

## GREEN MANURES FOR PADDY IN THE DRY ZONE OF CEYLON

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THE incorporation of green manures in the soils of irrigated paddy fields of the dry zone should be regarded as an essential operation in the cultural practices of the crop, for the purpose of supplying nitrogen and organic matter to the soils. On a number of fields situated under village tanks, paddy cannot often be grown for two successive seasons in the year owing to the insufficient supply of water available for irrigation from these tanks. Many of the fields thus remain uncultivated for one or more seasons. During this period, however, several leguminous plants, the chief of which are *Cassia tora* Linn. (*S. tora*, *peti-tora* T. *takarai*, *vadda-takarai*) and *Tephrosia purpurea* Pers. (*S. pila* T. *kavilai*, *kolinchi*), may be found growing on these fields as weeds. *Cassia* often forms a thick cover soon after heavy rains, but these plants are not long-lived. They shed their leaves and seed early so that with fresh rains, a dense growth of *Cassia* seedlings may again appear. *Tephrosia* is slower growing and does not usually form such an even stand as *Cassia*, but it is longer-lived and except during periods of severe drought it does not shed its leaves. When the rains are sufficiently heavy and the tanks have filled again, these green manures are turned under the soil with the preparatory tillage operations that are carried out for paddy and this non-deliberate method of green manuring the soil for the paddy crop largely contributes to the better yields obtained in the dry zone than when paddy is grown continuously on the same land.

Although *Cassia* does not possess root nodules, the incorporation of a large quantity of fresh, succulent green material into the soils leads considerably to an increase in the organic matter of these soils. In the case of legumes like *Tephrosia*, the root system is very deep and extensive (Fig. 1). The nodules on the roots containing the nitrogen-fixing bacterium are numerous and the type of nodulation is efficient according to Fernando (1).

Although more definite methods of green manuring than that mentioned above are in progress in the dry zone, they are not sufficiently widespread yet and it is necessary, therefore,

to draw the attention of paddy cultivators to the importance of more efficient methods of green manuring for improving crop yields.

There are, generally, two ways of green manuring paddy soils, *viz.* :—

1. Collecting and transporting green leaves from outside, whether leguminous or not, and applying them at the time of flooding the fields prior to puddling for the next paddy crop.
2. Growing the green manure, which should be a legume *in situ*, and ploughing it in at the time of the first tillage operation for the next paddy crop.

The first method is more generally practised but it is not so satisfactory as the second. In extensive paddy tracts, there may be great difficulty in obtaining a sufficient supply of green material from outside. Furthermore, it is only the aboveground portions of the plants which can be utilized and, in the case of leguminous plants, the nitrogen fixed by the bacteria in the root nodules of such plants cannot be supplied to the paddy crop, owing to the difficulty of uprooting the complete plants from outside and turning them into the soil of the paddy field. The first method also entails greater expense in cutting the green material from outside and in transporting it to the paddy field.

In the second method, the green manure is usually grown on the land when there is no paddy crop on it. Where, as is generally the case under major irrigation schemes in the dry zone, two early maturing paddy crops (4 months for *maha* and 3 months for *yala*) are taken in succession during the year, the intervals between the harvesting of one crop and the sowing of the next are barely sufficient for raising a green manure. The longer interval between the two crops occurs after the harvest of the *yala* crop in August and the commencement of tillage operations for the *maha* crop, towards the end of September or early October, but cultivators are generally reluctant to devote any time to growing a green manure during this period as they are occupied with the threshing operations of their last crop before the advent of the heavy north-east monsoon rains. If, however, a single late-maturing crop is substituted for these two early-maturing crops, and it is annually cultivated, then the growing of a green manure crop in the alternate season in the year can be satisfactorily undertaken. Experimental work is necessary in order to ascertain whether the substitution of a single late-maturing crop alternated with a green manure each year would result in more economic returns than a succession of early-maturing crops grown twice a year on the land.

With the biennial cropping of paddy, the possibility of growing a green manure in association with paddy should be explored. Nicol (3) has drawn attention to the advantages of an association between a cereal and a legume and quotes several instances in primitive forms of agriculture where the mixed cropping of legumes and non-legumes on arable lands is quite common. No instances have, so far, been recorded of associated growth in paddy fields, where a legume is one of the components providing nitrogen for the non-legume, although conclusive evidence has recently been put forward by Fritsch and De (2) of the rôle of certain algae, particularly the blue-green algae, in the fixation of nitrogen in the soils of paddy fields under water-logged conditions.

There is a possibility that some leguminous plants may be found capable of growing with paddy under conditions of periodic inundation which prevail in the fields of the dry zone and that either the immediate or the subsequent paddy crop may benefit by the association. If the legume is unable to develop during the early stages in the growth of the paddy crop, on account of excessive moisture in the soil but would germinate in the later stages when the water is drained off the fields, it could be left standing when the paddy is reaped so that soon afterwards it may flower and set seed. When preparatory tillage commences for the next crop, this green manure can be turned under and the nodules developed by its roots would decay and the nitrogen fixed by the nodule bacteria would be available to this crop. It is possible, however, that a legume may be found adapted to the conditions in paddy fields during the early stages of the growth of the paddy as, in the case of the latter crop, their roots are not of the true aquatic type but they are able to thrive because the algae in these fields are able to liberate oxygen which is utilized by the roots of the paddy plants. In such cases, the legume may be able to benefit the immediate crop. If, therefore, the seed could be collected without difficulty it could be sown in such proportion to that of the cereal as to prevent its growth interfering with that of the paddy. If, however, the legume seed is shed as the pods dehisce and remains dormant in the soil, germinating either with the paddy or at some later stage, the expenditure of collecting the seed of the legume and sowing it would be saved.

In the case of the legume to be grown during the alternate season, when no paddy is cultivated, a longer-aged species may be selected but it should seed before tillage operations commence for the next paddy crop, as otherwise the cost of obtaining seed from elsewhere and sowing it in the alternate season would have to be met as an additional item. It is, of course, to be realized that a green manure which is turned into the soil

before flowering has a greater nitrogenous value than when it has been allowed to seed but, where the collection of seed from outside becomes costly, it is preferable to turn in the green manure grown *in situ* after seed production has taken place. A still further advantage would be secured if the green manure not only shed its seed before the cultural operations for the next paddy crop commenced, but also exhibited delayed germination of the seed, so that it remained dormant while the next paddy crop was on the land, germinating soon after the paddy crop was harvested. This would result in a considerable saving of expenditure both in the collection of the seed and in the resowing of the green manure each year after the paddy crop is harvested.

With these objects in view, observations were carried out with a number of leguminous green manures sown under different conditions. The green manure seed was sown (*a*) mixed with germinated paddy at the time of sowing the paddy, (*b*) prior to the ploughing of the field in preparation for sowing paddy, (*c*) before the harvest of the paddy, and (*d*) after the harvest of the paddy. Brief notes on the crops which proved to be most promising are given below, but much further work remains to be done in order to select varieties which will give the best results in increasing yields of paddy under different systems of cultivation.

1. *Phaseolus lathyroides*. This plant grows wild on certain paddy fields in the dry zone, both in the standing crop when the fields have been drained and after the harvest. It is a small, erect, semi-shrubby plant.

This species is capable of growing in association with paddy, the seeds germinating on the third or fourth day after sowing. When, however, water is let into the fields, many of the seedlings which are not on high ground or on soils where the water is not retained on the surface for long will die. The surviving plants will be as tall as the paddy and they set seed about 3-4 months after sowing. Owing to the small size of the pods collection is difficult, but the pods dehisce readily when mature and the shed seeds germinate without any period of dormancy. The pods of this plant are subject to an attack by the common Dadap moth (*Anaplocnemis phasiana*).

2. *Sesbania speciosa*. Seed of this species was sent for trial by Mr. H. C. Sampson, Economic Botanist, Kew. He collected it from abandoned paddy fields on the Tana river delta in Kenya, stating that the plants on these fields appeared to develop from self-sown seed. Owing to the presence of a hard seed coat, the seed exhibits delayed germination unless



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FIG. 2—*Sesbania speciosa*.

lightly pounded with sand. The plant grows to a height of 6–8 feet and has conspicuous yellow flowers borne on terminal spikes, with the stems free from spines (Fig. 2).

When sown mixed with paddy it can germinate like *Phaseolus* on the third or fourth day, although the percentage germination is poor, and many seedlings die when the fields are flooded. Those that survive grow slowly but when the paddy is harvested they grow more rapidly. Seed which is not pounded is capable of germinating after the paddy crop is harvested but the plants that develop are few in number.

3. *Crotalaria juncea* L. (sunhemp): This plant has been grown for many years in the north of Ceylon, chiefly for the extraction of fibre and also as a green manure and fodder crop (4). It does not germinate under water-logged conditions when paddy is growing, but comes up well when sown after the paddy is harvested and the fields are ploughed. The seed rate is very high, about 112 lb. per acre being sown in the northern part of the Island for green manuring purposes, but in an experiment carried out on paddy lands, 60 lb. per acre was found to be the optimum as against 40 and 80 lb. per acre, for the production of green material (6). Sunhemp takes about 4½ months to produce seed and it is necessary to collect and resow the seed each season which is one of the objections to the use of this plant.

4. *Tephrosia purpurea* Pers. and *T. villosa* Pers. (*S. pila* *T. kavilai* or *kolinchi*). The first-named species is the most popular green manure in the dry zone and differs from *T. villosa*, which is rare, by its smooth or slightly pilose linear pods, the latter having stout, densely-hairy pods (Fig. 3). The flowers of *T. purpurea* are somewhat smaller and have a magenta hue while there are two varieties of *T. villosa*, one with amparo purple (Ridgeway—Colour Standards) and the other white flowers. Both are low shrubs of perennial habit with wide-spreading branches.

The two species possess hard seed coats and thus exhibit delayed germination but they do not grow in the standing crop of paddy even after lightly pounding the seeds with sand. They appear soon after the paddy crop is harvested when the fields are well drained. Even if a second crop of paddy follows the first, *Tephrosia* appears after the harvest of the second paddy crop. When sown after the harvest of paddy, *Tephrosia* germinates in about a week's time but its growth is slow in comparison with *Phaseolus* and sunhemp. The plants may flower in two months' time and seed in 3¾ months. *T. villosa* is considered to be superior to *T. purpurea* on account of its greater vegetative growth and more profuse production of pods (5).

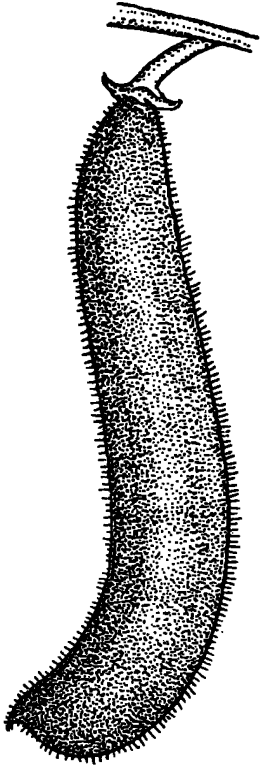
## SUMMARY

Observations carried out on a few leguminous plants suitable for growing as a green manure in paddy fields of the dry zone indicate that where a quick-growing green manure is required in the alternate season when no paddy is cultivated, sunnhemp is the most suitable, but seed has to be sown and collected again for resowing the following year. *Tephrosia purpurea*, or preferably *T. villosa*, is, on the other hand, slower growing, but when once established need not be resown as it is capable of shedding its seed which remains dormant until the next paddy crop is harvested. It is more drought-resistant than sunnhemp. *Phaseolus lathyroides* is capable of growing in association with paddy and at about the same rate, provided the fields are not kept inundated for too long periods at a time. *Sesbania speciosa* can also germinate with paddy but it does not develop at the same rate as the paddy plant though, after harvest of the paddy, it grows more rapidly. It does not, however, form an even stand, but the seeds when shed can remain dormant in the soil for several months.

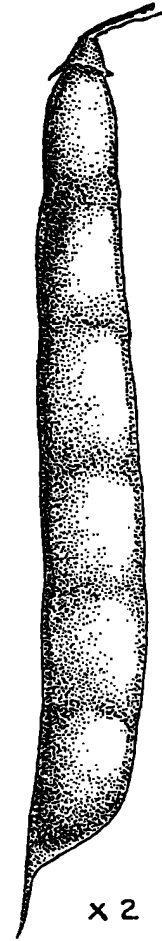
Experimental work is now desired to compare the yields of paddy when a single late-maturing crop is grown in one year followed by a leguminous green manure such as sunnhemp, or *Tephrosia villosa*, in the alternate season, as against two early maturing crops, in which a leguminous green manure is grown in association with the paddy at each season.

## REFERENCES

1. Fernando, M. .. The inoculation of legumes. *The Tropical Agriculturist*, XCI., 1938, p. 103
2. Fritsch, F. E. and De, Nitrogen fixation by blue green algae. *Nature*, P. K. No. 3602, 1938, p. 878
3. Nicol, H. .. Mixed cropping in primitive agriculture, *Empire Journal of Experimental Agriculture*, 3, 1935, p. 189
4. Paul, W. R. C. and Sunnhemp in the Jaffna Peninsula. *The Chelvanayagam, A. V. Tropical Agriculturist*, LXXXVI., 1936, p. 23.
5. Paul, W. R. C. and Jaya- *Tephrosia villosa* [as a green manure for the dry sundera, E. S. de S. zone. *The Tropical Agriculturist*, LXXXIX., 1937, p. 30
6. Paul, W. R. C. .. A comparison of different seed rate treatments of sunnhemp on the yield of green material and seed. *The Tropical Agriculturist*, XCII., 1939, p. 345



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FIG. 3—*Tephrosia villosa* PERS. (LEFT) AND  
*Tephrosia purpurea* PERS. (RIGHT).