Pathways towards sustainable agroforestry systems

Smallholder systems for sloping lands

The limitations of pruned-tree hedgerow systems have promted interest in a wide range of other alternative hedgerow components that perform the same soil conservation functions with less labor and greater economic benefits. The options include fodder grass strips and cash perennials such as coffee, timber and fruit trees, and many others, These alternatives are often very effective in erosion control, even on steep lands. They do not, however, solve the problem of maintaining a stable soil nutrient balance. Fertilization with manure, fertilizers, and/or additional plant residues is still required to avoid soil nutrient depletion. There are a variety of pathways by which smallholder may steer their farming systems toward sustainability. Figure 2 illustrates the major pathways available to smallholder to meet their production and income sustainability objectives particularly on sloping lands. Their choice of systems depends fundamentally on wether an external nutrient supply (organic matter or fertilizers) is available. Farmers without access to nutrient inputs must depend on some form of fallowing to regenerate the fertility of their land. To increase productivity they need better ways of accelerating the accumulation of nutrients in the fallow vegetation. The viable options are improved fallows (A1 in Figure 2), fallow-rotation hedgerow systems (A2), and agroforests containing cash-generating perennials (A3).

Farmers begin using external nutrient inputs when markets develop for the commodities they are capable of producing that give a substantial return to fertilizer investment--examples of these are vegetables, horticultural crops, cash perennial crops or high- yielding field crops. Credit mechanisms appear locally as such enterprises develop. When continuous cropping becomes feasible (see B in Figure 2) further evolution in their farming methods is needed to protect their investment in the fertility of the land. This entails some form of conservation farming. Options range from natural vegetative strips on the contour (B1), that may be further enhanced by value-added perennials (B2); or it may be pruned leguminous tree hedgerows in cases where abumdant labor is available. Futrther transformation of the farm may lead to commercial perennial crops or tree horticulture (B4)

There is a correspondence between the options appearing opposite each other on the left and right pathways in Figure 2. This reflects the potential for a transfer in the farm systems from left-to-right, or right-to- left, depending on changing nutrient availability. For example, a fallow rotation system may evolve into a contour hedgerow system when the land becomes permanently cropped and fertilzers can be used. The entire farm need not be managed according to any one of the strategies in Figure 2., Different parcels may be devoted to different combinations of the systems that are shown there.

Many different types of agroforestry systems have already been develop by farmers and employed on millions of hectares in the tropics. Unfortunately, little effort has so far been expended in understanding them. This shoud be the fundamental basis of building improved systems. Here lies major current challenge for agroforestry research and development in the coming years

Buffer zone management and agroforestry

Two decades ago it was commonly thought that protecting the environment causes a significant drag on economic development. The current consensus is, that the environmental conservation is not in conflict with development, but rather is a crucial element of sustainable development, The conservation of biodiversity has become a widely shared goals among nations. These concerns have lead to projects that are attempting to save many natural areas from furter degradation or complete destruction.

The classical method of preserving a natural area has always been to declare it off-limits and to enforce exclusion by local people. Boundaries were deliberated and guards patrolled. Unsurprisingly, this often resulted in serious conflicts of interest and hostility between the enforcement agency and the local communities. Enforcement just didn't work in most countries, either because population pressure on the land was too great, or the costs of enforcement were too high. Recently, a new approach has been under development. This approach, is that enforcement ought to be linked wiih some form of compensation to the communities that are directly affected by the presence of the natural area, to enable them to recover some benefits from foregoing their use of the protected area. Conservation would be ensured by reconciling the management of protected areas with the social and economic needs of local people. It is now acknowledged that the succesful long-term management of protected areas depends on the cooperation and support of local people.

These projects have come to be known as integrated conservation-development projects (ICDPs) During the past decade there has been a rapid expansion of ICDPs around the world. However, the concept was so novel that implementers of such projects have had little experience. Most ICDP projects are being implemented by institutions that have not done this before. It is a highly experimental stage, when the sharing and interpretation of experiences can be of great value to those embarking on new ICDP activities.

The general concept of buffer zones is now widely established. Management plans for parks and multiple-use areas round the world frequently refer to buffer zones. They are a key elenent in virtually all new proposals on protecting natural areas. This certainly applies to the Philippines also.

MacKinnon et al (1986) has defined buffer zones as "areas adjacent to protected areas on which land use is partially restricted to give an added layer of protection to the protected area itself while providing valued benefits to neighbouring rural communities". Wind and Prins (1989) defined them simply as " areas outside of parks that are designed to protect parks" The term has also been used to describe almost any initiative involving people that takes place near a protected area.

The buffer zone management is now generally considered a key priority for ICDPs. So far, however, there is large gap between planning and realisation of the concept. The problem is that there are a few working examples of buffer zones that can provide guidance on how to do it right. In many ICDPs, park mangement authorites have no legal authority to implement a buffer zone program outside the boundaries of the protected area itself, even if they want to and have the funding. Enabling legislation and administrative procedures are simply non-existent

There is a widespread assumption among practitioner of ICDPs that people made better off by a development project will refrain from illegal exploitation of a reserve area, even if no enforecement is practised. Wells and Brandon's (1992) global study found absolutely no evidence to support this,. Such expectations have been shown to be naive. A social contract between communities and outside stakeholders must include enforcement mechanism in tandem with the development benefits recieved.

Compensation to communities in terms of development activities may take many forms. Most projects attempt to encourage improved natural resource management practices in the areas outside the reserve. The objectives are to increase people's incomes, and to intensify their production systems away from the more extensive, environmentally-degrading systems they may currently practice. There is growing interest in the development of more intensive land use systems on the margins of protected forests all over the world. Agroforestry systems are emphasized in many of these projects. ICRAF is coordinating a global research program on Alternatives to Slash and Burn system that seeks to identify policy and technology directions to quide national efforts (van Noordwijk et al, 1995). Interested individuals or projects may contact ICRAF for more information relevant to their needs.

Agroforestry systems that enhance protection

Tree seedlings are often a highly desirable intervention by communities near protected areas. Provision of seedlings through nursery progrms has therefore been one of the most popular ICDP development interventions. Farm families can increase their nutrition and economic welfare through a greater quantity and diversity of fruit and timber trees in the home garden area and on their farms. In many areas there is an encouraging trend toward tree crop farming as an alternative to practicing shifting cultivation.

Where there has been a history of tree crop cultivation in the vicinity of a protected area, the environment of the farmed zone outside the boundary develops ecologically favourable characteristics for protection, and even extension, of the biological diversity of the park itself. One case exemplifying this is the 'damar' agroforest systems found on the boundaries of the Barisan National Park in Lampung, south Sumatra, Indonesia. Over the past century, local populations have extended the cultivation of the Dipterocarp tree *Shorea javanica* which is tapped to yield a resin that is sold for industrial products on the national and international markets. This man-made forest now extends over scores of kilometers along the western boundary of the national park. This agroforest harbors a major proportion of the natural rainforest flora and fauna species (Michon et al., 1995), and effectively acts as an extension of the biodiversity of the park itself.

Another example of the biological diversity protection role of an agroforest sysem is the 'jungle rubber' system practised in Sumatra and Kalimantan, Indonesia, briefly discussed above. The rubber seedlings are established as intercrops in a slash and burn cutivation system. After the 1-2 year cropping phase the plot is left alone and the rubber trees mature along with the secondary forest regrowth. de Foresta et al (1994) has found that these low-management agroforest systems retain floral biodiversity levels that often approach those of natural secondary forest. Since about 97% of the lowland primary forest in Sumatra has now been logged out, these rubber agroforests may be the major repository of lowland biodiversity in the fuure (de Foresta, 1995, pers. Comm.).

Even in the areas where smallholder agroforesty systems do not yield such striking levels of protection or extension for natural biodiversity, the benefits of increased tree cover on the landscape may nevertheless be very important, Where trees are grown in reasonable densities for fruit, industrial, or timber uses, even on very small farms of less than 1 hectare, the tendency for the family to illegally collect fuelwood or timber inside the boundaries of an adjacent protected area decline quite drastically (Muniarti et al, 1995).

In countries such as the Philippines, Vietnam, and Thailand, which are experiencing extreme enchroachment pressures on the remaining natural areas, there is a concurrent trend toward major increases in the value of farm-grown timber. Smallholders, even shifting cultivators on the frontier, are now engaging in farm forestry for the first time in great numbers, in response to the strong price incentives (Garrity and Agustin, 1994). This situation dramatically increases the prospect of stimulating smallholder timber production systems on the outside of natural reserve boundaries, as a major vehicle for rapidly increasing overall tree planting in the buffer zone areas. Agroforestry practices provide a variety of ways in which agriculture can be intensified, tree cover can be enhanced, and biological diversity can be extended on the outside of protected areas. Indigenous technology is very often the starting point for practical insights on what directions the farming system would best evolve. It is also a very rich source of site-specific solutions.

Sustainable Agriculture and Natural Resources Management Collaborative Research Support Program (SANREM CRSP).

The mission of the USAID-funded program, is to implement a comprehensive, farmer-participatory, interdisciplinary research, training, and inforrmation exchange program that will elucidate and establish the principles of sustainable agriculture and natural resource mangement on a landscape scale. One of the programmatic goals is to develop and evaluate viable management strategies for achieving sustainability in agricultural and natural ecosystems. To address this goal, we are employing farmer-participatory methodology combined with a cadre of expertise in innovative technologies such as integrated resource management, integrated pest management, agroforestry and integrated social forestry systems.

The goals of integrated resource management are the restoration of productivity of degraded lands. Maintenance of long-term productivity, and conservation and preservation of natural biodiversity. At the core of integrated resource mangement is improved soil, water, and nutrient management, which can lead to an alleviation of the pressure to expand onto marginal lands. Agroforestry strategies are being evaluated. Some of the benefits of agroforestry systems include: soil stabilization and improvement; recycling of nutrients; improving microclimate; fodder production; and production of wood for firewood, pulp wood , charcoal and boards for local construction.

One of the primary research sites for SANREM CRSP is the Manupali watershed on the island of Mindanao in the Philippines. The Manupali river, which drains approximately 80,000 ha, and is a tributary of the Pulangi river basin, is located on north-central Mindanao (longitude 125^0W , latitude 8^0N), 20 km south of Malaybalay and 85 km south of Cagayan de Oro city. The Manupali watershed is characterized by an ecosequence that includes the second highest peak on Mindanao (Mt. Kitanglad, approx. 3,000 m elevation), steepy sloping uplands, moderately sloping agricultral lands, and lowlands. The watershed has greater than half of the land area with slope of > 15%, with fragile acid soils and severe erosion. A rapid increase in small-scale farms, with insecure land tenure and a necessity to provide food for the family, has resulted in unsustainable agricultural practices on the uplands. Farm sizes range from 0.25 to 19.5 ha, with an average of 3.0 ha. Farm sizes < 3.2 ha typically are tenant or leasehold farms. The Manupali watershed has a diversity of agricultural crops. There are large tracts of irrigated wetland rice, sugarcane,banana and pineapple farms which utilize high external inputs. In addition, production of cabbage, lettuce, potato, cassava, tomato and some small vegetable gardens are present in the uplands. The upper reaches of the Manupali watreshed is occupied by the Katanglad Philippine National Park, a primary forest bio-reserve. A major activity of the SANREM CRSP program has been to characterize, regenerate, and expand the natural biodiversity of the national park and buffer zone management. Three key technology thrusts have been identified through dialoque with the farmers; contour hedgerows, timber production, and home tree gardens. In addition, agroforestry systems are being evaluated throughout the watershed, but especially in vegetable growing areas. Several different systems are being evaluated for adaptation to the area, including: an emphasis on fruit trees combined with vegetable production in agroforestry systems; use of perennial species other than trees in contour hedgerows, such as asparagus, pineapple, or pigeon peas and use of natural vegetative strips on the contour as opposed to planted introduced species. These systems offer the farmers either a cash return on the hedgerow species or a low labor and input requiring alternative to introduced leguminous trees.

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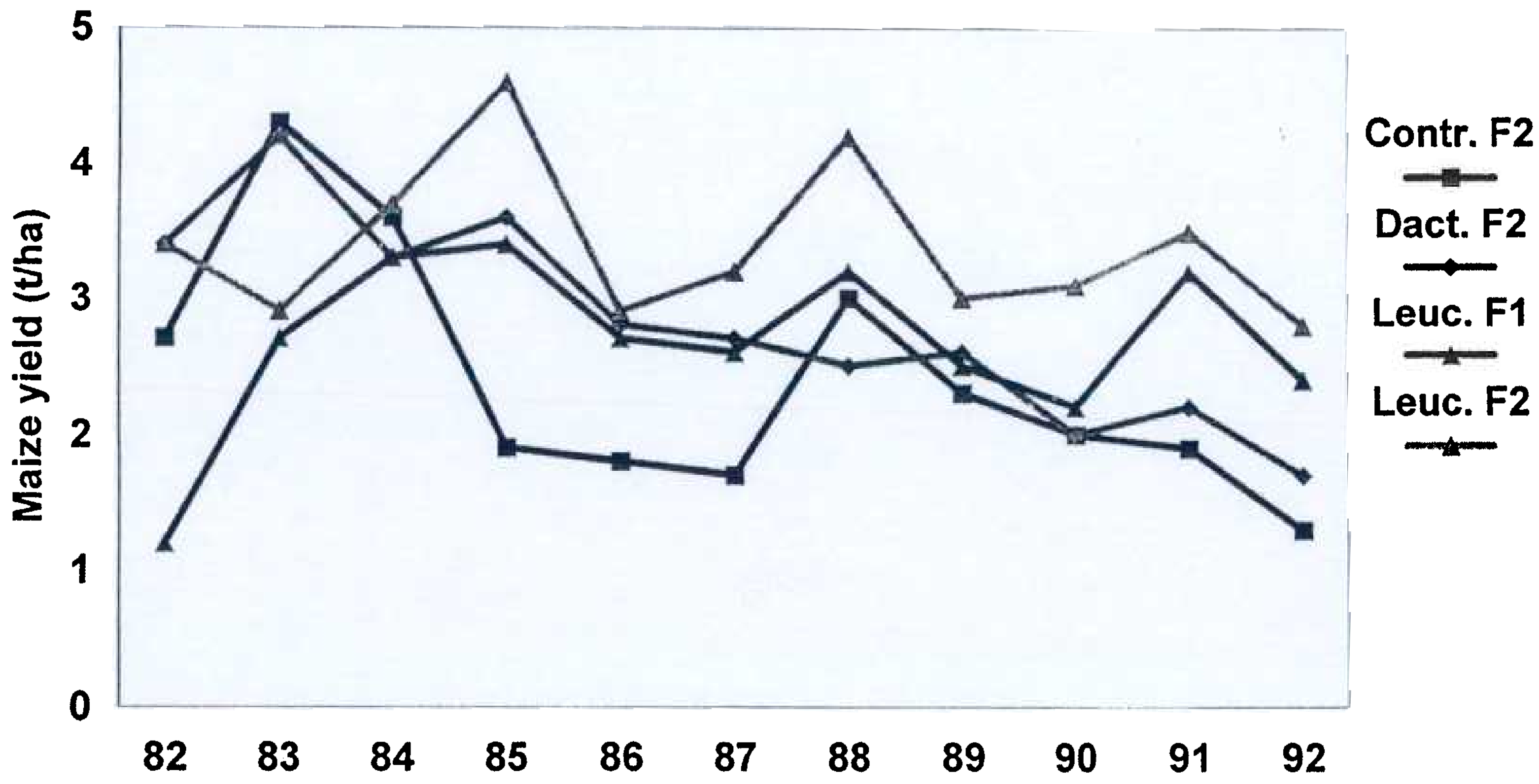
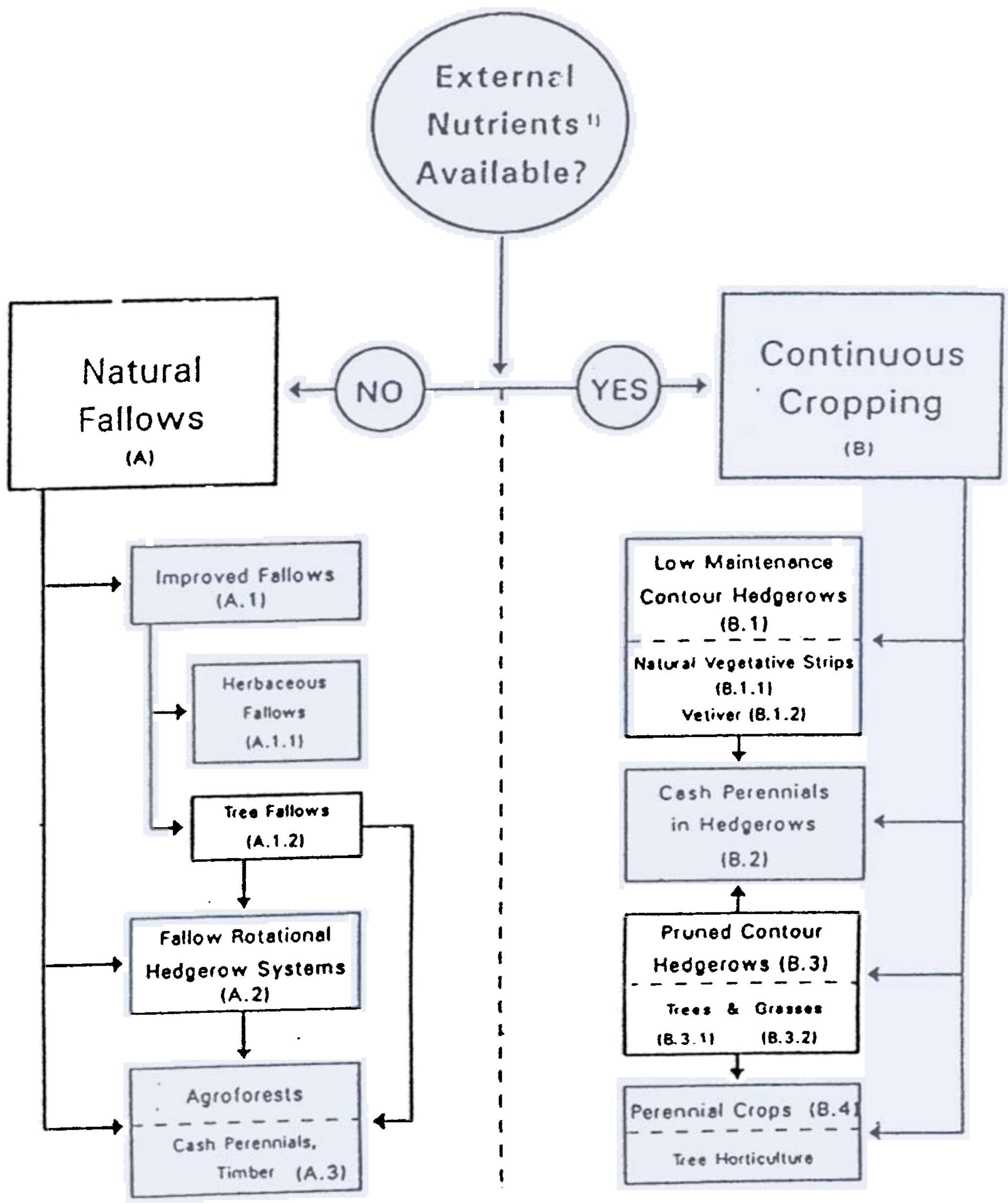


Figure 1. Effect of alley cropping with Leucaena leucocephala (Leuc.) and Dactyladenia barteri (Dact.) without (F1) and with nitrogen fertilizer application (45 kg N/ha) (F2) on a degraded Alfisol on maize yield (B.T. Kang unpublished data).

Figure 2. Pathways Towards Sustainability on Sloping Lands
From Garrity (1995)



1) Manure, fertilizer or off-field plant residues