GREEN MANURE CROPS

BY ROLAND BUNCH & ECHO STAFF

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INTRODUCTION

Green manure crops are crops that are grown to be turned under to increase soil fertility. Leguminous green manure crops, i.e. those which can make nitrogen fertilizers from atmospheric nitrogen, can offer small-scale Third World Farmers a tremendous number of advantages, including:

- They provide large quantities of nitrogen for the soil.
- They add many tons of organic matter to the soil, thereby improving topsoil depth, water-holding capacity, nutrient content, friability, and texture of the soil.
- Inasmuch as the green manure crop grows in place, it presents no transportation problems, in contrast to either compost or chemical fertilizers.
- Green manure crops require absolutely no capital outlay after the initial purchase of a handful of seed. Because they require no chemical inputs, dependency on outside sources of fertilizer, nutrients, and pesticides is reduced.
- Green manure crops can shade the soil up to eleven months out of the year, a factor extremely important in tropical climates for preservation of soil moisture and organic matter.
- The cover they provide for the soil protects the soil from wind or water erosion.
- Green manure crops provide generous amounts of high protein fodder for animals, which can be especially valuable if it is available during the last months of the dry season (inasmuch as fodder at this time of year is the limiting factor in traditional animal raising in much of the Third World).
- Some green manure crops provide human food, including various kinds of edible beans, peas, and pods.
- Green manure crops can provide cash income, by selling firewood, food or feed (and maybe seed).

ECHO, 17391 Durrance Rd., North Ft. Myers FL 33917, USA
Phone: (239) 543-3246; Fax: (239) 543-5317
e-mail: echo@echonet.org; website- http://www.echonet.org/

- They often provide an incentive for people to abandon harmful traditional practices, such as burning crop residues or letting animals loose in the dry season to devour everything in sight.

- Some green manures, when intercropped with basic grains, can control most weeds, thereby eliminating costly weeding operations.

Something like 30% of all the increases in harvests achieved by small farmers in the third World during the last three decades has been achieved through the use of chemical fertilizers. Should petroleum prices shoot up once again, as could easily happen sometime in the next decade, prices of chemical fertilizers could easily become too expensive to be economically feasible for use with traditional basic grains. Almost overnight, Third world basic grain production could plummet, causing famines the extent of which would make the present situation in Africa seem mild by comparison. Widespread use of green manure crops could avert much of this impact.

COMPARISON WITH COMPOST

Inasmuch as composting is a technology that is often recommended for Third World development programs, it might be useful to compare composting with the use of green manure crops.

- Compost merely decomposes the organic matter one already has, whereas a green manure crop can often add over 40 tons of additional organic matter per hectare. Inasmuch as organic matter is often in short supply on villagers' farms (or is already being recycled), this is an important consideration.

- At best, compost will return to one's field about 98% of the nitrogen one started out with. A green manure crop, however, will add considerable quantities of new nitrogen to the system.

- A compost heap takes a tremendous amount of work, as anyone who has personally made one can attest. Though compost will often pay in a vegetable garden, it is not economical when used on basic grain crops such as corn or millet. On the other hand, although a green manure crop takes a bit of labor to plant (Using a dibble stick) and a fair amount of labor to incorporate, it takes nowhere near the labor a compost heap does. And in some cases where the green manure crop is intercropped among traditional crops (such as corn, sorghum, or millet), it covers the ground so well that one or even two weeding operations can be eliminated, thereby actually bringing a net savings in labor.

- A compost heap requires water. This often means it is made near a water supply but at a fair distance from where it is to be applied. Green manure crops are planted to take advantage of available rain water, and are planted right where they will be used.

- Compost cannot be used as a food source, either for animals or humans.

CROPPING SYSTEMS

In spite of the advantages of green manures, their use has seldom become common among farmers in the Third world. They cannot afford to give up scarce cropland just to grow a soil amendment. If they do have the land, they cannot afford the labor. Nor are they generally willing to spend money to improve crops grown for subsistence, because they earn no money to improve crops grown for subsistence, because they earn no money from them with which to replace what they have spent.

What characteristics should we look for, then, in a legume that will be useful under these circumstances?

- It must be a non-woody annual with vigorous growth.

- It should grow well in the poorest of soils in the area, without needing any kind of fertilizer.
- One must be able to plant it in local fields with no special soil preparation, and either with a dibble stick or, preferably, by broadcasting the seed.
- The plant must have few enough natural enemies that it will grow vigorously without the use of any pesticides or major labor requirements.
- The legume should either be very shade-resistant (for intercropping) or drought-resistant (for growing into or through the dry season).
- If possible, it should first cover the ground well, then climb any stalks that remain in the field.
- If possible, the green manure crop should be edible by animals and/or humans.

World Neighbors/Central America has found a number of ways to overcome most of the problems associated with green manures to the extent that farmers have accepted them faster than any other agricultural technology with which we've worked through the years. One program sold 65 pounds of seed last year to local farmers and 1500 pounds this year in the same area with minimal promotion. In Central America our work has used the following four ways to produce green manure without reducing the amount of land used for other crops:

1. Green manure crops can often be planted among traditional row crops, especially corn, sorghum, and millet, without decreasing the production of the main crop at al the first year, and usually with major increases in the major crop in succeeding years. The major instance in which this is not possible is when people are already intercropping two or three other crops with their major grain.

2. Green manure crops can often be intercropped with basic grains toward the middle or end of the growing season, with the idea that their major growth would occur during the dry season, thereby using land that would not ordinarily be under cultivation.

3. Wherever multiple-year fallows and/or shifting agriculture is used, green manures can be planted on land the first year it is to go fallow. Thus the period of fallow can be cut to one year instead of three or more years.

4. Use a green manure crop in conjunction with alley cropping.

What can be done in areas where animals are let loose during the dry season while the green manure crop is still growing? One approach is to first show people the results of the green manure plant on an enclosed piece of land. Next get a good number of people to try it out, perhaps timing the planting to get a good start before the animals are let loose. Those who experiment first can often be motivated to spread the word to others with the idea that the destruction for each person will be less if more people plant it. Eventually, if enough people plant it, community pressure will make everyone keep his animals locked up (except in cases where the person with all the animals is a large landowner).

On very steep hillsides, something must be done to keep the organic matter from washing away. Piling crop residues along roughly contour lines can help, as can contour ditches. Another possibility is incorporating the green manure immediately after cutting it, but this is hard work before the rains come (if soil is a heavy one), and once the rains have come, people generally do not have extra time.

On flatter land, the green manure should usually be cut and allowed to dry for a couple of weeks before incorporating it (if during the dry season). The labor saved in incorporating it will be worth more to the farmer than the small amount of fertility lost. In one case farmers cut holes in the Canavalia cover to plant corn when the

rains came, cut down the Canavalia entirely about two weeks later and replanted the Canavalia. Then, two weeks later, they incorporated the dead Canavalia vegetation. In this manner, they avoided both weeding operations in their cornfields!

Where weather is unreliable, a combination of similar plants, one of which is more drought-resistant (e.g. jackbean and velvet bean) reduces risk of total loss, yet assures a vigorous crop if rains are plentiful.

In West Africa, we are trying a system of planting a perennial every sixth row (pigeon pea), and then gathering the corn or millet residues under the pigeon pea plants at the end of the year, to be distributed six months or so later when well-mixed with better C:N pigeon pea leaves. The presence of the pigeon pea trees (already known as a cash crop) will also prevent burning of residues.

On South and Southeast Asian hillside areas, *Leucaena leucocephala* is planted as a contour barrier and constantly pruned, thereby providing erosion protection, some green manure, and firewood (see the booklet produced by World Neighbors called *Leucaena-based Farming*). This produces less green manure than other systems, but can be sued where green manure cannot be intercropped among traditional crops.

SOME PLANT SPECIES SUITABLE FOR GREEN MANURES

Although a good deal of research still needs to be done in finding adequate plant species (far too much of the research has been done on fertile experimental stations or with the use of chemical fertilizers, thereby making it virtually useless to small farmers), there are a few species that seem to fit most of the requirements for being a good green manure. They are:

Canavalia ensiformis (jackbean) is an incredibly drought-resistant, hardy legume that grows well in extremely poor, droughty soils (and apparently less well in fairly fertile soils). There are two kinds of jack bean, one that climbs and thoroughly covers the soil, and another that has a bushy growth habit and does not climb at all. It begins flowering after 4-5 months, then produces seedpods continuously for at least the next year. It will grow through some 5-6 months of dry season if above about 600 meters and can serve to shade the soil during this time to prevent loss of organic matter. Under 500 meters it will often stop growing after about 3 months without rain and may even drop its leaves if soils are thin and temperatures exceptionally high. The stem will become somewhat woody, but only if left for seed and under fairly warm conditions.

Jack beans grow vigorously at sea level, and can be used as a green manure crop up to about 1600-1800 meters. It does not thrive in soils with excess water. They do very well in cornfields, but are preferred over velvet beans only when it is too dry for velvet beans to thrive. This tends to be the case where corn has been replaced with sorghum or millet due to insufficient rainfall.

The jackbean will be eaten by grazing animals, but is liked less than other green manures. Hence jack beans are preferable where animal damage is feared. Non-climbing varieties are proving to be very good for weed control and nitrogen fixation under fruit trees. It has virtually no natural pests or diseases. Its leaves are sprinkled on leaf-cutter anthills to eliminate them. [Ed: I am told that ants carry leaves into the mounds as food for the fungi upon which they live. Jack bean leaves reportedly kill the fungi. Dr. Warwick Kerr in Brazil writes that planting sesame near the mounds has a similar effect].

Jack bean should be planted in soil that has been cultivated within 3 years and weeded very recently (although at elevations below 500 meters or in sandier soils, cultivation may not be needed). We use 4-5 seeds per square meter in order to control weed growth. (In cornfields an important advantage of this and the velvet bean is that use of these plants may entirely eliminate at least the second weeding). Jack bean has even been planted in fields already intercropped with both corn and beans in Haiti (Bois de Laurence) without much adverse effect on even

the beans. If planted in a corn or sorghum field, it should be seeded within 15-30 days of the primary crop, depending on climate, speed of growth of the other crop, etc. It can be planted with a dibble-stick or broadcast, though if broadcast it will take another 2 weeks or so to germinate unless soaked in water overnight before planting.

People can eat immature pods like green beans when they are about 7-8 inches long. In Southeast Asia the mature beans are eaten, but we have not been able to find out how. Cooking must be sufficient to eliminate certain substances in the mature bean that inhibit the assimilation of calcium by the body.

In summary, jack bean can be used in grain fields, under orchard trees or to shorten fallow periods, but is not as vigorous as the velvet bean and should be used only when conditions, perhaps mixtures of the two would function best.

Mucuna deeringiana or *Stizolobium pruriens* (velvet bean) is the most promising green manure that we have worked with in Central America. It covers the soil completely and then climbs as high as its support allows (up to well over 6 meters). It is highly palatable to animals and has gained wide acceptance in our Honduras program areas as a coffee substitute. Especially encouraging is that there are at least 4 large areas where velvet bean use has spontaneously spread from village to village without any outside intervention (in Mexico to shorten fallows and in Honduras to intercrop with corn).

Velvet beans first cover the ground almost completely, then climb vigorously. Where corn stalks are present, it will eventually form a mat of leaves at about the top of the stalks, with little more than stems and pods underneath. Stems remain thin and non-woody throughout the plant's life. The plant dies after it has set seed. [Ed: Seeing velvet bean growing to the tops of pine trees at ECHO prompts many to ask if it might not take over like kudzu in the southeastern USA. This might happen were it not that the plants die after seed set. It was a major US crop for years, and I never heard of such problems.]

Sometimes velvet bean roots produce solid clusters of dark red nodules that are 4 cm in diameter. We think that heavy nodulation occurs most frequently in infertile or sandy soils. Like jack bean, the velvet bean will volunteer heavily the second year if seed is allowed to mature and fall on the ground. In fact, farmers in Chiapas get growth each year in their cornfields without bothering to reseed it. They harvest 4 T/ha of monocropped corn planted year after year on the same land under typical jungle conditions, using chemical fertilizer plus velvet bean.

About the only soils in which velvet bean has not done well for us are those that are waterlogged or have a pH of 4.5 or less. Like the jack bean, it needs to be planted in a field that is either sandy or has been cultivated within the last 3 years. Velvet bean will take a bit cooler climate than jackbean, but still does best at sea level and does poorly over 2,000 meters. In cool climates it will grow 3-4 months into the dry season, but is not as drought-resistant as jack bean.

The velvet bean is presently our species of choice, in most cases, for growing in cornfields, rehabilitating depleted land, and weed control. It has been used in Guatemala and parts of Honduras to eliminate serious weeds such as nutgrass (*Cyperus rotundus*), Bermuda grass (*Cynodon dactilon*) and imperata grass (*Imperate cylindrica*). I am not aware of what is required to do this, though I would guess that the grass must be cut back and the velvet bean then allowed to grow a full 6 months in order to choke out the weeds.

It is an extremely good, fairly palatable high-protein fodder for most animals, especially cattle, and is eaten by virtually all animals except, sometimes, chickens. Thus, like the lablab bean, it can be an important source of high protein fodder well into the dry season, when many domestic animals are losing weight for lack of food.

We were taken off guard by the degree of acceptance of the dry beans as a coffee substitute. Having introduced it as a coffee stretcher (to be used 50-50 with coffee), we found that people were soon drinking it straight. Use is so

widespread after just one year that a group of women is roasting and grinding the bean and selling some 40 pounds a week under the name "nutricoffee".

Like the jack bean, velvet bean is native to Central America. However, there are two kinds. The more common one has an extremely irritating itchy powder on the mature pod. Villagers who know this plant will not want to plant the non-itchy-powder varieties until they've been shown that the pods are harmless. We would under no circumstances recommend that anyone use the irritating kind with small farmers.

Slugs damage velvet bean in warm climates (though much less than regular dry beans). Rabbits, leaf-cutter ants (its only serious insect pest here) and iguanas are other pests. In some locations rats used the velvet bean stems to climb up and eat the corn. Planting the beans later or cutting its tendrils when it gets too large has helped with this problem. It must be watched and cut back if planted near trees.

Everything that was said above about planting jackbean also applies to velvet bean. However, fine-tuning is needed to determine when to plant velvet bean in local cornfields. This is affected by speed of growth of the native corn, climate, soil fertility and existence of problems with rats. One should plant as soon after the corn as possible to get maximum velvet bean growth and weed control, but not so soon that the velvet bean outgrows the corn or causes rat problems. Especially in fertile or heavily fertilized soils, the velvet bean grows very rapidly and may even need to be pruned once to retard its progress.

Corn crops growing where velvet bean or jackbean have been incorporated can often do extremely well without any initial fertilization with chemicals, but will often show signs of nitrogen deficiency by tassling time. Farmers in our programs in Honduras almost always add a side dressing or urea to these crops. In general we recommend this practice where fertilizer is available and affordable. Over the long run, one would think phosphorous would also be needed, but in the short-run neither visible symptoms nor level of yields would indicate much problem with this element. Quite likely the increased organic matter is increasing the availability of soil phosphorous enough that deficiencies just are not a problem.

In corn fields, the velvet bean produces an average of about 6-7 pounds of above-ground organic matter (wet weight) per square meter (30 T/Ha), but has produced twice that. The effect on subsequent plantings is roughly equal per pound to that of cow manure or half that of chicken manure, although this varies from field to field. When incorporated into the soil, the velvet bean often approximately doubles subsequent corn yields and when used as mulch increases yields by about 35%. Even dry bean yields following velvet beans have shown yield increases of over 100%.

[Ed: Even though leaving the residue as a mulch has many benefits (erosion control, weed control, moisture retention), the greater effect on corn yields after incorporation might lead you to incorporate residues rather than leave them as a mulch. All nutrients probably become available in one season when incorporated, whereas they are more slowly released when left as mulch, accounting for the greater effect. However, almost surely some or much of the remaining nutrients will benefit the second and subsequent corn crops. Roland and I asked during a regenerative agriculture conference at Rodale International for a perspective on this question. The consensus was that over several years the total amount of nutrients available for plants is about the same whether residues are left as mulch or incorporated. We would welcome your input on this question. I tend to vote for a no-till approach except in famine situations where immediate yield is imperative.]

Farmers in areas with enough moisture for two crops of corn or sorghum have recently started doing the following. The green manure (velvet bean or jack bean) is intercropped with the first grain crop. After harvesting the grain they cut the residue and green manure down, leaving this on the surface as mulch. The second crop is planted 20 days later with a dibble stick right through holes cut in the mass of dead velvet bean. There is usually a net saving of labor because planting and cutting of the green manure requires less work than the two weeding operations that are thus saved with the second crop. This is the sort of technology one dreams of, but rarely finds: net savings of

labor, zero cash cost and decreased risk (the mulch gives some protection from erosion and drought), increased productivity, increased soil fertility and increased protein intake for animals or people.

In Togo velvet bean grew well and was incorporated into the soil 5 months before planting corn. There was virtually no response to the green manure. Our hypothesis is that the green manure was burned or leached out. We are now testing whether under such conditions a green mulch (jack bean for instance) throughout the dry season will be able to reduce surface temperatures sufficiently to maintain organic matter. We have serious doubts about the claims that organic matter in tropical soils are impossible to maintain.

Recently villager nutrition groups have discovered that by toasting the velvet bean somewhat less than they do to make coffee, they have been able to produce a really passable hot chocolate. By grinding the flour finely, they have even been able to use a recipe for soybean cake to make "velvet bean cake".

Dolichos lablab or *Lablab purpureus* (lablab bean) is a legume very similar in appearance to the velvet bean, but even faster growing where soils are fairly fertile. It has not been as valuable to us because of its need for somewhat more fertile soils and occasional insect problems, but may well be important to us later on when the other green manures have raised fertility sufficiently. The lablab bean is almost as drought-resistant as the jack bean, is very shade-tolerant, and is among the most palatable of legumes for animals (definitely preferred over velvet bean or jack bean). Lablab beans grow well from sea level up to about 1500 meters. They require well-drained soils. In pure stands, lablab beans should be planted about 10/square meter. We have not found a good system yet for planting in cornfields because of its rapid growth, but it should be possible with heavy pruning (which it withstands well). The lablab bean requires either a recently cultivated or a sandy soil.

Lablab beans start flowering after 3 months and continue most of the first year, producing seed as well as remaining green. If soils are deep enough and other conditions permit, it will grow right through the dry season. I have seen plants that survived 3 years in droughty areas of the central plateau of Haiti. [Ed: in the sandy soils at ECHO lablab beans get nematodes so badly that it is difficult to keep them alive an entire year]. It nodulates profusely, producing mostly white nodules. Whereas the velvet bean growth is reduced if it has nothing to climb, plants in thick stands of lablab beans will begin to climb up each other. Another difference from the velvet or jack bean is that the lablab bean can be cut off nearly at ground level and will grow again, although with somewhat less vigor.

Though we have had problems with insect attacks, its growth is so vigorous that it still usually grows as fast as the velvet bean. Because animals prefer it to almost anything else, lablab beans cannot be grown where animals run free. Where it grows well, the lablab bean has produced a phenomenal 11 kg per square meter (110 T/Ha) of above ground organic matter (wet weight).

Lablab beans are traditionally planted toward the end of the agricultural cycle in come villages in Honduras to provide dry-season pasture for animals. It is also edible, and in some places, such as Haiti and West Africa, is widely appreciated as a regular food. Young pods or immature beans can be eaten green (beans taste similar to a sweet pea - a white seeded variety is best for this). Dry lablab beans can be substituted for dry beans in most recipes.

Clitoria ternatea is even more drought-resistant then the *Canavalia*, although being small-leafed, it does not cover the soil well. We really do not have much experience with this plant yet. It grows well at sea level.

Pueraria phaseoloides (tropical kudzu or puero) grows vigorously and can even smother the vigorous native imperata grass if the grass is manually bent over. This is not the same kudzu that took over so much land in Alabama and elsewhere. They then cut circles perhaps 2 meters wide and plant fruit trees, coffee, etc. in the middle. It had not rained for 60 days when he visited and the ground in the circles was hard and dry. But one arm length under the ground cover the soil was moist and could be molded with the hand! [Ed: This account was provided Pete Ekstrand after his visit to the Paul Carlson Medical Program in Zaire.]

Crotalaria ochroleuca (sunn hemp) is reported to be receiving widespread acceptance as a versatile green manure in East Africa according to Fr. Gerold Rupper in Tanzania. The jackbean, velvet bean and lablab bean are all vines. Sunn hemp is a vigorous upright legume growing 2 meters tall. When planted in narrow rows, mature plants tend to fall over. When planted in the field plants tend to hold each other up. While sunn hemp has a different growth habit than most of the green manures we have featured, the uses are much the same, including weed control, livestock feed, and erosion control.

Sunn hemp is especially suited for weed control in fruit groves because, unlike vining ground covers, continual vigilance to keep it from covering the trees is not necessary. It is being used with banana, plantain, citrus, and coconut. It can be cut at any time and left in the field as mulch. If it is cut one foot (30 cm) from the ground it will grow a second time. Fr. Rupper stresses that not less than 10 kilo of seed per acre must be planted.

Fr. Rupper wrote, "In Hanendi, sunn hemp was planted in an orchard affected badly by insects. When it had grown a bit, the insects left the trees and started to live on the sunn hemp. When the sunn hemp was cut for mulching, the insects returned to the orange trees." "Just this week we were informed that insects which attacked the freshly planted maize moved to inter-cropped sunn hemp, ate the roots and are perishing."

Crotalaria is known to contain toxins, but this variety is free of toxin, except perhaps the seed. It is cut about 3 months after planting. It is best cut in the morning, but keeps until evening. Later in the season cattle can be allowed to graze in the sunn hemp field. One farmer noted that after first spending an hour in a grass field, his cows even ate the dry stems. Fr. Rupper mentions that cattle must not be allowed to spend more than about one hour in the area. [He does not say why.] He also says that the seeds should not be stored in a closed room where people are working.

Sunn hemp seeds are used to keep weevils from stored rice and maize. Sunn hemp seeds are spread over the ground and bags put on top of the seeds. This procedure is continued, layering sunn hemp seed and bags of stored grain. After about 9 months, the process must be repeated.

When we asked our **EDN** readers for suggestions on how to keep monkeys out of the garden, Fr. Rupper wrote: "Early in the campaign for planting sunn hemp (also called zanziberica), we got a report from a youth group that monkeys had been afraid to traverse a belt of sunn hemp around their field of maize. I could not ask the monkeys why they did so. But one can imagine that first of all it is a strange sight to see sunn hemp growing together and forming a barrier. Secondly, the husks give a clattering sound, which may disturb the monkeys. [Editor: The genus for rattlesnake is Crotalus coming from the Greek root crotal meaning a rattle or castanets]. Thirdly, if they are caught stealing maize, it is almost impossible to flee through the sunn hemp field as the branches form a rather strong network like wire. In the case of maize [corn] there is some synchronization between the crop and sunn hemp. The husks of both crops form about the same time (depending on the variety of maize). People like to let the corn dry in the fields, at which time the barrier effect of sunn hemp becomes important. Meanwhile we have developed a new method of planting sunn hemp; two rows of maize alternate with one row of sunn hemp. Here the maize is well protected against monkeys."

As with velvet bean, farmers are especially appreciative of its usefulness in controlling weeds and improving the texture of the soil. He tells farmers, "If you have no chemical fertilizer when the season starts, plant sunn hemp between your food crops. If fertilizer arrives you may still be able to use it. If not, use sunn hemp and you will at least get a modest crop." According to Fr. Rupper sunn hemp will completely kill striga. A simple alley cropping system has been developed for controlling this important weed. When a field is ploughed and sowed to corn or sorghum, sunn hemp is sown along with the grain at a rate of 10 kilos (mixed with 20 kilos of sand) per acre. At weeding time, sunn hemp is left standing in every third row, knowing that it will kill the crop. After seven or eight months sunn hemp seeds are harvested and the dry stems are placed in the furrows and buried. If this is practiced

each year you have a sustainable system free of striga. Other uses for sunn hemp include applying the dry stems and any husks to trees or gardens as mulch, or as bedding for livestock.

The seeds, about the size of millet, are mixed with two parts of coarse sand and broadcast by hand. They do not need to be covered, although it might be well to draw a branch across the newly planted field. They sprout after a few days and develop a strong root. Growth is rather slow until they reach about one foot, then they quickly grow to 2 meters or more. Sunn hemp is fairly drought resistant, recovering well when rains return. Plants bare seed after 3-4 months and die after 6 months. However, if they are cut back to about one foot (30 cm) above the ground, they again develop new leaves. If planted densely in a well-prepared field, no further work is needed (except to keep out animals). Sometimes sunn hemp is interplanted with maize. Some species of *Crotalaria* are also useful in suppressing nematodes, but we do not know if this is one of them.

ECHO also carries another species of sunn hemp, *Crotalaria juncea*. Variety 'Tropic Sun', released by the University of Hawaii, is included in rotation with vegetables, ornamentals and others to add nitrogen, organic matter, suppress weeds, control erosion and reduce root-knot nematodes. In 60 days it can produce 145 pounds of nitrogen and 3 tons of dry matter per acre. Seed should be broadcast at the rate of 40-60 pounds per acre and covered 1/2 inch deep. High populations make the stems more succulent and hence better for incorporation into the soil. If allowed to grow too tall, stems become fibrous and difficult to deal with. Seeds can be inoculated with cowpea inoculant to maximize nitrogen fixation [presumably not needed where cowpeas are commonly grown]. It also lacks the poisonous alkaloids that make some species of Crotalaria poisonous to livestock.

WHERE CAN I GET SEED?

ECHO will send a small packet of any seed mentioned in this article. If you want to purchase larger quantities of seed we will try to find a source. [Yates Seed Company is an excellent source of seed for a large number of tropical pastures (Yates Seed Co., P.O. Box 117, Rockhampton, 4700 Australia).]

We also have the "90" day " velvet bean that was grown in the southeastern part of the USA 50 years ago. At the time of the last corn cultivation, farmers would plant 90-day velvet bean. Both corn and beans were left in the field. Cattle were allowed to feed in the fields a couple of hours each day in the fall and winter, reportedly getting very fat. This variety is not sensitive to day length so produces 3 months after planting. The tropical type of velvet bean only produces when days are short (flowering starts in November at ECHO). The 90-day type has some of the itch-producing hairs Roland refers to, but not nearly as many as I have seen on the wild "pica-pica" in Honduras.

The following is an English translation of a pamphlet used to introduce farmers in rural Colombia to the use of green manures. While it contains no new technical information, we feel that it complements our Technical Note on the subject.

The Poor Man's Plow

by Lewis Baker

The plow is used to prepare the land for planting. The plow does several things, but most importantly it removes from the surface of the soil the vegetation that would interfere with planting, such as weeds and residues of previous crops. The plow requires a lot of energy to turn over the upper layer of soil, and so a powerful tractor is used to pull the plow. But tractors cannot be used on steep slopes; and even if they could, they are very costly to buy and operate. Therefore, farmers with scarce economic resources have to use other means to prepare their land for planting. In some areas farmers use oxen to pull their plows, or they use heavy hoes powered by human energy to prepare the soil; however, most poor farmers use fire to prepare the land for planting.

Fire is the poor man's plow because it, like the tractor or ox-drawn plow, removes from the surface of the soil the vegetation that would interfere with planting. The tractor-drawn plow does this by turning over the upper layer of soil and covering and mixing with the soil, the weeds, and residues of previous crops. But the use of fire converts them all to ashes and smoke.

Although fire clears the surface of the land to facilitate planting, it also does a lot of harm because it destroys the organic materials. (The organic materials of rotted leaves, branches, and stems add nutrients to the soil and help it to hold the moisture that the growing plants need.) Fire also destroys many of the beneficial microbes of the soil, which are very necessary for its fertility. And, then, fire leaves the land bare and defenseless when the heavy rains come. On hilly land the rains wash away the bare earth, and carry much of the good soil to the creeks and rivers where it is lost forever. Thus it is that the poor farmer, by using fire, is destroying the health and wealth of the land that God has been preparing for thousands of years.

But God is very great and very wise. God has given to humankind--to the poor farmer--some plants that fertilize the soil, and these same plants also protect the soil from eroding when the heavy rains come. These plants cover the soil and choke out the weeds, but once they are cut they dry up and rot very quickly. In other words, God has given to the poor farmer another plow that improves the soil and does not harm it as fire does. There are several kinds of these plants, all of them legumes, which can be used as the poor man's plow, and God has arranged things in such a way that beneficial microbes which fertilize the soil can live and multiply in the roots of the leguminous plants.

One of these plants is called Velvet Bean (Mucuna deeringiana), but you may know it by some other name. It is a spreading and climbing vine with many leaves similar to those of ordinary beans, but larger. The pods appear at the beginning of the dry season and they form in bunches. They look something like bean pods, but they are much thicker, and they are covered with fuzz when they are immature. This fuzz does not irritate the skin, as does the fuzz on the pods of some similar plants. The mature pods turn black, and the seeds are round. They may be black, white, gray or mottled.

The velvet bean is very easy to grow and once established it will cover the ground, and in a very few months it will smother out all the weeds. After the weeds are gone it is relatively easy to chop up the lush growth of the velvet bean. Since it rots very quickly it presents little difficulty to the farmer who plants by hand. Without burning, one can then plant corn, rice, or any other crop in the soil which is protected by the mulch formed from the velvet bean. The plants of velvet bean which sprout up after a different crop is planted can be pulled out quite easily, so they do not present a serious problem.

Another plant not quite so well known is called Tropical Kudzu (Pueraria phaseoloides) (not the same species as found in southern USA). It is also a vigorously growing vine that covers the ground, fertilizes it, protects it against erosion, and chokes out the weeds. The leaves are very similar to those of the velvet bean, but the pods and the seeds are quite different. The pod is long and very thin--almost as thin as the lead of a pencil. Each pod has about 30 small round seeds, brown in color, and very hard. When the pods are mature they turn black, and with the heat of the sun they spring open to scatter the seeds.

Another leguminous plant native to some forested areas is known variously as Ox's Eye or Deer's Eye (We at ECHO are unfamiliar with this species). *It has similar properties to the velvet bean and kudzu, in that it fertilizes and protects the soil and smothers out the weeds. The vine is heavier than either of the other two plants mentioned, and the leaves are larger but with the same general shape. The seeds are less numerous, but they are very large. Each pod usually has from two to four of these black seeds shaped something like large checkers. They remind people of the eye of an ox, cow, or deer--hence, the popular name.*

It may be necessary to experiment with different ways and times of planting to learn how to obtain the greatest benefits from any of these plants. For example, in one area a person could try planting velvet bean with corn when the corn is knee-high, using three seeds per hill, with the hills two meters apart. In other areas, different times, different densities, and different distances could be tried with a view to comparing the results. The goal would be to have the legume well established when the corn is harvested, without the corn having suffered. After the corn is harvested, the velvet bean should be given enough time to cover the ground and smother out the weeds. Also, enough velvet bean seed should be harvested for replanting before cutting it down to plant another crop of corn.

God has made these leguminous plants--velvet bean, kudzu, cow's eyes, and others--to help maintain and increase the fertility of the soil. But farmers must cooperate with God by gathering the seed and planting it at the appropriate time in the appropriate place. With God's guidance we can learn to use these marvelous plants that He has given us, and farmers rich and poor can have a better life--a life that glorifies Him who has placed us as stewards over the earth and all that is in it.