INTRODUCTION

The following report is the result of a two-week consultancy with the SFDP Song Da Watershed Project during March of 1997 in Son La and Lai Chau Provinces and a one-week consultancy with CARE in Son La and Thanh Hoa Provinces. Since both consultancies covered the same issues in areas with many similar characteristics, this report will include information from and pertinent to, both of these areas. It is felt that the additional information thus provided will add to the usefulness of the report for both institutions.

The report will make recommendations covering several aspects of upland agriculture that will impact on forest cover and conservation and villager development in northern Viet Nam, and which, at the same time, were chosen because they have been major themes in the consultant's experience over the last 30 years. These will include primarily those of soil retention, soil recuperation or restoration (both of which are commonly included under the term "soil conservation"), and the intensification and stabilization of present upland fields, all of which can and should have major impact in reducing migratory or swidden agriculture, thereby reducing the destruction of the areas' forests. It will also include several issues having to do with agricultural extension methodology adapted to upland areas that will be particularly important in achieving maximum adoption and adaptation of the more technical recommendations.

Specific aspects of the present farming systems will be described in the report only as they are needed in order to make clear the appropriateness or lack of appropriateness of various possible innovations. Thus, the report will not attempt to give a general description of the present farming systems, as they are already quite well known to the SFDP personnel.

The bulk of the report will be organized around the various subjects included as objectives in both of the TOR's of both consultancies (soil retention, soil recuperation, intensification of land use, and extension methodology).
Nevertheless, it should be understood that most of the technologies considered will impact on several of these objectives all at once. For instance, cover crops will, all at the same time, prevent erosion, retain soil, improve fertility, and contribute to, as well as allow, the intensification of soil use. Therefore, none of these categories can be dealt with in isolation of the others.

A second, smaller section of the report, will deal with specific issues that came up in one or the other of the consultancies that is largely specific to the situation of that project.

In all honesty, many of the ideas herein were provided by the villagers we interviewed, as well as personnel from the projects and Extension Services. I wish to thank them for their thoughtful participation during the entire process, and especially for their willingness to dialogue with me and correct me on those occasions when it was needed. The final version of this report will also reflect ideas presented during meetings with the Project personnel at which previous drafts were presented. This report will include only those general ideas with which the personnel present at those meetings already agrees.

SOIL RETENTION

General Background

There is no doubt that one of the first tasks that must be carried out on the steep hillsides of the Project areas is soil retention. Otherwise, these soils will inevitably wash away, with the inevitable negative consequences to productivity, rural welfare and forest cover that we all know so well. If even the minimum objectives of the Projects are to be met, upland soils must be held in place.

At the same time, over the last three decades as we have acquired more and more experience and gradually achieved better results, there have been a series of major shifts in thinking worldwide about what are the best techniques for achieving this end. The first of these changes occurred when it was realized that large earthen structures (bench terraces, earthen bunds, etc.) were far too expensive for small farmers and far too often ineffective. This realization produced a major shift (still incomplete) toward more porous and less expensive barriers, of which vegetative barriers, including the hedgerows used by these two Projects, are the most common example.

Since then, another major shift has occurred, spearheaded by practical experiences first in southern Brazil and Paraguay and more recently in Mexico, Guatemala, and Honduras, and by research in Southeast Asia (mostly Indonesia). These experiences are further backed up by theoretical considerations long known to scientists. This shift is based on the idea that soil erosion caused by rainwater is primarily caused by the initial impact of the raindrops on the soil surface, The erosion caused by rainwater as it runs down the soil surface is of much less importance. As a result of this fact, soil cover is a much more important factor in soil retention than are barriers of most any kind, including hedgerows, and the closer this cover is to the soil surface, the better (1). To the extent that we can keep the soil covered whenever it rains, hedgerows (insofar as they act to catch eroding soil) become largely irrelevant. It is, admittedly, hard to recognize this fact, especially for people like myself who had worked for twenty-five years promoting hedgerows when first confronted with this idea, but the primary importance of soil cover is a fact now well-substantiated by widespread and varied experience, as well as scientific research results of various kinds.

Lastly, a major shift worldwide is also occurring away from the use of subsidies and artificial incentives to other means for promoting soil conservation works. One of these methods is to find soil conservation works that are either extremely inexpensive (some actually have a negative cost, i.e. they reduce costs at the same time that they protect the soil) or pay for themselves in the short run (e.g. within one cropping season) through increases in yields. Another method is to introduce soil retention methods together with technologies that increase yields, thereby associating in the farmers' minds the increase in yields with the soil retention measure. All three of these cases could be important for the present two projects.

Also, a general rule of thumb should definitely be kept in mind: the level of subsidies and artificial incentives used to promote soil conservation techniques correlates negatively with the sustainability of the technology. (2)

Specific Technologies
**Hedgerows.** Contour hedgerows provide a series of advantages already hell-known to the Project, including especially the retention of the soil and production of green manure, in addition to a series of other possible uses, such as fodder production, human food production, and income generation.

Nevertheless, hedgerows also have a series of disadvantages, such as the shading of crops, competition with crops for nutrients and moisture, the taking up of space in the fields, and labor requirements for pruning which come during precisely the season of highest labor demand by traditional crops. However, in the project areas, another major disadvantage must be added to the list. Farmers cannot burn their fields where there are hedgerows. Thus, they must pile the residues along the hedgerow, thereby reducing the organic matter (ashes) otherwise available to crops, or they must carry it to other fields, requiring additional labor (though in this case during times when labor demands are low). Thus, quite ironically, the hedgerows, in order to retain the soil, may actually be working to reduce the fertility of the soil available to crops between the hedgerows.

Data from two different studies does not help clear up very well the issue of hedgerow impact on crop productivity over time. Siep Littooy's study of hedgerows indicates that the longer the hedgerows existed, the lower yields were, by 15 to 40% per year, although not enough cases existed to draw statistically significant conclusions. (3) On the other hand, Dr. Tu Quang Hien's data indicate that yields of maize with hedgerows increased over time and in comparison with control plots. (4) Two factors might explain this discrepancy. First, in Dr. Hien's plots, the green manure was distributed among the crops, whereas most farmers studied by Littooy concentrated cuttings and crop residues under the hedgerows. Secondly, Dr. Hien applied chemical fertilizer to the plots, so much of the positive impact he observed may have been due to the green manure's impact on fertilizer utilization and the hedgerow's impact on fertilizer losses to erosion. But fertilization of upland maize plots is rare in either project's area. Thus, I would tend to think that Littooy's data may provide a closer idea of what is happening under farmers' conditions. In conclusion, there exists a real possibility that yields in farmers' fields will not increase because of the hedgerows, even in the fourth and fifth years.

One likely advantage hedgerows will have (though no one mentioned it during interviews) is that of catching more water, and therefore increasing the water supply during the dry season in streams and springs, including that available for paddy fields. This fact could and should be used as an additional advantage during the promotion of hedgerows.

The list of the advantages and disadvantages of hedgerows, as presently seen by the farmers, would look something like this:

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retain the soil</td>
<td>Do not allow burning</td>
</tr>
<tr>
<td>Provide green manure</td>
<td>Occupy space</td>
</tr>
<tr>
<td></td>
<td>Compete with crops</td>
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<tr>
<td></td>
<td>Reduce crop residues available to the crops</td>
</tr>
<tr>
<td></td>
<td>Require labor, when demand for labor is highest</td>
</tr>
<tr>
<td></td>
<td>Do not permit growing of cassava the first year</td>
</tr>
</tbody>
</table>

As a result, it is the tentative opinion of the author that hedgerows, as presently promoted, will probably suffer a very high rate of abandonment in the Project area after four or five years or whenever Project seed buying terminates. Evidence of this includes such factors as a) enthusiasm for them among farmers was difficult to find, b) farmers were already modifying them, using tephrosia seed broadcast in fallow areas or planting them further apart than recommended, c) hedgerows were planted mostly on land being fallowed or otherwise seen as the poorest land they owned, and d) most important of all, very few farmers in the Mai Son District are replanting their hedgerows now that the tephrosia is dying out (which it naturally does after four to five years).

Nevertheless, whether or not I am right (and no one will know for sure for several years to come), it behooves the Project to try to find the very best possible technology for the farmers, given the prevailing conditions in the area. More attractive options would either reduce future abandonment, or increase spontaneous spread of the technology, whichever the case might be.
Recommendations

1. In the future (such as when the present hedgerows die out in 3 to 4 years, and when establishing new hedgerows), the distance between hedgerows should be approximately double the present recommended distance. That is, they should probably be a minimum of about 3.5 (two people's height) vertical meters apart, especially on very steep fields. Many farmers have already informed the extensionists that they would greatly prefer such a distance. The advantages of such a change would be that the labor requirements, space occupied by the hedgerows, and competition with crops would all be halved, while, on the other hand, the green manure would be halved but the retained soil would decrease by only about 30-40%. Since other recommendations made below will supply much more green manure and do a more effective job of retaining soil than a hedgerow can, neither of these disadvantages will be of any importance whatsoever if the recommendations are implemented successfully. Furthermore, since most of the farmers are piling their hedgerow clippings at the foot of the hedgerows anyway, they are already losing most of the green manure benefit the hedgerows could otherwise provide.

2. Additional species should be found for use in the hedgerows. These species should be longer-term perennials, since the short-term perennials now being used may suffer considerable abandonment when replanting is required. Furthermore, every time the hedgerows need to be replanted, erosion can occur, additional seed and labor must be invested, poor establishment may occur, and green manure production the first year or two is reduced.

The new species, whenever possible, should have additional uses, including (in approximate descending order of importance) human food, fodder (if animals are not roaming in the village), a source of income, green manure, and firewood. (In putting human food as a higher priority than fodder, I am disagreeing with Alan Robertson's paper on "Recommendations on Forage/Fodder Development..." (5) but the added efficiency of feeding humans directly, the greater equity achieved through the production of cheaper leguminous sources of protein for humans, as well as farmers' own preferences, argue strongly for the priority of human food.) At the same time, it goes without saying that hedgerow species must be able to retain the soil, survive the dry season, either grow low to the ground or withstand frequent and heavy pruning, and compete as little as possible with nearby crops.

For reasons mentioned below, not all these species would need to be leguminous. Total biomass production during the dry season, especially in March and April, may become a good deal more important than the amount of nitrogen they might fix.

Species that should probably be looked at quite closely for their advantages and disadvantages would be (in more or less descending order of farmer preference, although their preferences will vary depending on their specific needs): sugarcane, Napiergrass (Pennisetum purpureum), "guinea grass" (both of these first two species are commonly known in northeastern Viet Nam as "elephant grass"), Calliandra calothyrsus, and Gliricidia sepium.

- **Sugarcane** may cause shading problems, will last a maximum of 15 to 20 years, and is not frost-resistant, but on the positive side, it can provide a very good income, human food, an excellent dry-season fodder (of better quality than that of any other grass species under droughty conditions), and plentiful biomass which stays green throughout the dry season. Sugarcane hedgerows are already widely used in Colombia by small farmers. The man who initiated that very successful work, Thomas Preston, now lives in Ho Chi Minh City and is available for consulting. Furthermore, studies in Honduras five years after project termination show that sugarcane is the species most often added to hedgerows after project termination (the very best indicator of farmer acceptance that we have). Farmers in the project areas seemed to express genuine excitement about the possibility of using sugarcane in hedgerows, and at least one farmer in Mai Son has already spontaneously established some. The main concern of farmers was that other people might steal the sugarcane, so hedgerows of this species would have to be fairly near people's homes until most everyone in the village had some.

- **Napiergrass**, an excellent fodder, would very likely produce more biomass than any other hedgerow species, especially during the dry season. It already exists in Viet Nam (it was reportedly imported from Cuba by the government experimental station in Moc Chau, and villagers there have since planted it around town as fencing and a fodder source), is frost resistant, will grow for decades (some Napiergrass hedgerows in Guatemala are now over fifty years old, with no replanting), and would be particularly helpful to women that are spending a lot of time collecting fodder. In many cases, a few hedgerows of Napiergrass near the home would undoubtedly help farmers to agree to control their buffalo and cattle during the dry season. And, if it is felt sufficiently important to bother with its importation, the "dwarf Napier" available from Brazil (see the address below) would be particularly
good, as it grows only a little over a meter, so would not shade out most of the crops or need to be pruned.

- **Guinea grass**, which should not be confused with the P. Purpureum species that is also called “elephant grass” here in Viet Nam, can be distinguished from the latter because it has very short internodes (less than 10 cms. long) and a thick stem (about 3 cms.), as well as much thicker and wider leaves. This species already exists in Viet Nam in sufficient quantities to obtain truckloads of stalks immediately. It is a very palatable fodder which is already known and quite popular among some Hmong farmers in the Tua Chua District. It is a perennial and grows vigorously in hedgerows. Both of these grasses should be sufficiently frost-resistant to grow well in the upper reaches of the Mai Son and Tua Chua Districts. Even under the very heavy frosts 2,500 mts. high in central Mexico (about the same latitude as northern Viet Nam), Napiergrass’ leaves were temporarily burned off, but none of it was killed.

- **C. Calothyrsus** provides good for fodder, firewood, and green manure, and would function much like the tephrosia, but last for much longer. The red flowered variety would be preferable at altitudes above 500 mts.

- **Sepium** would serve as a permanent green manure, an excellent fodder (although cattle often will not eat it until they are trained to do so by being given it after two or three days without food), a natural rat killer, and is increasingly being used in Central America as a natural insecticide and nutrient spray. Its flower is also edible by humans. Furthermore, it can be propagated very easily with long stem cuttings. In fact, it is called “quick stick” in some countries. In areas in which animals roam free, this characteristic might permit the fodder to be out of reach of grazing animals before the end of the growing season.

All of the above species should grow well in hedgerows under virtually all of the upland conditions we encountered (except, in some cases, frosts), although trials by farmers should be done to make sure of this.

Tephrosia will certainly continue to be counted among the species to be used for many years to come, because of its proven ability to produce large quantities of nitrogen-rich biomass on a wide variety of very poor soils, its drought resistance, and its resistance to damage by roaming animals during the dry season. However, its lack of use for other purposes means it will probably be more acceptable to farmers if half or more of their hedgerows are of other species.

3. In the future, hedgerows should not all be identical. The mix of species in a given farmer's hedgerows should reflect the needs and preferences of that farmer's family (including the women). For instance, a family with a lot of animals may need fodder. Women will likely appreciate having plentiful sources of fodder in those fields nearest the house. Sugarcane may also need to be nearer people's homes to prevent theft. Leguminous species will have to be present in most fields, at least until good green manure substitutes are widely in use.

Two or three species may be `intercropped" within the hedgerow, or the hedgerows may consist of one single species for, say, 50 or 100 meters, and then of another single species, depending on how well the various species grow and can be managed in association. It should be noted that intercropping grass and closely planted tree species in hedgerows has been largely rejected by farmers in the Philippines because the presence of tree trunks makes regular cutting of the grass very difficult, whereas the intercropping of G. sepium with C. calothyrsus has been quite popular in Indonesia.

Note that free-ranging cattle and buffalo will be a major problem for the introduction of any edible fodder in the hedgerows, but many villages already control their animals year-round, and the land allocation process is moving many more to do so. The increasing possibilities of growing crops, green manures, and hedgerows with fodder potential will also help convince more and more villagers to control their animals year-round. Nevertheless, in some areas this factor will continue to be a serious problem in hedgerow acceptance, as well as that of green manures. In some cases, certain villages may have to be left until neighboring villages where animals are controlled can provide a good example of the benefits of doing so. In other cases, small fences may have to be constructed around experimental plots until the demonstration effect convinces the village to control their animals or individual farmers to fence their fields. Relatively inexpensive fences can be grown of local spiny species, or even of Napiergrass reinforced with split bamboo.

Were these two recommendations adopted, plus the use of the green manures and in-row tillage mentioned below, the points on the above list of disadvantages would either disappear or become only half as great, and the list of advantages would become much longer, with the provision of human food, animal feed, firewood, higher incomes, etc., added to complete erosion control and massive amounts of green manure.
In-row tillage and zero tillage. In-row tillage, or "strip tillage," is a kind of conservation tillage in which the crop row (about 30-50 cms. wide) is tilled, while the area between the rows (50-70 cms.) is left untilled. The advantages of this type of tillage are incredibly numerous. Among the more important:

1. In-row tillage can lead to zero tillage. If in-row tillage includes, as it always should, the incorporation of large amounts of organic matter, it will permit, in a period of from two to five years, a second change to zero tillage. Somewhere over ten thousand farmers in just the State of Santa Catarina, Brazil, have made this change, which has resulted in greatly reduced costs and improved soils, while maintaining or increasing yields. Zero tillage also has important positive impacts on the erodability of soils, maintenance of organic matter content, humus formation, and microbiological activity.

Zero tillage will also improve soil fertility in a number of important ways, such as allowing the formation of better soil structure, reducing erosion, increasing microbiological activity, and slowing the mineralization of organic matter. Interestingly enough, farmers were quite willing to believe that zero tillage would work here; they used to practice it, using just a dibble stick to plant their crops, when the land was recently forested. Thus, many of them are aware that if their soils had plenty of organic matter, they could produce good yields without tilling.

2. In-row tillage reduces people's workload. In-row tillage requires perhaps 60 % of the labor that traditional tillage does in Viet Nam. The incorporation of organic matter will often bring that figure up close to traditional levels. But when farmers can move to in-row tillage with organic matter placement on the surface, or zero tillage, major decreases in the workload result. This possibility could have tremendous importance for upland farmers. In areas where a large part of the uplands is presently hoed by hand, zero tillage could very likely do more to decrease women's onerous workloads than any other single innovation we could ever introduce.

3. In-row tillage can end the burning of crop residues. Farmers in the project areas repeatedly affirmed that the only reason they burn crop residues is to make tillage operations easier. Even if insect pests or some other reason exists in some areas, the felt need to burn crop residues would largely be eliminated by the simple and single fact of no longer having to plough or hoe the fields. Thus organic matter availability (especially nitrogen and sulfur) would be tremendously increased, the soil would have more cover (reducing erosion once again), and much more soil moisture would be retained. Even before zero tillage is reached, in-row tillage may make burning unnecessary because it provides spaces between each row that are not tilled, where crop residues that are not yet ready for incorporation can be left until they are.

4. In-row tillage increases yields by concentrating organic matter in the crops' root zone. The concentration of organic matter almost doubles its impact on crop productivity. Furthermore, since the row that is tilled is in the same place each year, the residual effect of last year's organic matter--a factor of considerable importance--continues to feed the farmer's crops, rather than his or her weeds (or hedgerow, which is certainly not the farmers' highest priority).

5. In-row tillage provides a space for undesirable materials. Stones or slow decaying organic matter (such as cornstalks and perhaps some rice straw) that are undesirable in the crop row can just be moved a few centimeters out of the row. Between the rows, they no longer cause any problem during hoeing, and they reduce weed density. In fact, in highly rocky areas, the small rows of stones every two or three rows that result from this system are to be greatly preferred over the large stone bunds or rock walls every five to twenty meters that many of us recommended in decades past. Of course, the organic matter placed between the rows can then be moved back into the row when it has had time to decompose or when needed there for weed control purposes.

6. In-row tillage gradually forms micro-terraces. On hillsides, the mere practice of in-row tillage over a period of three to four years gradually forms, with no extra labor required whatsoever, a system of approximately 1-mt.-wide micro-terraces. This modification of the soil surface then becomes a major factor in holding water, organic matter, and soil not only on the hillside, but in the crop's root zone, where they are most useful (rather than under the hedgerows, where they are least useful). This means that the hedgerows will only have to hold the soil on occasion (mostly as an emergency measure during particularly heavy rains). Thus, the wider spacing of the hedgerows should not cause any problems.

7. In-row tillage has a series of other, less important advantages, including concentrating moisture in the root zone, capturing water so springs and streams have more water in the dry season, making it easier to work on steep hillsides, reducing labor and time dedicated to weeding, and providing what amounts to a "natural vegetative filter strip" between each row. (6)

The disadvantages of in-row tillage are surprisingly limited:
1. In-row tillage will cause a temporary increase in labor demand on the land that people plough.

2. With in-row tillage, the ploughing on a contour that is required is a little more difficult. Both hoeing and ploughing require fairly simple changes in work-habits under in-row tillage.

3. The ploughed or hoed area will have to be increased to 50 cms for cassava and approximately 70 cms if and when rice or vegetables are planted in the fields. However, in most cases, in-row tillage can be initiated when maize is planted in the fields, and the shift to zero tillage will be complete before other crops need be planted there.

SOIL RECUPERATION

General Considerations

The degree to which soil can be improved, very inexpensively and even while it is being cropped, has been drastically underestimated by modern scientists and agronomists. We seem to have forgotten that before the 1940's, all farmers around the world maintained yields over time, and some for centuries (the best documented case being the book Farmers for Forty Centuries that reports on turn-of-the-century farming techniques in China). We also seem to have forgotten that virtually everywhere in the tropical world, forests recuperate soils to an amazing degree in a relatively short period of time. That people, purposefully trying to do so, can telescope the process used by forests, should not be altogether inconceivable.

At the same time, if soils are to be significantly improved, large amounts of biomass are necessary. Somewhere over 10 to 20 t/ha of green biomass are needed each year. Though hedgerows can contribute to this biomass production, they cannot provide anywhere near enough material to do the job completely. (4)

And if we are hoping to move toward zero tillage, even larger quantities are needed. Therefore, the need for gm/cc's.

In fact, the process for recuperating soils in the tropics follows very closely the process used by the forest (7):

1. Maintain biological diversity. Although we cannot do this as well as the forest, we can do a lot better than most "modern" agricultural systems.

2. Maximize biomass production. Of course, we cannot produce biomass at ten or fifteen meters in height, as a forest does, but this is not a problem. What we can do is produce heavy amounts of biomass beneath and between our crops, as intercropped green manures, and during drier or colder periods when crops cannot be grown.

3. Keep the soil covered at all times. Especially important in the lowland tropics, this factor is most important in the uplands for the prevention of erosion and control of weeds.

4. Never plough or turn over the soil. Zero tillage has a series of advantages, many already listed above.

5. Feed the crops primarily through the resulting mulch. Undoubtedly the most surprising of the general rules for soil recuperation, this one also follows what tropical forests do. Scientific research has now confirmed that food crops can extract nutrients from the litter layer and that they redesign their entire root architecture in order to do so more efficiently. Especially when soils are particularly hostile to crop roots (with excessively low pH's, virtually no phosphorus availability, and aluminum toxicity), the alternative of feeding from an organic litter layer is particularly attractive, and much more efficient.

Literally hundreds of thousands of farmers from Mexico to Brazil and Paraguay, as well as farmers using certain traditional systems in Africa, are presently taking advantage of such systems. Though they are as yet little known in the scientific literature (because in many places they are just beginning to emerge due to the need to find substitutes for the soil recuperation previously achieved by long-term forest fallows), they are appearing spontaneously and spreading rapidly in many places. In West Africa, for instance, the number of farmers who are known to be using such systems has gone from just a handful to over 60,000 in just seven years.

Nevertheless, whereas this option is widely applicable around the world (already being worked on by
programs in some 65 nations), we must be very alert to note local conditions which might modify the nature of the process or make it unattractive to farmers. In general, the conditions in upland Viet Nam would seem to be ideal for such practices, particularly where cropland is hoed by hand every year. Nevertheless, there is one major change that would likely need to be applied here in Viet Nam—one which should render the process even easier.

Everywhere else where the above principles are being applied, as far as this author knows, the process relies exclusively on the greatly increased use of legume species. Only in Brazil are non-leguminous species sometimes used, and in that case only when farmers use levels of chemical fertilizer that would be impossible for most Vietnamese farmers. Nevertheless, we very likely will be able to use many non-leguminous species in Viet Nam.

The reason for this assertion first came to our attention as we interviewed farmers about their claim that they could significantly improve their soils' fertility through the use of 3-year cassava. This practice, used in many villages in the project areas, consists of leaving cassava that could be harvested by the end of two years to grow in the fields for a third year. In spite of the normal agricultural burning, farmers reported that after employing such a practice, they could once again grow rice, soy beans, or maize in fields previously too poor for anything but cassava. While such an assertion may lack precision, it certainly is important evidence of successful soil recuperation that should be taken seriously, and studied scientifically. Upon observing fields where this practice was in different stages of being conducted, we noted that while leguminous species were not only present and amazingly varied (probably ten to twelve species were common, varying from Crotalaria species, the dominant species of weed, along with the cassava itself, were not leguminous or nitrogen-fixing. Furthermore, the burning would have taken most of the fixed nitrogen out of the system, even were legumes more voluminous.

This widespread experience provides very important evidence that not only are Vietnamese farmers already recuperating their soils without medium- or long term fallowing, they are doing it without depending primarily on leguminous species. I had never observed such a phenomenon, though I have travelled to some forty nations observing villager-farmer practices.

In fact, this practice is in total accordance with what we know theoretically about the more acid soils of northern Viet Nam's uplands. Many of the soils here are highly deficient in available phosphorus. This fact was borne out in the project areas by the observance of striking phosphorus deficiency symptoms on local maize crops, as well as by the assertion by both farmers and agronomists that productivity responses to phosphate fertilizers were far more significant than those to urea. Thus, in the more acid soils of the Vietnamese uplands, the over-all amount of biomass applied to the soil (applications which we know scientifically, can increase the availability of existing phosphorus by up to 50 and even 100%) may well be much more important than the amount of nitrogen fixed or exclusively leguminous material applied.

This probability could have far-reaching positive consequences. Whereas we will continue to have to use legumes, our over-all biomass to be produced will probably not have to be more than, say, 50% leguminous in many cases. This will allow us to produce considerably larger amounts of biomass during the dry season (highly drought-resistant annual legumes are still fairly rare and poorly known), and that flexibility in kind of biomass can allow us to produce more advantageous by products. Thus, for instance, biomass from sugarcane hedgerows may well be used as a green manure just as well as that from tephrosia hedgerows can be, with the added factor that sugarcane has many additional uses.

It should be noted here that even though the combination of in-row tillage, green manures, and hedgerows can do a very good job of stabilizing even fairly steep hillsides, it is probably not a good idea to use these techniques on slopes of more than 70%. Such slopes should be allocated for forest use.

Specific Technologies

Green Manure/Cover Crops (gm/cc's). A tremendous lot has been learned in the last 20 years about these species and their use by resource-poor farmers in the tropics. (8) Whole books have now been written on the subject, but they are unfortunately only in Portuguese at present. (9) Very simply, gm/cc's are plants that are grown at least in part because of their positive impact on soil fertility and/or weed control. Contrary to what the name implies and their customary use in temperate climates, they may or may not be applied when still green, and they may or may not be incorporated into the soil (as a manure).
Gm/cc's have been found to be widely popular among villager farmers, providing the following four conditions are fulfilled:

1. They must be grown on land that has no opportunity cost. That is, they cannot take the place of any other crops, commercial or subsistence. This means they must be grown intercropped with existing crops, during periods of drought or frost when other crops cannot be grown, under the shade of trees or bushes, or on land that is too infertile for other known crops. Interestingly enough, every one of these possibilities could be quite useful in at least some of the areas in which the above projects are working. In most places, intercropping them with maize and cassava and growing them during the winter months would seem to be the most promising possibilities.

2. They must not occasion very much additional labor. In some cases, gm/cc's can actually decrease over-all labor requirements of a system, because of their impact on weeds.

3. They cannot cost the farmer cash. This means that all species must produce their own seed locally (after the initial introduction of seed), must be free enough of diseases and insects to continue producing large amounts of biomass, and must do so without inoculation. If diseases or insects attack them seriously, new species must be found (unless the additional advantages, such as their use as human food or a cash crop, make the control of the problem economically worthwhile, as would probably be the case with green beans and rice beans).

4. They must have multiple uses. In many cases observed around the world where gm/cc systems fulfilled the above three conditions, they have still experienced unacceptably high abandonment rates where their only benefit was that of increasing soil fertility. Nevertheless, their adoption and sustainability has been highly acceptable (in some cases, truly dramatic) where gm/cc's have provided other benefits. Uses that have been most popular include income generation (e.g. green beans in Yen Chau District), human food (e.g. lablab bean (Lablab purpureus) in Central America), animal fodder (e.g. tiger beans (Mucuna spp.) as pig feed in southeastern Mexico), weed control (e.g. imperata grass (Imperata spp.) control in Benin, Togo and Colombia), and the ability to reduce costs by moving to zero till systems (e.g. southern Brazil). Once again, every one of these possibilities could be important in some areas of the visited projects.

Some people may have doubts that gm's will work here because of ActionAid's report that trials of gm's were unsuccessful. These trials, however, were designed to find winter gm's, and included only tropical species susceptible to frosts.

The species with most potential (all of which already exist within northern Viet Nam, unless otherwise noted) would be the following, roughly in descending order of applicability under project area conditions:

1. The rice bean (Vigna umbellata?) is already known and widely cultivated in the project areas as an intercrop with maize or as a monocrop following rice or maize. The bean is widely adapted, is appreciated as a food (although is not considered as tasty as the green bean) and, according to many farmers' testimony, results in significant increases in yields of subsequent crops (especially the climbing rice bean). In fact, some Hmong farmers claimed to have grown the climbing rice bean associated with maize for 100 years on the same upland field without having to fallow it (a piece of data well worth confirming). On the negative side, it is probably quite susceptible to frosts.

Because of the widespread use of this bean, its high food value and already existing markets, the projects should study these systems closely and propagate them wherever possible.

2. The green bean is also used in some villages of Yen Chau District both for home consumption and as a very remunerative cash crop. It is quite possible that its spread has been limited by an almost invisibly small insect that eats the seeds. Nevertheless, farmers in several villages have learned how to control this problem, and have frankly become quite well off, selling as much as D 4,000,000 to 7,000,000 of green beans each year beyond what their families can consume. It is quite possible that just by teaching other farmers how to control this insect, green beans could become a major crop in much of Yen Chau and beyond. The green bean is tasty, has a very well-developed market (at least in Yen Chau), grows in very poor soils, and improves soil quality significantly. It is grown in the uplands as well as on paddies, as either a monocrop or intercropped with maize, although some farmers complained that it did not tolerate well the shade caused by the maize. On the negative side, it is not likely to withstand frosts, nor does it produce the impressive yield increases of rice bean. The "the" bean, which I am guessing is a tan-colored variety of the same species as the green bean (which I would also guess is the same species as the "green gram" of India), should also be looked into closely. Some farmers claimed they planted this bean and were not too unhappy if it did not produce any beans, because the benefit to the soil was so significant, whereas others said its impact on the soil did not
3. The swordbean (Canavalia gladiata) and jackbean (C. Ensiformis) have three very important positive characteristics: they will grow well in the very poorest of soils, they can fix up to 230 kgs. of nitrogen, and they are extremely drought resistant. I would see three primary uses for them:

a) in situations where no other green manure is capable of growing because of the deteriorated state of the soils, such as in wastelands or when farmers would normally have to fallow their fields. After one or two years of swordbean, crops--and more beneficial gm/cc's--can once again be planted.

b) the non-climbing, or "bush-type" jackbean could be very useful intercropped with cassava. In fact, farmers might well avoid leaving the cassava in the field a third year by planting jackbean under it during the second year.

c) where soils are too poor for lablab beans (most of them in the area) and frosts are not a problem, the swordbean would grow well into the dry season, providing a "winter green manure".

d) under fruit trees, the bush-type jackbean could provide weed control and good green manure impact, thereby lowering costs and increasing productivity.

The swordbean and jackbean are also quite shade-resistant and the tender, thin pods can be eaten like stringbeans (e.g. in soups). On the down side, the Canavalias are not good for much of anything else: they do not provide fodder or any other human food. Thus, they serve, in many cases, as a gm/cc for critical situations, with little benefit but to revive the soil and provide a basis for using better crops and gm/cc's in the future.

The swordbean, the seed of which is brown or pink-colored, exists in northern Viet Nam. The jackbean, which is white-seeded, also probably exists here (it has been a traditional food in western Indonesia for centuries), but I found no evidence of it. If no bush types of either species exist in the country, it might be better just to import the dwarf tiger bean (see below) and use it under cassava and fruit trees, rather than bothering with importing bush-type Canavalias.

4. The lablab bean (Dolichos lablab or Lablab purpureum, also known in Asia as the hyacinth bean or horse bean) has a whole series of advantages: it is a tasty bean already grown and appreciated by farmers in Viet Nam (usually on trellises near their homes where they also provide shade or on fences around home gardens); humans can eat the green pods, green beans, or dry beans with very little preparation: the seeds and/or leaves are a very palatable fodder for animals (from chickens to cattle) and are 23% protein; the plant is highly resistant to drought; it can be intercropped with maize; and it is a perennial that produces beans during much of the dry season, but can also be grown as an annual. Nevertheless, the lablab bean has one rather debilitating shortcoming: it requires quite fertile soils for it to grow well. Thus, its use for poorer farmers is often rather limited. I would think it could best be used intercropped with maize in row tillage or grown between fruit trees once other gm/cc's have raised the soil fertility to the point that this legume will grow well. On occasions (but not very frequently), lablab beans may suffer severe insect attacks.

5. The tiger bean (Mucuna spp., known more commonly in English as "velvetbean") is the most popular gm/cc in the tropics, largely because of its incredibly vigorous growth and ability to control virtually every known weed. It also fixes up to 140 kgs. of nitrogen/Ha and the seeds (after just ten minutes of boiling, plus grinding) can be an extremely good feed for pigs (23% protein, 91% of that digestible). On the down side, the tiger bean requires a lot of processing to be eaten safely by humans, and is such an aggressive climber that it cannot be associated with many crops, such as cassava or fruit trees. In Viet Nam, it could probably be used best as a monocropped improved fallow. If it has grown well, soils will be fertile and relatively weed-free within one year.

Another possibility would be that of importing from Brazil the non-climbing "dwarf velvetbean". In this case, it could also be used as an intercrop with maize and cassava, and as a very good gm/cc under fruit trees, providing nitrogen, very good weed control, and a very good feed for pigs. Dwarf velvetbean seed can be ordered from:

Eng. Valdemar Herculio de Freitas
Manager, Projeto de Microbacias, EPAGRI
Letters should be sent certified or registered.

6. Broadbeans or fava beans (Vicia faba) are already grown by farmers in the upper reaches of Tua Chua District. People here eat the pod when it is green and the seed both boiled green and toasted when dry. This plant could be grown alone or intercropped with maize at higher elevations. Although a heavy frost can affect the plant while in blossom, it is, in general, quite frost-resistant, as well as being fairly drought-resistant.

7. A series of native and/or non-leguminous species could be used, especially in situations where the above group of legumes cannot produce adequate amounts of biomass, such as toward the end of the dry season or in areas of heavy frost. In these cases we have very little information available to us, but the native crotalarias, native faster-growing Bauhinias, and epatorium would seem to be likely possibilities. The species mentioned above for use in hedgerows, including the grasses, should also be seen as major sources of biomass for green manuring/weed control among crops, as long as a balance is maintained between leguminous and non-leguminous sources of biomass.

In general, local people who already know these species can tell how to plant and care for them. Most of the intercrops will use two to four seeds/sq. mt. In those cases where climbing beans, such as the rice bean, swordbean, or tiger bean affect maize production by smothering the maize before it is mature, they can be planted at later dates in order to give the maize time to mature, although this will, of course, reduce biomass production and soil cover. The swordbean and tiger bean can be broadcast as long as the land is loose (has been ploughed within the last five or six months) and fairly free of weeds.

**Phosphate Applications.** While this author clearly recognizes that phosphates will eventually have to be added to these soils, that phosphates do produce profitable responses in most crops, (10) and that cropping without the application of phosphates is basically a case of non-sustainably “mining” the soil, it is my opinion that the application of phosphates is not appropriate at this time. Such applications are outside of the economic possibilities of most of the farmers in the area, which means that their promotion would either benefit only the few already wealthier members of these communities, or a tremendously large, complex, and expensive credit program would have to be organized. Even if credit were given for phosphate purchases, or phosphates were loaned in kind, farmers would probably apply it to their paddy fields (this would likely be a wise economic decision on their part) and the uplands would remain unaffected. Furthermore, the experiences of the 3-year cassava and rice bean systems shows clearly that phosphorus is not yet so limiting that generous applications of organic matter cannot achieve considerable increases in productivity.

Therefore, it is herein recommended that, for the time being, the projects not try to apply phosphates. Sometime in the next five to ten years, such applications should begin, but hopefully by that time, farmers will be much more economically able to make such purchases with their own resources.

**EXTENSION METHODOLOGY**

Entire books about this subject have been written, so obviously I can only touch here on a few of the more important issues having to do with the projects visited. I would very much recommend that people read other sources on farmer-to-farmer, or farmer-led extension. The experiences of the “farmer field school” movement in Southeast Asia also provide important lessons. And lastly, allow me to put modesty aside and recommend that program personnel read Two Ears of Corn, or Hai Bap Ngo. (11)

**Wager Experimentation**

The reasons for getting villagers to experiment are explained at length in Chapter 10 of Two Ears of Corn. More reasons have emerged since the book was written. Perhaps the most important is that a recent study has shown very clearly that the sustainability of agricultural development at the village level does not depend on technologies lasting for a long time. The problem is that technologies must change as situations change. And in the modern world, situations change with increasing rapidity. When the market for one agricultural product becomes uneconomic, one must look for something else to produce, just as one is smart if he or she is always looking for new market niches, even before the old ones disappear. But also, the labor supply in a family changes, roads and infrastructure are built, new insect pests and diseases appear, seeds degenerate,
government policies change, new inputs become available, and old inputs become more expensive.

In fact, the very adoption of some technologies makes other technologies obsolete, or a technology may cause changes, intentionally or otherwise, that make itself obsolete after a while. For instance, once hedgerows have accomplished their task of building terraces, the hedgerows themselves will not be needed to prevent erosion (though hopefully they will continue, in modified form, to be useful for other reasons). In-row tillage and cover crops will also affect the role, and therefore probably the nature, of hedgerows. Any agriculture that does not change frequently--will eventually become outmoded and largely unprofitable. Thus we cannot expect one technological package to be of use for very long. The half-life of even the best technologies is approximately five to six years (i.e. after this period, half the technologies introduced in an area will no longer be appropriate).

What can be sustainable in agricultural development is the process of innovation within the villages. Experiences in Central America have shown that villagers, including traditionally-oriented groups of minorities with high rates of illiteracy, can carry on the process of innovation, and can continue to increase their agricultural productivity over decades. (12) But in order to do so, they must know how to try out new ideas and adapt new innovations to their changing needs. Only in this way can agricultural development become locally sustainable.

In the particular situation in which the projects visited find themselves, villager experimentation is particularly appropriate, even crucial. Hedgerows are a technology with a very short history in Viet Nam. Thus, we have little technical knowledge about them in this context, and will acquire it only gradually over time. Furthermore, the variety of species that can be used in hedgerows and the variety of situations in which they will be used, provides opportunities for literally hundreds of variations as to their species composition, placement, method of planting, associated crops and animals, and management practices. Viet Nam just does not have enough researchers to try out all of these possibilities and then try to fit them with the tremendously varied situations in which they would work. If we wait for researchers to study all these issues, with all their permutations and combinations, Viet Nam's agricultural development will be retarded by decades. Instead, we can, and must, eventually get thousands and thousands of villagers trying out these many possibilities, plus others they will themselves develop, by experimenting year after year, so that we are benefitting from vast amounts of new information each year. Only in this way will we find the most efficient systems for each group of farmers as quickly as possible.

Of course, there are issues that small farmers cannot, or will not, investigate. Farmers cannot do research on the nitrogen-fixing levels of legumes or the chemical impact of organic matter on phosphorus availability, nor will they try out highly risky possibilities. The role of the professional researcher should complement what the farmer can and will do. In this way, the entire process is much more efficient, with each sector of the population doing what it can do best and/or most cheaply.

For farmers of all ethnic groups, if provided a little information on each species and a variety of management techniques possible for the species, can very well try them out, see how well they do under their own conditions, make judgments as to their economic advantages and disadvantages, and even make modifications in their species composition, management, or use in order to make the hedgerows more suitable to their own purposes. Farmers can easily look for additional species that might add value to their hedgerows and find out how to propagate them, fit them into the hedgerow, and manage them. And no one, including professional researchers, will ever be able to judge their usefulness to the farmers as well as the farmers themselves, taking into account their own wishes and preferences, felt needs, markets, labor availability, distance from markets and market relationships, cultural factors, cropping and animal-raising systems, availability of credit, financial situation, soil fertility and availability, microclimate and village organization. And every one of these factors can and often will impact on what species will best form part of a farmer's hedgerows and how he/she will manage them.

How villager experiments can be done is also explained in Two Ears of Corn, except for one major issue:

**Flexibility of Recommendations**

Probably the most important single thing extensionists could do in Viet Nam to improve their work would be to provide flexibility in their recommendations. Hedgerows in some conditions could best be approximately two persons height apart, but in some soils, or under certain conditions (e.g. of lower rainfall) they could easily be even further apart. If, for instance, farmers have tea on terraces, a hedgerow every 3.5 vertical meters would likely be much more than needed.

Farmers must know that many different species can be used in hedgerows. Three species were tried in many
programs (tephrosia, leucaena, and pigeon pea), but there are scores of species used in hedgerows around the world, and tephrosia would definitely not be one of the more popular ones.

The same goes for green manures. I have provided a list of species that seem promising, but I by no means would be happy if these species and only these species eventually became widely used in Viet Nam. These species should be seen only as those with which we are starting the process, in part because we know a little more about them, or because they have already-established markets. But farmers should be constantly trying out new species, trying the suggested species, under different conditions, etc. Probably the best program in the world for promoting gm/cc's among small-scale farmers is that of Santa Catarina State in southern Brazil, with well over 125,000 adopters, not counting spontaneous adoption. They are working at present with 65 species of green manure, 35 summer species and 30 winter species (capable of withstanding frosts). And they continue to search for additional species, after nearly twenty years of work. Any idea that in Viet Nam we will be able, within the next ten years, to advise farmers as to which species or combination of species is the very best for each and every situation, is only a dream. Or more correctly, a nightmare.

We must work together with the farmers, trying out different ideas, looking for new species and management techniques, achieving a frank and open dialogue with the farmers so they can feel as free as possible to tell us clearly what they like and do not like, and then documenting these experiences and preferences and lessons learned so they can be shared with all the other institutions that are involved in the same search.

We must not act or think as if we know the answers. We are a long ways from knowing them, and this applies to researchers and extensionists working with small farmers anywhere in the world.

It applies to me, too. The recommendations given above are merely a starting point. Hopefully they are a step in the right direction. But they are by no means recommendations to be taken as carved in tablets of stone. They undoubtedly can (and most certainly should) be improved upon, and eventually totally rejected when new and better ideas have been found.

Some agronomists may also have doubts as to whether farmers can do research, or can continue to find technologies to improve their productivity. Evidence that they can was found time and time again during this consultancy. Farmers were observed to be already experimenting with different distances between the hedgerows (e.g. in Moc Chau), the use of different species within the hedgerows (e.g. in Mai Son), and even the use of sugarcane as a hedgerow species. I was asked, as an international consultant, to come to Viet Nam to find ways of maintaining soil fertility in upland fields. Nevertheless, we found, during just two weeks of village visits, two distinct systems which farmers have already found through which they are significantly improving fertility (i.e. the 3-year cassava and climbing rice bean) and have thereby cropped the same fields for over twenty years. Both are systems which also provide additional human food and/or income. We could hardly ask for more proof that farmers are capable of finding technology to solve their own problems. In this latter case, they have done so before the agronomists did.

Of course, villagers will make mistakes as they experiment. But the better we get at helping them to avoid mistakes, the more efficient and useful will be their experimentation, and the more we will therefore also learn.

Of course, researchers will worry about the statistical significance of the villagers' results. But in an extension program, data at a 1% or 5% level of significance is not that important, in the beginning. If an experiment is successful among 20 farmers the first year, then that gives us enough confidence to recommend it to 100 the second year, and success in those experiments can provide us with enough assurance to suggest it to 500 the next. By the fourth year, with five hundred experiments done, we have more than enough information to reach 1% or 5% levels of significance, if the results are generally positive. At the same time, we have had enough time to see if the innovation is enjoying spontaneous adoption or heavy levels of abandonment--by far the most important measures, respectively, of success or failure in rural extension.

**Villager Extension Workers (VEW)**

A good deal of the necessary information for selecting, training, and managing VEW is already contained in Two Ears of Corn, chapters 12 and 14. Nevertheless, I will mention two particularly relevant aspects here.

In general, it is far better not to select VEW until after working with a specific technology for one or two years. In this way, one can see which people try out the technology, which ones do so most successfully, and which ones are willing to begin teaching it to others. Thus, everyone can see, much better which people have the most interest in the technology, the most competence in using it, and the willingness to work voluntarily for the good of others. These are by far the most important criteria in choosing good VEW, and cannot be observed clearly at the beginning of a program.
Nevertheless, in a few cases, such as the growing of green beans in Chieng Dong Commune, some Thai farmers already know how to grow green beans after rice and maize, even on upland fields. Some of these farmers could be paid by the day to visit other villages or communes and teach people there how to do the same. Such an approach would have the advantages that the VEW already know the technology well, can teach it in a very practical way (entirely through field demonstrations), and can teach it in the Thai language. In this case, it would just be decided, together with the prospective VEW, how many days of work are necessary to visit the target farmers and show them all they need to know to grow the crop successfully, including the control of the insect that is devouring the seeds. Other similar examples could be used wherever some farmers already know a practice (e.g. growing the climbing rice bean, fava bean, or litchi trees), wherever distances are not too great between the communities of the new VEW and those being taught. In these special cases, VEW could be used right away.

RECOMMENDATIONS FOR SPECIFIC PROJECTS

**SFDP Song Da Project**

Phasing of agricultural extension work, so we don’t try to do too much all at one time, is extremely important (see chapter 6 of Two Ears of Corn). Some villagers and even members of the People’s Committees, said they wanted to begin working with multi-species hedgerows, in-row tillage, and gm/cc’s immediately. Nevertheless, it is far better to do things gradually, in order to do them well. In the early stages of agricultural development, quality is far more important than quantity. In fact, quality early on is what will bring quantity later on. Furthermore, there are some operations that are just not advisable this late in the season. For instance,

in any given village). Necessary aspects of the management of the various species should also be taught.

**November or December:**

- After the harvest, I am hoping to return to Viet Nam. At that time, we could do a series of demonstrations as to how best to do in-row tillage and, at the same time, establish a series of in-row tillage plots with farmers, taking advantage of the hedgerows and gm/cc crops to fill the rows with organic matter.

- At this time, we would also check the growth and management of the new hedgerow species and gm/cc crops. After looking over the general situation, we could then settle on strategies for the following year.

**ActionAid/Mai Son**

Our visit was short, but I think there are some specific ideas that emerged during the rest of the visit that would definitely be worth your trying out:

1. **Hedgerow species.** As you can see from the above descriptions, the Napiergrass should definitely be a possibility worth looking into for your area. It is available in Moc Chau, and is apparently well-liked by villagers there. They claimed it was only slightly and temporarily affected by even the heaviest frosts they have. And I know from experience at 2,500 mts. in Mexico that even if a frost destroys two or three months’ of fodder production, it will not kill the plants. In highlands Guatemala, farmers calculate that just 60 linear mts. of well-established hedgerow will support one large animal, as 2 mts. are all the animal can eat per day, and in 30 days it has regrown (as long as it is cut at a height of at least 25 cms.).

   If the Napiergrass does not work well, I would recommend trying kinggrass. You asked specifically about tree species that would withstand frost, last longer than the tephrosia, provide green manure, and grow well after frequent pruning. I did not know of any species, but asked Paul van der Poel at GTZ. He says he has information about several species that fit that description and would be worth trying.

2. **Green manure species.** I would think you should try the broadbean right away. It does not cover the soil as well as some others, nor fix quite as much nitrogen, but it does quite well in many poor soils, and has the tremendous advantage of being edible in a number of tasty ways. It can also be intercropped with maize. After
that, I would suggest you contact the Brazilians (see the address above) describing your situation (very similar to theirs), and ask them for two or three of the best winter species. They can send you samples of seed. I would guess they will send you Vicias, some peas, and some Lupinus, but, frankly, they would know better than I. Specify that you want legumes, or they will send you oat or forage turnip seeds, which work nicely, but require heavy additions of urea, so would not be advisable here.

CARE/Thanh Hoa and Son La

Of litchis and other fruit trees. Frankly, I know of hundreds of projects around the world that would give almost anything to have a commercial possibility for their farmers that was anywhere near as promising as are litchis in Thanh Hoa. It is a tremendous opportunity that shouldn't be lost. And not only the people's insistence on acquiring litchi trees, but also the tremendous care with which they are planting them (cubic meter holes in the ground with organic matter, mini-terraces, etc.) are clear testimony to the people's felt need to partake of the bonanza. Even should the price tend downward over the next eight to ten years, people planting trees now could still earn a good deal.

At the same time, you are absolutely right in spreading a bit of caution about the whole thing. If it were at all possible, it would be good if you could send someone to China to look into the market. The more you know about the market, the better you can plan future activities.

At the same time, as you know, some diversification is also warranted. Should litchis no longer be profitable, it is, of course, easy to rip them out and grow something else. Unless, of course, that "something else" is another kind of fruit tree that takes years to begin producing. The other species you are trying seem to be good. Would shellac be another possibility?

In Son La, very little care was taken in the planting many of the trees I saw on upland areas. Such a lack of care will reduce tremendously their productivity later on. If major work is going to be done with fruit trees, it might be a good idea to take some villager leaders on a study tour to the Thanh Hoa area, as that is a very good example of putting a great deal of effort into the "care and feeding" of fruit trees.

Cinnamon seems a possibility here because of the reason Hanne mentioned: villagers need something, like cassava, that they can store easily until the day a truck arrives. Still, some people in Viet Nam say the cinnamon market may soon be flooded. Diversification would be wise, though finding other products for which the Dong/kg. value is high enough to pay for the transportation to major markets (something which must be taken into account with all products destined to outside markets) will be difficult.

Gm/cc's among the fruit trees. Another way of diversifying while the people plant litchis everywhere is to look for economic possibilities that people can take advantage of even when their uplands are full of litchi trees.

In this case, I would very much recommend finding gm/cc's that could grow between and under the fruit trees. The first advantage of this practice would be that of the benefit to the fruit trees themselves, as the gm/cc's would gradually provide softer, more fertile, weed-free soils between the trees, so the trees wouldn't be so totally dependent on just the nutrients originally supplied to the trees when they were planted. This fact of increasing litchi production through better soil fertility would probably be the best argument you will have for growing gm/cc's around the trees. But the practice would also reduce women's labor load by reducing the need for weeding between the trees, and, also plenty attractive for the people, it could supply forage or feed for their animals, or even human food. After all, animals are a source of income that competes quite well with that of many fruit trees.

To work well in this case, the gm/cc's would have to be at least moderately shade resistant, vigorous enough to smother weeds, and relatively labor-free. Preferably, they would also be non-climbing perennials that are tolerant of poor soils, and could be used for human food or feed for pigs or cattle. Of course, as you know, any major effort directed at chickens, pigs, or buffalo would have to be accompanied by an effective, sustainable vaccination program. In such a case, making vaccination sustainably profitable in the absence of any project incentives would be a prerequisite to the paravets becoming a sustainable institution in the area.

For the more fertile soils, I think the lablab bean (see above) would be ideal, even if it does climb some. Its uses as an animal feed with very little processing would make it very popular. It would be especially useful in the spaces between the younger trees, intercropped with maize or alone. The dry seeds can be ground and
fed to pigs, and the foliage is eaten by cattle, buffalo, and chickens. The seeds can be eaten by people either as green peas or dry as beans, and the green pods are also eaten here.

In most of the poorest soils, we basically have three choices: either use 1) climbing beans that people will periodically have to cut down out of their trees (the pruning is usually less work than weeding, but is nevertheless not appreciated), 2) beans that are local but are untried as intercrops under fruit trees, or 3) beans that won't climb but will have to be imported.

I would say that the best choice would be to try the climbers and the untried species first. If people complain too much, import the bushy types.

The climbers I would suggest are the climbing rice bean, or, for very poor soils, the local swordbean. The untried species I would try would be the non-climbing rice bean and the green bean. The non-climbers that would (as far as I know) have to be imported, are the dwarf velvetbean (just like the tiger bean, but doesn't climb) and, for poorer soils, the bush-type jackbean (be specific that you want the variety with a bushy habit, because the climbing and bush types belong to the same species).

One other species suggested to me for this purpose by Dr. Gibsen is greenleaf desmodium. He says it is a very shade tolerant perennial, will grow low to the ground without climbing or spreading, improves the soil, and produces good fodder for cattle. I have no personal experience with it, and it would perhaps have to be imported from Thailand, but it sounds like it would be worth a try.

Three other species are commonly used under fruit trees, but which I would not recommend because they spread and can become noxious weeds, are the perennial (or forage) peanut and the common or tropical kudzus.

**Hedgerows.** While I was there, we talked some about sowing beans under the hedgerows so they could climb up the hedgerows. In thinking that over, especially in light of the villagers' apparent lack of enthusiasm for the idea, I have decided that it was probably not a good idea. Much better would be the ideas above for improving and diversifying the main species in the hedgerows.

In between fruit trees, I don't think hedgerows are going to be too popular. Furthermore, inasmuch as people are already making very nice individual terraces for their fruit trees, a very simple, zero-cost innovation would make the hedgerows totally unnecessary. All that needs to be done is have people plant their fruit trees, and therefore make their individual terraces, in a staggered or triangular fashion as you go down the hillside. In this way, the water one terrace does not catch will be caught by the next one. Erosion will be thereby totally controlled, and a maximum amount of water will be available to the trees. If there is danger of there being too much water at any time, the terrace should be slanted inward so the water will not collect around the base of the tree, but rather on the inward side of the terrace.

**Winter crops in Son La**

You had very good results with white potatoes as a winter crop. As I mentioned while there, any major production in that area would very likely result in the arrival or intensification of various insect pests and diseases, which in potatoes are both very common and severe. The excessive use of pesticides to control these problems, especially in the amounts needed in an area somewhat warmer than the ideal for potatoes, would probably not be advisable. I think it would be better if you tried some alternative crops that require fewer toxic chemicals, such as many of the cold weather vegetables already consumed in Viet Nam (cabbage, Chinese cabbage, carrots, and various greens).

**Sustainability**

A second way to make activities sustainable (in addition to sustained innovation, as described above) is to make them locally profitable for small-scale entrepreneurs. This is the direction you are going with the paravets, and could be used also to make tree nursery establishment a permanent local business. Once again, subsidies will have to be reduced until the activity becomes obviously profitable without project incentives. Then a good number of individuals (to maintain a healthy level of competition; a monopoly on such knowledge can soon become a commercial monopoly) could be given special intensive courses on nursery management and practical aspects such as where to obtain good material for propagation, etc., and helped to establish nurseries of their own. Of course, such an approach does not make the whole development process sustainable, but it can make certain specific technologies sustainable.
NOTES

Since it is impossible to carry my entire library with me, I do not have with me many of the works referred to in this report. Where I have felt the source might be of special interest and can remember sufficient information for someone to order or ask for it, I have included below what information I could. Many other sources I have used in this report, or which provide relevant information or support, have not been cited at all. Once I have returned to Honduras, I would be very happy to supply, upon request, bibliographic references for any of the statements made herein.

1. See, for instance, Agroforestry for Soil Conservation, published by ICRAF.


4. Tu Quang Hien, "Final Report, Experimenting to Evaluate the Efficiency of Green Hedgerow with Different Distances and Different Growing Manners in order to Prevent Soil from Erosion and Increase Agricultural Crop Production." Photocopied.

5. Robertson, Alan, "Recommendations on Forage/Fodder Development...." Photocopied


8. Perhaps the most useful introduction to this topic would be Roland Bunch's "The Use of Green Manures by Villager Farmers: What We Have Learned To Date", Technical Report No. 3, Second Edition, CIDICCO, July 1995, as well as a number of the other Newsletters and publications from the International Cover Crop Clearinghouse (CIDICCO) at Apartado 4443, Tegucigalpa, Honduras.

9. Monegat, Claudino, Plantas de Cobertura do Solo, Caracteristicas e Manejo em Peguenas Propriedades (Chapeco, Santa Catarina: Claudino Monegat, 1991) and Ademir Calegari, et al., Adubacao Verde no Sul do Brasil, 2a edicao (Rio de Janeiro: AS-PTA, 1993). The former of these will have been published in Spanish within the next month or so.

