness in guava sites.

Uses: Lawn grass under algaroba and ironwood trees. Suitable for use in the shelter of trees or shrubs on scars. Good to hold soil in the bottom of gullies. It is an excellent pasture grass.

Planting notes: See Bermuda grass.

Objections: None.

*CASHEW NUT*. *Anacardium occidentale*.

Home: Mexico. Site: Guava and better lantana sites, especially where there is a dry season.

Uses: The fruit is apt to be astringent, especially if not fully ripe. A choice variety reminds one of strawberries and pineapples. The fruit is eaten fresh or can be made into ice cream or cooling drinks. The seed, larger and thicker than a lima bean, is attached to the pulpy stem. *The seed must be roasted and peeled before being eaten*. Because the nuts are delicious when properly roasted, there is a steady demand for them.

Planting notes: The tree is low and straggly. It requires no special care.



Objections: The nut is poisonous but the troublesome properties are removed by peeling, which is made easier by proper roasting.

*CLAMMY CHERRY. Cordia collococca.*

Home: Jamaica. Site: Guava and better lantana sites.

Uses: Shade for poultry and hog pens, as the tree is low and spreading. The fruits are eaten greedily by pheasants, turkeys, and pigs.

Planting notes: Because of the tap root the young trees should be set out promptly.

Objections: None.

*COCONUT. Cocos nucifera.*

Home: All tropics. Site: Sandy loam near the coast.

Uses. Innumerable. Probably the most profitable use would be a grove of trees bearing large-sized nuts which could be sold while immature to visitors for the coconut water they contain and for the gelatinous meat.

Planting notes: The coconuts should be sprouted in a shady place where they can be watered daily. The nuts are placed on their side and half-buried in sand or loam. They should be planted in large holes and the top of the nut should be barely exposed, but it should be at least six inches below the surface level of the ground, thus giving the tree a deeper root system than if it had been planted at the surface.

Objections: The falling nuts and leaves are a menace and, therefore, the trees are objectionable around houses or playgrounds, unless the nuts and old leaves are picked off whenever necessary.

*CORDIA (White). Cordia alba.*

Home: Tropical America. Site: Guava and uluhe regions.

Uses: The flowers develop after every rainy spell and are eagerly sought by bees. This tree is recommended as a tree for honey producers. Pheasants are said to eat the fruit.

Planting notes: None.

Objections: The fruit is very sticky and the trees should be planted where the fruit cannot become a nuisance by clinging to auto tops and clothing.

*DOMBEYA. Dombeya wallichii.*

Home: South Africa. Site: Guava.

Uses: Bee pasture and ornamental shrub because of white flowers. It blooms freely after rainy weather.

Planting notes: None.

Objections: None.

*EUCALYPTUS* sp. Details follow regarding blackbutt, blue gum, ironbark (narrow-leaved), lemon-scented gum, red gum, swamp mahogany.

Home: Australia.

Site: Depends on the species.

Uses: Depends on the species.

Planting notes: While many eucalyptus trees, especially red gum and swamp mahogany, can be planted as bare root stock, the growth made by potted plants is so much greater that the use of bare root stock is not justified except where conditions are very favorable and where a slow start is not a serious factor.

Objections: Very few plants can grow under eucalyptus trees except where there is plenty of rain. It is important to cut up eucalyptus on the same day that it is felled, as the wood becomes very tough in a day or two.

*BLACKBUTT. Eucalyptus pilularis.*

Site: Guava and better lantana sites.

Uses: Windbreak, fence posts, firewood. Posts are very durable. This tree in the sites mentioned and where it is not too windy is far better than the swamp mahogany which has been planted so extensively in the past.

Planting notes: Trees of this species should be ordered far in advance in order to be sure of a supply when needed.

*BLUE GUM. Eucalyptus globulus.*

Site: Guava and koa sites. It is also recommended for the slopes of the higher mountains between 3,000 and 6,000 feet.

Uses: Firewood and oil from leaves. Because this wood is not durable in the ground, and because it is hard to season, it is not recommended for planting except for firewood. An eight-year rotation is probably the best. One plantation has kept records on a eucalyptus grove and as a result, this company will not clear off any of the grove for pineapples, though the land is well suited for their production. The net returns from this grove have amounted to \$33 per acre per year. The deep roots of the blue gum are said to penetrate hard pan in wet land and thus help to drain the land. The young leaves are distilled for their oil, which is widely used in cough medicines.

*IRONBARK (narrow-leaved). Eucalyptus crebra.*

Site: Guava and lantana.

Uses: Fence posts and poles. The wood is very durable in the ground.

Planting notes: The trees must be ordered far in advance as seed is hard to get.

*LEMON-SCENTED GUM. Eucalyptus citriodora.*

Site: Guava and better lantana sites.

Uses: Lumber, posts, and oil from the leaves. Distilling the oil is a profitable industry in Australia.

*RED GUM. Eucalyptus rostrata.*

Site: Guava and moist sites.

Uses: Fence posts, railroad ties, piling, and firewood.

Planting notes: This tree should be planted 6 ft. by 6 ft. in order to force it to grow erect. It should be sheltered from strong trade winds.

*SWAMP MAHOGANY. Eucalyptus robusta.*

Site: This tree will grow in wet or in very dry places. It stands wind well.

Uses: Planted with ironwood for windbreaks it does better than when planted alone. Though often used for temporary fence posts, this tree should not be considered for fence posts as the unseasoned posts last less than a year. If peeled, dried in the shade for two months, and then soaked for ten months in water, the posts will last for seven years, according to certain landowners in Kauai.

*HALA* also called pandan and screw pine. *Pandanus tectorius.*

Home: Tropical Asiatic coasts, East Indies, Pacific Islands.

Site: Sea beaches, low valleys, and hillsides in guava sites, and rainy districts in general.

Uses: Used by Polynesians. Modern uses few. Shade on beach. The seed is used as an emergency food by Polynesians.

Planting notes: Wild seedlings are easily transplanted when small. Seeds can be planted in seed spots.

Objections: None.

*HAU. Hibiscus tiliaceus.*

Home: Tropical islands of Indian and Pacific oceans.

Site: Beach and guava sites.

Uses: Inner bark used for cordage. Shade for pergolas; shelter for trees from spray and wind near the beach. Barrier against trespassers, especially in watershed reservations. Live fence posts. (It is a poor tree for this purpose in as much as the tree needs constant pruning.)

Planting notes: Planted by means of cuttings one to four inches in diameter and four to seven feet long. The top end of the cutting should be wrapped in grass, wet moss, or the like to keep the top from drying out.

Objections: Spreads over other shrubs and occupies a large area.

*IRONWOOD. Casuarina sp.*

The longleaf ironwood, the lowland ironwood, the ruddy ironwood and the saltmarsh ironwood are discussed here. The term ironwood is a local name only. In Australia the tree is called oak because of the similarity of the wood to oak. The tree is also called pine, but this is a mistake as the tree is not a conifer. This local tree named ironwood

should not be confused with various trees called ironwood in many tropical countries.

Home: Australia. Site: Depends on the species.

Uses: Depends on the species.

Planting notes: In all cases potted plants do much better than bare root stock.

Objections: Plants do not thrive under ironwoods except in moist places. Buffalo grass and velvet grass do better than other grasses under these trees.

*LONGLEAF IRONWOOD* also called highland ironwood.

*Casuarina quadrivalvis.*

Home: Australia. Site: Guava, koa, and uluhe regions.

Uses: Firewood, ornament and shade, and soil binder.

Planting notes: Potted plants are far more satisfactory than bare root stock for planting.

Objections: The tree sends out root sprouts.

*LOWLAND IRONWOOD* also called she oak, beef wood.

*Casuarina equisetifolia.*

Home: Australia, East Indies, Polynesia.

Site: Beaches, dry windy sites.

Uses: Windbreaks, firewood, hedges. This tree is the only ironwood recommended for windbreaks along gardens or cultivated lands where there is a strong wind and a long dry season. It has no root sprouts. For hedges, the tree should be topped and kept cut back as soon as it reaches the desired height.

Planting notes: (See under ironwood.)

Objections: (See under ironwood.)

*RUDDY IRONWOOD* also called forest oak. *Casuarina torulosa.*

Home: Australia. Site: Guava, koa, and sheltered lantana sites.

This tree cannot stand both strong winds and dryness. It can endure either alone but not the two combined.

Uses: Furniture. Because of its beautiful foliage, it is recommended as a screen in gardens to hide unsightly views. For this purpose it is better than other ironwoods. It can also serve as a windbreak or as a hedge in gardens.

Planting notes: Trees must be ordered long in advance as this tree is not kept in stock.

Objections: This tree has some root sprouts but these can be kept cut down, the tops being used for decorations.

*SALTMARSH IRONWOOD* also called saltwater oak. *Casuarina glauca.*

Home: Australia.

Site: Edge of salt water marshes and tidal lands, near mineral springs, and in any dry place such as klu and lantana sites.

Uses: Soil binder and fuel. Recommended for planting on scars only. When used for firewood there is no need to replant the area.

Planting notes: (See under ironwood.)

Objections: This tree must never be planted as a windbreak or where its root sprouts can invade agricultural land as it rapidly takes possession of adjacent land. Hence, it should be planted where a soil binder is needed or in land used for raising firewood.

*INDIAN ALMOND* also called false kamani. *Terminalia catappa*.

This tree should not be confused with the true kamani which is also a beach tree. The leaves of the Indian almond are red before they fall. The tree has horizontal branches, and is leafless in the dry season.

Home: Indian ocean region.

Site: Beach, lantana sites, and lowlands near the coast.

Uses: Shade. The seed is small but edible.

Planting notes: Seedlings can be dug up under old trees along the beach. This tree is seldom raised from seed in nurseries because the volunteer seedlings are so abundant and hardy.

Objections: The tree is leafless in the dry season and the fallen leaves are unsightly.

*JAMAICA YOKEWOOD*. *Catalpa longissima*.

Home: West Indies. Site: Guava and koa sites.

Uses: This tree is prized for its beautiful wood. It should make good poles for corrals and rafters.

Planting notes: None.

Objections: None.

*JUJUBE*. *Zizyphus jujube*.

Home: China. Site: Guava slopes.

Uses: Fruit, edible fresh or dried. There should be a ready market for the fruit.

Planting notes: None.

Objections: The fruit is attacked by the fruit fly.

*KAMANI* (Do not confuse this with the Indian almond or false kamani) *Calophyllum inophyllum*.

Home: Tropical Asia, East Indies. Site: Beach and moist well drained sites.

Uses: Shade tree, shaped like a mango tree with sweet-scented, white flowers. The wood is brown, hard, cross-grained, and is valuable for furniture and hubs of wheels. The nut is used by Malays for making illuminating oil. The tree is slow growing but no better shade tree for beaches can be recommended.

Planting notes: This tree must be planted at the beginning of the wet season. It should be ordered in advance because this tree is not carried in stock in the nurseries. The use of fertilizer is recommended if quick growth is desired.

*KIAWE* also called algaroba and mesquite. *Prosopis chiliensis*.

Home: South America.

This tree is very similar to the mesquite of the southwestern part of the United States. Its uses are so many that the tree has been more fully discussed elsewhere in this bulletin.\*

*KLU* also called aroma and cassia flower. *Acacia farnesiana*.

Home: European shores of Mediterranean Sea. Site: Dry, rocky hills in the leeward regions of the Hawaiian Islands. Associated with kiawe, cactus and lantana.

Uses: A thornless variety has been found which is recommended for stock feed. The flowers are used to make the "Cassie" perfume in France and Italy. The gum is superior to gum arabic. The thorny variety is a pest, and insects have been imported to destroy the seeds; hence persons propagating the thornless variety should protect the pods from beetles.

Planting notes: The thornless klu can be propagated by cuttings, which should be protected from stock by piles of brush. Because the supply of cuttings is limited each landowner should raise his own.

Objections: None to the thornless variety.

*KOA* (Not to be confused with the koa haole). *Acacia koa*.

Home: Hawaiian Islands.

Site: In moist, well-drained sites and in the better guava sites. This class of land is seldom found outside of forest reserves.

Uses: The variety found on Hawaii is suitable for saw logs. The one on Oahu is merely a shade tree.

Planting notes: The Oahu form of koa can be had at any time. The Hawaiian variety must be ordered specially.

Objections: The Oahu form is a low, wide-spreading tree that dies after thirty or forty years.

*KOA HAOLE* false koa; ekoa (Hawaii), ipilipil (Philippines) *Leucaena glauca*.

Home: Central America, now in all tropics.

Site: Klu, cactus, lantana, and drier guava sites. It will not grow in shade, in wet lands, or above 2,000 feet on the lee side of Oahu. Its limits on Hawaii and Maui are not known.

Uses: *Fuel*: It is possible to cut firewood off the same land every seven years. It cannot compete with blue gum for firewood production in good sites. It is not worth planting for firewood alone because other trees not only produce fuel but other products as well.

*Stock feed*: Hogs and cattle eat the leaves readily and break down the trees to reach the leaves and pods. As a supplement to algaroba and lantana pastures it is very valuable, but, except in certain localities, there are two important objections against its use.

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\* See page 23.

*Green manure*: The roots fix nitrogen in the soil, and the leaves are a good green manure, but unless the trees are plowed under when three feet high this plant should not be regarded as a practicable green manuring plant.

*Soil binder*: This shrub or tree grows in dry places and can be sown at the base of earth scars and on the slopes to hold the soil. Young seedlings are uprooted by cattle, hence the need of protecting the trees from stock until they are well rooted. Sown broadcast on hills suffering from sheet erosion, the seedlings should soon hold the soil, and then young trees can serve as stock feed if the grazing is regulated.

Planting notes: The seeds can be gathered at any time and if fumigated can be kept a year or more. The cost of collecting seed ranges between 7c and 10c per pound. Either the seed may be sown broadcast at the beginning of the wet season, using 10 pounds per acre, or else seed spots may be prepared. Cuttings of any size and length will grow readily in the wet season.

Objections: This tree is one of the worst possible pests for agricultural land because of the deep tap roots, its readiness to sprout from the stump, its prolific seed crops, and its rapid rate of growth. It must not be planted where irrigation water, streams, flood water, or wind can carry the seed into agricultural land. Its value as stock feed does not extend to horses and mules, as these lose the long hair on their manes and tails if they feed on koa haole.

*KUKUI* also called candle nut and lumbang. *Aleurites moluccana*.  
Home: East Indies.

Site: Moist, sheltered gulches. It extends down stream beds into the lantana site, where it requires shade and protection from wind to do well.

Uses: The nuts are valuable for making paint oil. The oil is used for all purposes for which linseed oil is used. A kukui tree in the Philippines is just as valuable as a coconut tree. There is a good market for this nut.

Planting notes: Commercial groves must be planted on smooth slopes, free from rocks, in order that the nuts may be raked up. Young volunteer seedlings may be used or seeds may be planted. The seeds should be covered two inches deep with mulch.

Objections: None.

*LAGUNARIA*. *Lagunaria patersonii*.

Home: Norfolk Island, Australia.

Site: Beach, and salt-water marshes.

Uses: Shade tree.

Planting notes: This tree may be grown from cuttings or from seed. It is not carried in stock in the nurseries and must be ordered in advance.

Objections: None.

*LOOKING GLASS TREE* also called dungon laté. *Heritiera littoralis*.

Home: East Indies. Site: Edge of salt-water marshes, also dry sites.

Uses: Ornamental foliage. Durable posts.

Planting notes: Seedlings will be raised on order only, as the seed supply is limited.

Objections: The wood dulls tools; hence it is recommended only for use as posts and poles.

*MACADAMIA NUT* also called Queensland nut. *Macadamia ternifolia*.

Home: Queensland, Australia. Site: Guava site, sheltered from wind.

Uses: The nut is delicious and finds a ready market. The price of the nut probably will be governed by the price of almonds. At present nuts for seeds retail at 50c a pound.

Planting notes: The tree produces a tap root and the seeds should be planted in tubes, or else in the site where wanted, and protected by netting from mice. The tree cannot endure wind.

Objections: None.

*MADRE CACAO. Gliricidia sepium*.

Home: Mexico. Site: Lower guava sites, sheltered from wind. This tree does not do well on Oahu above 1,000 feet. It will not thrive in dry, lantana sites.

Uses: Fence posts, fuel, and shade for coffee and cacao.

Planting notes: Seedlings should be planted early before the tap root is injured. This tree grows readily from cuttings and makes a good live fence post. In the Philippines such posts keep the farmer supplied with fuel. Planted three feet apart in groves, the trees will be forced to grow erect. When they become too crowded, some can be removed for fuel; however, care must be used not to let in too much light at any one time, as then the trees will form side branches and will become short and crooked. If the thinning has been properly done the mature trees will be six feet apart. Each tree should make two posts, or over 2,000 per acre. The heartwood posts should last 40 years in moist sites. The sapwood is not durable.

Objections: None.

*MAMANI. Sophora chrysophylla*.

Home: Hawaiian Islands. Site: Mountain slopes with some rainfall occurring between the dry and lehua ohia forests. It thrives between 4,000 and 7,000 feet in the Kula District on Mt. Haleakala.

Uses: The leaves of the tree are good stock feed. The wood splits readily and makes a very durable post and it, therefore, is used for posts in preference to other woods.



Planting notes: If stock is excluded, the small trees will recover from the damage done by cattle but tree planting will bring quicker and more uniform results.

Objections: None.

*MANGROVE. Rhizophora sp.*

Home: The one on Oahu came from the tropics of the Western Hemisphere. Site: Salt-water swamps and muddy tidal flats.

Uses: Protection to coasts, soil binder, firewood, tanbark.

Planting notes: Plant "seeds" where needed. The seeds are really sprouted trees shaped like a long plumb bob. These must be ordered long in advance as the supply is limited and the seedlings are hard to get.

Objections: It makes impassable thickets in salt-water swamps.

*MILO. Thespesia populnea.*

Home: Tropical coast of Asia.

Site: Beach, and moist lowlands near the coast.

Uses: Shade tree. Wood valuable for turned articles and bowls.

Planting notes: None.

Objections: None.

*NORONHIA. Noronhia emarginata.*

Home: Madagascar. Site: Beaches, and moist lowlands along the coast.

Uses: Fruit eaten by children. The tree makes good shade and shelter.

Planting notes: None.

Objections: None.

*OPIUMA. Pithecolobium dulce.*

Home: Mexico. Site: Sandy or well-drained soil in lantana regions.

Uses: The bark can be removed for tanbark without killing the tree. The wood is good for charcoal. The fruit is eaten by children.

Planting notes: As the tree has a tap root, the seedlings should be transplanted early or seeds can be planted. Birds scatter the seed.

Objections: The trunk and limbs are thorny and, therefore, not liked for firewood. The tree can be a nuisance in agricultural and pasture land.

*PAPER BARK* also called broad-leaved tea. *Melaleuca leucadendron.*

Home: Australia. Site: Beside lowland, fresh-water swamps and other wet land, and in guava and lantana sites.

Uses: The wood is very durable, probably lasting 20 years in Hawaii, for it lasts 40 years in Australia. The bark is used as an insulator for ice boxes, and the shredded bark is

used in packing grapes. It can also be used to insulate hot-water tanks. The leaves are distilled to form cajeput oil, which is used in compounding certain medicines.

Planting notes: Potted plants are so much more successful than bare root stock that the latter should never be used. Seed should be taken only from tall slender trees as these make the best posts.

Objections: None.

*SANDALWOOD. Santalum freycinetianum.*

Home: Hawaiian Islands. Other species in East Indies and Polynesia. Site: Warm guava slopes where it is sheltered from wind.

Uses: Turned work, glove boxes, incense.

Planting notes: A fast-growing tree. It should not be kept too long in the nursery.

Objections: None.

*SILK OAK* also called silver oak. (Not an oak tree). *Grevillea robusta.*

Home: Australia. Site: Lantana, guava, and koa sites. This tree will not stand as much wind as swamp mahogany.

Uses: Lumber and dimension stuff for interior use, furniture, and barrel staves. This wood is not durable in contact with the ground.

Planting notes: Wild seedlings may be used. These are found on the windward side of walls and shrubs that are to the leeward of silk oak trees.

Objections: Some people consider this an undesirable tree because of the litter it makes.

*TURPENTINE TREE. Syncarpia laurifolia.*

Home: Australia. Site: Moist, well-drained slopes. Lehua and better guava sites sheltered from trade winds.

Uses: Best posts for sugar cane fields as the wood withstands fire, besides being very durable. It makes salt-water piling if the bark is kept on, as it resists teredos better than any other wood.

Objections: The logs warp and check unless soaked. The wood is not good as a firewood. It is not easily sawn, as it blunts tools.



