

GREEN MANURING OF COCONUTS

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The practice of green manuring on coconut estates, though, gradually extending is not as popular as it might be. The reasons for this appear to be three-fold. Firstly, the value and advantages of green manuring in the tropics are not sufficiently well understood and, where realized, the practice is not adopted either through lack of funds or from general apathy, the policy on many coconut estates being apparently to let well alone until periods of low prices compel estate owners to take some measures to increase crop yields. Secondly, coconuts are not generally cultivated on hilly land but in flat or undulating land, in many cases under grass. The adoption of measures for the prevention of soil erosion, of which the planting of cover crops is one of the most effective, is therefore not rendered so imperative if the estate is to be saved from deterioration, as on tea and rubber estates. Finally, in a large portion of the coconut area in Ceylon the soils are very light and sandy with low water-retaining capacities and the rainfall is comparatively low. Soil moisture, therefore, becomes the limiting factor of crop growth in these districts. The fear is thus entertained that by the growth of cover crops and green manures the coconut will be deprived of the little moisture present in the soil during periods of droughts.

The systematic green manuring of coconut estates in Ceylon has only been recently undertaken, and the practice is far from being general. Individual estates are, however, carrying out useful work on the subject. In the Dutch East Indies and the Philippines it is extensively practised on European and American owned plantations. In Malaya conditions are similar to those in Ceylon. In general, coconut estates in Ceylon on which green manuring has been adopted, as it should be, have benefited favorably on the results

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obtained, and neglected properties for years under grass are being brought into conditions by cultivation and green manuring. Green manuring is not only practicable in all the coconut districts of the Island but also essential if yields are to be appreciably increased at a comparatively small cost. The advantages resulting from the practice are so many that if only they are brought home to coconut planter, universal adoption of the practice is bound to follow.

The term "green manure" is employed in its widest sense to mean the use of plant and plant material leguminous as well as non-leguminous for incorporating into the soil or as cover crops.

The advantages of green manures which have already been fully explained in Section 1 on the principles of green manuring, may, at the risk of repetition, again be summarized:

1. Green manures when used as cover crops prevent soil erosion, improve the physical condition of the soil and increase its water-holding capacity, and reduce weeding costs.
2. By ploughing in green manures large quantities of organic matter, so deficient in tropical soils, available nitrogen, potash and phosphoric acid are supplied to the soil. It is reckoned that with a crop of 4 tons per acre, containing on an average 20 per cent of dry matter and 6 per cent of nitrogen, about 8 tons of organic matter are added to the soil and about 35lb. of nitrogen are made directly available to the crop.
3. Most green manures can be used as fodder.

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In contrast to the advantages derived from green manuring, the disadvantages of present-day estate practice where neither green manuring nor artificial manuring is adopted will be apparent and need little elaboration. Estates on which only regular ploughing is carried out are bound sooner or later to have their yields fall to a very low level, owing to the exhaustion of the soil organic matter which is so closely connected with soil fertility.

Estates on which no cultivation whatever is carried out, no weeding is done, and no measures taken to prevent the loss of soil moisture during drought or of the surface soil during heavy rains if the land is undulating will necessarily give low yields. Estates left under grass and which are uncultivated are generally reported to yield well. This is probably because of the accumulation of organic matter and nitrogen under uncultivated grass. There is little doubt however that grass has some detrimental effect on yields and it is more than probable that if it were replaced by a leguminous cover crop, higher yields would be obtained. Grass can affect coconut palms adversely by depriving the latter of some of the soil moisture, by causing the surface soil to get "bound" and so preventing good soil aeration and the absorption of the rain water, by increasing the carbon dioxide content of the soil air and by assimilating the available nitrate of the soil as well as a part of the manure applied to the crop. On hilly and undulating lands grass will prove useful against soil erosion, but its disadvantages may counterbalance any advantages accruing therefrom.

PRACTICAL CONSIDERATION OF GREEN MANURING COCONUTS

Under this heading will be discussed the soil and climatic conditions under which green manuring of coconuts can be carried, and the treatment of green manures in various coconut districts.

Soil and climatic conditions determine the adoption of green manuring. The greater part of the coconut areas of the Negombo, Chilaw and Puttalam districts consists of light sandy soils markedly deficient in organic matter. The

rainfall conditions are not ideal, especially in the Puttalam district and long periods of drought are not unknown. The question may well be asked: Will not the light soils of these areas be deprived of the little moisture they contain by the growth of green manures? The results of investigations carried out at Peradeniya on this question have shown that once cover crops have been well established, more moisture is found in the soil after a period of drought than a bare soil or in one in which such crops are not grown. In the case of bush green manures it has been found that, from the point of view of soil moisture lopping before the drought sets in is essential and that forking the loppings into the soil towards the end of the rains is distinctly advantageous.

Provided there is sufficient rainfall, green manures can be grown with advantage even on poor sandy soils. In such a case, growing a green crop and turning it in will eventually increase the water-holding capacity of the soil and enrich it with nitrogen and humus.

The treatment of green manures, especially in the season prior to drought: In order to secure maximum amounts of nitrogen and optimum decomposability, bush and creeping green manures should be cut just before flowering. In the case of the former, care must be taken that the branches do not get too woody before they are lopped as the more woody they become the more resistant they are to decomposition.

But in the dry districts particularly, green manures should be cut towards the end of the rainy season when the showers alternate with dry weather, and should be ploughed in at once. On sandy soils in districts where a long drought follows the rain, if it has not been found possible to turn in the loppings, these should be cut at the commencement of the drought and left as a mulch on the surface. On those soils moisture and not nitrogen is often the limiting factor of crop growth, and the mulch of green material will form a useful means of conserving soil moisture. It is preferable, however, to turn in the cuttings about three to four weeks before the droughts sets in, as by that time a certain amount of decomposition will have taken place

and the decomposed material will have been able to retain some moisture for the subsequent use of the crop. On no condition should green manures be cut and forked into the soil during a drought, even at the beginning of it. This applies particularly to light sandy soils. The decomposition of the green manures does not take place if the soil has insufficient moisture at the time of burying or subsequently. If they are ploughed in during dry weather when the soil is dry, the material remains undecomposed and leaves large air spaces that cause loss of water by evaporation. It may be necessary in some instances to compact the soil after green manuring in order to minimise the losses of soil water and to establish capillarity in the soil.

In districts of average quality soil and with average rainfall the general treatment of cover crops under coconuts before a drought is a comparatively simple matter. Most covers die down during a prolonged drought, and the decayed leafy material obtained forms a very good mulch. If, in addition, light disc-harrowings are periodically given, the palms should not be affected to any great extent by drought. Immediately the rains start, the cover crops come up again. In the case of those covers which stand drought well, experiments at Peradeniya indicate that once the cover has been well established less moisture is lost from the covered area than from the bare soil. In districts with a good rainfall, though some moisture will be lost from the soil through cover crops in the early stages of their establishment, there will not be any permanent ill-effects on old coconuts. In young plantations it would perhaps be useful to grow a mixture of drought-resisting and no-resisting covers. Where the soil is sandy and rainfall good and evenly distributed, the growing and forking in of quick-growing annual covers (such as cowpeas and *Mucuna*) are advised; and when the soil is sufficiently enriched with organic matter, this should be followed by the establishment of a more permanent cover. In the case of sandy coconut soils in dry districts quick-growing annual crops should be established in the rainy season and ploughed in towards the end of the rains. Boga medeloa or other bush green manure should also be grown and the loppings

cut and left as a mulch on the surface at the beginning of the drought. After a few years of this treatment, the question of the establishment of a permanent cover should be considered.

It is necessary to emphasise the point that cover crops must periodically be turned into the soil. It has been observed that on estates where cover crops have been established they have often been allowed to get quite out of hand, no agricultural treatment whatever having been given since the establishment of the cover crops. In some cases the cover crop had grown to a height of from 2 to 3 feet and had even climbed up the trunk of the palms. Further, on many of the estates no artificial manuring whatever had been one since the covers were first planted. On estates which had been manured, the manures had often been either broadcasted over or forked around the palms clear of the cover and the latter allowed to grow over the manured areas. Sometimes cover crops and green manures had been established on areas fertilized with a mixture intended for the coconuts. The impression seemed to be fairly general that green manuring meant merely the growing of leguminous cover crops and not their incorporation into the soil. A warning must be issued against such misunderstanding of the process of green manuring which, instead of producing any results of value, would only cause a setback to the crop.

Green manuring is the practice of turning into the soil undecomposed plant material with the object of increasing soil fertility. If the green manure is a leguminous cover crop, the turning in of the green material will add to the available nitrogen content of the soil, as practically all leguminous crops fix free nitrogen in the nodules present on their roots.

Some of the nitrogen as fixed in the nodules is steadily transferred to the leaves, and stems, and therefore, unless the green material is incorporated with the soil, the main crop would get comparatively little benefit from the nitrogen so fixed. In regard to potash and phosphoric acid it has to be emphasized that green manure crops take the whole of their need of these constituents from the soil. Unless the green

manure crops is turned in, it would therefore be depriving the main crop of some of the available phosphoric acid and potash present in the soil. As phosphoric acid and potash are the chief manorial ingredients required by the coconut palm for good yield production, there is little doubt that on estates where these fertilisers are not applied, the cover plants are bound in time adversely to affect yields, unless they are systematically incorporated into the soil. In fact, estates are known on which cover crops have been grown for some years now, but to which latter no treatment whatever has been given, and the results have been disappointing. This is not in the least surprising. On the other hand by turning cover crops in the soil, the phosphoric acid and potash assimilated by them is returned to the soil in an easily available form, with obvious benefit to the main crop.

From an economic point of view, by the growth of the green manures and the practice of green manuring on coconut estates weeding costs are reduced and a free source of organic nitrogen is obtained. The manure bill can be very appreciably reduced by eliminating all organic nitrogen from it. Any nitrogen added, where required, should be in the form of cheap artificial nitrogenous manures. But green manuring cannot obviate the necessity for the application of potassic and phosphatic fertilisers to coconut. It is essential that on green manured coconut estates potash and phosphoric acid be applied, and preferably in larger quantities than those normally required by the crop tree (5).

On some estates the manure mixture is broadcasted over the cover crop. This is obviously a practice to be avoided wherever possible, as a great deal of the manure intended for the main crop will be taken up by the green manure crop even temporarily. Further, if the mixture contains artificial nitrogen, a leguminous crop will make no attempt whatever to fix free nitrogen, which it would otherwise do. Broadcasting of artificial manures over a cover crop is advisable only when the cover is to be turned in immediately after. The practice of growing leguminous green manures on fertilised areas is also to be discouraged for the reasons just stated.

In regard to all coconut manuring it has to be remembered that manures are applied for the benefit of the main crop, and that green manuring is for the same purpose. If therefore, the manuring is so carried out that the cover crop gets the chief benefit of the manures applied, and if the cover is left unturned into the soil for long periods, it cannot be expected that the main crop will derive an appreciable advantage for the expenditure incurred manuring. When coconut under covers are manured it would be advisable, where the application is made between the rows of palms; to plough or turn the green manure in along with the artificials. Where manuring in trenches around the palms or in trenches between the rows is adopted, the green manure should be kept a good distance away from the manured trenches for at least three months after the application. The green manure material obtained from the cleared areas should be buried in the trenches along with the artificials. If ploughing or turning in cannot be done, cattle and buffaloes can be tethered around the palms in order to eat the cover and to trample down the soil at the same time. The manure can then be applied in circular trenches or forked in circle around the trees.

In regard to the treatment of cover crops on coconut estates, the most beneficial practice would be to cut and deep fork the green material into the soil at or just before flowering. This involves a heavy expenditure and will not be practicable at the present prices ruling for coconut. Ploughing in, if the cover is not too thick, is the next best procedure to adopt. Disc-harrowing as a preliminary to ploughing is also useful. If the cover is too thick it would be advisable to let cattle or buffaloes graze over the area before the ploughing. The latter will doubtless utilize some of the nitrogen and minerals of the green cover for their own purposes, but a fair proportion of these fertilising ingredients will return to the soil in the dung. Keeping cover crops low by means of cattle is a wise practice, especially if such crops cannot be frequently turned into the soil, as the losses or nuts are minimised and snakes will perhaps not be numerous. The frequency of forking in covers will depend entirely on the growth of the cover. Once a cover is well

established it should be turned in about every other year. Alternate rows of cover if convenient, may be treated every year.

THE PRACTICE OF GREEN MANURING AND CHOICE OF CROPS

Now that the advantages of green manuring coconuts have been indicated and some practical considerations have been dealt with, the question of suitable green manure crops will be considered in detail. Many varieties have been found useful for new clearings and mature palms. Mention will be made of only a few. It is now proposed to deal in detail with such considerations as seed rate, method of sowing of or green manures suitable for a particular district. These are matters essentially for the men on the spot to discover by treatment or enquiry.

The practice of growing green manures under coconuts and oil palm is popular in the Dutch East Indies, where it is doubtless to some extent responsible for the high yields of coconuts obtained. Most of the varieties now grown in coconut and rubber-producing countries were first experimented with, and grown on a large scale, in the Dutch East Indies. (3) in the Philippines cover crops are grown on every progressive estate. (2) The green manures found most suitable are certain varieties of the lima bean (*Phaseolus lunatus*). This bean is a long-lived perennial of exceedingly vigorous growth which has been reported to be useful terminating illuk (*Imperata arundinacea*). It dies down in prolonged dry weather, but comes up again with the rain. Unlike those of the most green manure plants, its leaves cannot be used as fodder owing to the pressic acid they contain. Other plants found useful for coconuts in the Philippines are *Tephrosia candida* (boga modeloa) and *Tephrosia vogelii*. On the poor sandy coast soils of Porto Rico, species of *Mucuna* have been very successful. *Mucuna* grows very quickly and thick, and quantities of green material (up to 6 tons per acre) are obtained. The leaves are rich in nitrogen and can be used as fodder.

Many varieties of green manure have been found suitable for coconuts in Malaya (1.8). Among these are *Centrosema pubescens*, *Calopogonium mucunoides*, *Dolichos hosei* (*Vigna*), *Centrocema plumieri*, *Pueraria phaseoloides*, besides bush varieties like *Tephrosia candida* (boga), *Tephrosia vogelii*, and *Crotalaria spp.* In India *Vigna cataiang* (Cowpeas) and *Dolichos uniflorus* (horse gram) are grown successfully, both as catch-crops and green manure crops (9).

In Ceylon green manuring of coconuts was undertaken as early as 1905 at the Experiment Station, Peradeniya (10). The crops tried were Cowpea, groundnut, soya bean, *Crotalaria spp.* and boga. Cowpeas gave very good results, and so did boga and *Crotalaria*. Soya bean as not a success, perhaps due to the deficiency in the soil of the specific bacteria associated with this crop. It has been found in America that inoculation of soya bean is always necessary before the crop can be introduced into new areas. Recent trials with soya bean at Peradeniya have proved successful on areas which had grown legumes previously. Groundnut (*Archis hypogea*) is useful as a green manure owing to its rapid growth provided it is turned in when young. It is not to be recommended as a catch-crop owing to its attraction to rats, which attack the coconuts.

In young coconut plantations where the rainfall conditions are satisfactory, the growth of a cover crop is very advantageous. The bush varieties, e.g. boga, are not entirely suitable as they are inclined to become too dense and to compete with the young plants unless they are grown in rows not more than 6 feet wide between the palms and are regularly lopped. The practice of growing shrubby green manures like boga or even tree green manures like *Gliricidia maculata* round very young palms is not to be recommended unless they are frequently lopped and kept low. In regard to all cover plants in young coconuts, it has to be emphasized that they must never be allowed to climb over the young palms; if they do, the latter will suffer a setback.

The following will be found useful and can be recommended for young coconut areas in Ceylon: *Caloipogonium mucunoides* grows well on most soils but requires good rainage. It has a tendency to climb. During the periods of prolonged drought it may die out, but with the advent of the rains a fresh cover is obtained. It is best sown in rows 3 to 5 feet apart and requires weeding in its early stages. A good cover about 2 feet thick can be obtained in about four months will die out in twelve to eighteen months. It can be grown under coconuts which does not give much shade but it does not thrive as well as in the open. *Mucuna* spp., after they have formed a good cover in new clearings, should be ploughed in and followed by a more permanent cover, such as *Centrosema pebescens*, a twining creeper requiring a fairly good soil. It is rather slow in growth but forms an excellent cover in about five or six months; difficulty may be experienced at first in establishing it. If it is grown after a crop like *Mucuna* has been ploughed in, its growth will be quicker. It stands drought admirably. It does not thrive under heavy shade, but it grows well under the light shade of coconuts. *Dolichos hosei* (commonly known as vigna) is more suitable for heavy shade, but does well in young clearings. The disadvantages with vigna are that it is rather difficult to establish on eroded hilly land, needs constant weeding, and dies down during drought. *Pueraria phaseoloides* is a strong twining creeper suitable in young plantings. Twining cover is useful for young clearings, but it must be kept away from the young palms. It dies down in drought. It is better suited for heavy land than for sandy soils. *Centrosema plumueri*, *Dolichos lab lab*, *Dolichos biflorus* (horse gram) have also been recommended as green manures for young coconuts. *Vigna catiang*, *Vigna sinensis* (cowpeas) are suitable for both young plantations and old coconuts. The cowpea is a quick-growing annual which forms an excellent cover in three to five months. It thrives on the poorest land and stands drought well. It is therefore, very suitable for Ceylon coconut lands. It has been successfully used at Peradeniya as a green manure for coconuts and also in the Kurunegala district. Soya max or *Glycine hispida* (soya bean), where it could be

established would be suitable for young clearings as well as old coconuts. There are more than 400 varieties of this bean in existence. It is a herbaceous annual of erect growth, varying in height according to the species. It is particularly resistant to drought and will thrive on most soils except the very poor ones. Inoculation is often necessary when this crop is grown for the first time. It can be treated both as a catch-crop and green manure crop.

Of the bunch varieties of green manures *Tephrosia* spp. and *Crotalaria* spp. are most suitable for coconut. *Clitoria cajanifolia* is also a suitable hedge plant. Of the former, *tephrosia candida* (Boga medeloa) is perhaps the best for Ceylon conditions; hence its popularity as a green manure for coconuts. If the land is rich boga will, unless lopped, grow too tall and affect the young coconuts adversely. It should be sown in rows whenever possible. On hilly land boga should be grown in contour hedges across the slope. On poor and badly-drained soils, on which it is difficult to establish the crop, the following methods will be found useful: (1) a drain is cut and the soil heaped in mounds over husks. The seed is then sown in the mounds, a little artificial or cattle manure being added if necessary. It can also be grown on the mounds of contour terraces of coconuts; (2) cattle or buffalo manure is forked in lines between the rows before sowing the seed, the lines being previously lined if necessary. Boga gives a very good yield of loppings rich in nitrogen and organic matter and also in minerals because it is so deep rooted, it stands loppings well. And, like all shrubby green manures, it must be cut before the drought sets in towards the end of the rains. It is preferable to fork the loppings into the soil if a sufficient interval of time between the turning in and the onset of the drought is anticipated. In case a sufficiently early forking is not possible, the bushes should be lopped at the beginning of the dry period and the loppings left as a mulch on the surface. In this case, the soil moisture must be conserved even at the risk of incurring appreciable losses of nitrogen. The leafy portions added during manuring time in the manure trenches. When shrubby green

manures are cut at other periods the cutting should be done just before or a flowering. The disadvantages of shrubby green manures are the difficulty of supervising labour and of gathering the crop. Other varieties of shrubby green manures suitable for coconuts young and old are *Tephrosia vogelii*, *Caganus indicus* (dhal); *Crotalaria striata*, *Crotalaria usaramoensis* and *Crotalaria anagyroides*. The latter are quick growers and give large amounts of organic matter. They need frequent lopping but die off comparatively soon.

Green manures for Old Coconuts - The shrubby green manures have been dealt with. Of cover crops, *Centrosema pubescens*, *Centrosema plumieri*, *Dolichos hosei*, *Pueraria phaseoloides*, *Phaseolus lunatus*, *Vigna catiung* (cowpea), *Archis pypogea* (groundnut), *Mucuna spp.* will grow successfully if the shade is not too heavy. *Calopogonium mucunoides* is suitable if the shade is light. *Desmodium polycarpum* has been found to be a very good green manure for coconuts in the Kurunegala district.

Some estates grow *Gliricidia maculate* and *dadap* (*Erythrina lithosperma*) between the rows of old coconuts for green manuring. While these trees may be useful in districts with good annual precipitations, they are not suitable for dry coconut districts. They are inclined to interfere with the cultivation operations of the main crop and to compete with the coconut roots for the phosphoric acid and potash of the soil. Especially on poor soils *Mikunia scandens* can be left where it grows if it cannot be replaced by a green manure crop. It must, however, be ploughed in before the drought sets in. It is a non-leguminous twining

weed common on estates and is useful for suppressing other weeds, e.g. illuk. It has been found useful in Malaya (1) and the Philippines (2) as a cover crop for coconuts. In general it may be stated that any leguminous plant growing on a coconut plantation should be encouraged and, if indigenous legumes grown well in the neighbourhood, attempts should be made to introduce them on the estate. In the case of non-leguminous plants which grow well outside estates, e.g. wild sunflower, it would be advantageous to lop them before they have flowered and to use the cut material for green manuring coconuts.

SUMMARY

In the preceding pages the benefits to be derived from green manuring coconut in Ceylon are pointed out, the varieties of green manures suitable for the different soil and climatic conditions under which coconuts are grown in Ceylon have been indicated, and their treatment, especially before periods of drought detailed. No statistical data are available to demonstrate the effects of green manures on crop yields and the increased profits derived by the adoption of the practice, but it is acknowledged by all coconut planters who have used green manures for some time or their estates that they are distinctly beneficial both to crop and soil. Green manuring has been adopted in progressive coconut-growing countries like the Dutch East Indies and the Philippines. The wider adoption of the practice in Ceylon should eventually result in increased yields of better quality, and in a permanent improvement of the conditions of coconut estates.