

Achieving sustainability

Yam (*Dioscorea* spp.) is particularly useful for developing the extensive production of food if grown like the forest yams of this area. It can give good yields and only requires the farmer to dig a planting hole and carry out some initial weeding. With its preference for stalks, yam is an excellent woodland (inter)crop and flourishes amongst fruit tree stands, reforested areas and secondary forest as well as on marginal and fallow land. Trees can be left undisturbed to develop into a yam/bush agroforestry system. Although yam is usually raised as an annual crop, it is a perennial and can be left in the field during years of plentiful food supply to provide a reserve for years when food supplies are scarce.

Red tannia (*Xanthosoma violaceum*) is not a climbing crop, but is larger, sturdier and more perennial-like than the normal white tannia. Both types of tannia can be planted on swiddens and ploughed farms, but red tannia also produces well on extensive farms. It requires little attention apart from the digging of a planting hole and some ring weeding. Erni (1989) observed that red tannia, once established, yields continually for many years and needs only little additional care. Although not as flexible as yam, red tannia can also serve as a food reserve.

Mangyan traditions as a source of knowledge for innovation. Both yam and red tannia were traditionally important crops which have now been rehabilitated in order to overcome contemporary problems. Thus, even though the Mangyan no longer practice the original traditional swidden cycle, knowledge of this cycle is still very relevant as they develop new agricultural strategies. These adjustments, unlike introduced agricultural technologies such as plough farming and SALT, also strengthen the cultural identity of the swiddens. Hopefully, the flexibility and the potentials of swidden agriculture will be recognised by the agriculturalists and policy makers responsible for the uplands and forests inhabited by swiddens.

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Teaching farmers that green manure and cover crops have valuable uses besides maintaining soil fertility can help sustain the widespread use and adoption of green manuring practices

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Today, well over 125,000 farmers are using green manure and cover crops in Santa Catarina, Brazil. Green manure and cover crops are equally popular in neighbouring Pará and Rio Grande do Sul. In Central America and Mexico, an estimated 200,000 farmers are using 20 traditional systems involving some 14 different species of green manure and cover crops and organisations from Central Mexico to Nicaragua are promoting their use in at least 25 additional systems. Across the ocean in West Africa more than 50,000 farmers have adopted *Mucuna* spp. or *Dolichos lablab* as green manures in the last eight years.

The present widespread use and rapid adoption of green manure and cover crops has taken many people by surprise. To some extent this is because little attention has been given to the extent to which green manures and cover crops have always been used in traditional systems. Gene Wilken, for example, in his otherwise excellent book, *Good farmers: traditional agricultural resource management in Mexico and Central America*, stated that "cover cropping is not widespread in traditional Middle America." (Wilken 1987). Many scientists believed the technology inappropriate for village farmers. As late as 1989, Anthony Young in the classic *Agroforestry for soil conservation* dismissed green manuring as "a form of non-productive improved fallow which has rarely found favour with farmers". (Young 1989)

Sustainability

For more than a decade it has been accepted that green manures and cover crops would only be accepted by small farmers if they could be grown on land that had no opportunity cost, could be intercropped with other produce, grown under tree crops or on fallow land and be cultivated in periods of expected drought or extreme cold. They would also be favoured if they involved no extra labour or out-of-pocket cash expense (Bunch 1995).

Whilst these assumptions have proved correct, recent experience has shown that the sustainability of green manure and cover crops is more likely to be guaranteed when they provide farmers with some other benefit besides fertile soil. This condition is consistent with the observation that village farmers generally prefer multiple use technologies.

Experiences worldwide

Experience from many parts of the world confirms the value farmers' attribute to green manures and cover crops that have multiple uses. In most known, traditional systems legumes are appreciated not only because they maintain soil fertility, but because the seeds or pods can also be eaten. Examples include the *Vigna* spp. which is intercropped in Southern Honduras, El Salvador and South-east Mexico and the high-altitude scarlet runner bean (*Phaseolus coccineus*), which is widely used from upstate New York (Seneca bean) to Mexico (ayocote) and from Guatemala (piloy) to Honduras (chinapopo) and Northern Chile. The velvet bean (*Mucuna* spp) is easily the most popular of

in the use of green manures

all the green manures/cover crops used today and was initially used and spread by farmers along the southern border of the Himalayas in Nagaland partly because it was such a valued source of food (Young 1989). In Central Honduras, where World Neighbors and COSECHA have taught farmers to intercrop velvet bean with maize, there has been a disappointing failure (35%) to continue this technology except in those villages where it is consumed as a major component of coffee, hot chocolate, bread and tortillas. In fact, the value of green manures and cover crops as human food seems to be the strongest factor motivating their sustained adoption.

Perhaps the second most common use of green manures and cover crops is weed control. In South-east Asia, a perennial species of the velvet bean is used to improve fallow and to control weeds. More modern practices include using jack bean (*Canavalia ensiformis*), tropical kudzu (*Pueraria phaseoloides*) and perennial peanuts (*Arachis pintoi*) under a variety of plantation crops, including coffee, citrus, and African oil palm. The velvet bean is also used to control imperata grass (*Imperata* spp.) and this practice is spreading rapidly throughout Benin, Togo, and Columbia. Velvet bean and jack bean are used to control paja blanca (*Saccharum* spp.) in Panama and to combat nutgrass in several other countries.

A third practice, which is now more widespread but which is still under-appreciated, is the use of green manures and cover crops to stabilise swidden agriculture. Since decreased fertility and weed infestation are the two most important reasons why farmers abandon their fields today, and since green manures and cover crops can, to some extent, often solve both these problems they have proved to be an effective way of stabilising shifting cultivation in many countries.

One dramatic example can be drawn from the work of the Centro Maya in Guatemala's northern Petén region. In this humid forest area, farmers could only grow maize for one or two years and then the ground had to be left to regenerate. Now hundreds of farmers are growing velvet bean intercropped with maize on the same fields year after year. Those who initially adopted this system have been growing maize on the same land for eleven consecutive years and productivity has improved over time. Another interesting example is that of Central Ghana, where village farmers are inventing their own ways of stabilising their agriculture, including one system in which 30,000 leucaena trees (*Leucaena* spp.) on one hectare are intercropped with maize and burned very lightly each year. This practice has allowed maize to be planted on the same land for 20 years in succession.

A fourth potential benefit and one that will probably acquire more significance as experience increases, is the use of green manures as animal feed. Most green manures and cover crop species, with the major exception of *Melilotus albus* cannot be grazed well, but many can be used for cutting and carrying even after months of drought. The most notable examples of this type are *Lathyrus nigriventer* and lablab bean (*Dolichos lablab*). Seeds also provide fodder. One good example is the seed of the velvet bean which in Campeche, Mexico is cooked for a half hour, mixed with an equivalent amount of maize and then ground into pig feed. The University of Yucatan calculated that this velvet bean feed cost less than commercial feeds per unit of weight gained.

Green manure and cover crops can be used in other ways as well. Two years after Alter-Vida stopped working in El Naranjito, Paraguay, farmers abandoned using velvet beans as a green manure, but continued to use them when they wanted to prepare their land for tobacco. In Southern Brazil, hundreds of thousands of farmers regularly use some 25 different species of green manure and cover crops for soil improvement partly because this allows them to increase the amount of organic matter in their soil to the point where tilling is no longer necessary. The financial as well as ecological advantages of zero-till systems are tremendously attractive.

Conclusions

A number of conclusions can be drawn from the examples given above. First, the variety of sustainable green manure and crop cover systems already established in traditional as well as more recently introduced agricultural system is remarkably diverse.

Green manures and cover crops have

been adopted on a wide scale despite the seemingly prohibitive conditions mentioned earlier in this article. The fact that virtually every system we have referred to has some elements of these conditions confirms their predictive value. Thus, programmes to introduce new green manure and cover crop systems should teach farmers not only how these species can be used to improve their soil but that they have other uses as well. Tremendous potential still exists for the development of new green manure and cover crop systems. Scores of potential systems for using green manure and cover crops still need to be investigated, most notably the major possibilities of using them for animal feed; the potential latent in new as yet untried species, including trees and non-legumes, and the value of combining of green manures and cover crops rather than using individual species. Experience leads us to believe that, with the possible exception of very intensive farming systems such as irrigated vegetable and rice, green manure and cover crops systems can probably be introduced into many, if not most of the world's, small-scale farming systems.

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In Central Honduras where velvet beans are also consumed as a major component of coffee, bread or tortillas its introduction as a green manure has been successful.