Chapter 27

The Naalad Improved Fallow System in the Philippines and its Implications for Global Warming

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Global warming, or the increase of the earth's atmospheric temperature, is one of today's most pressing issues. Greenhouse gases (GHGs) such as carbon dioxide, methane, nitrous oxides, and chlorofluorocarbons absorb thermal radiation emitted by the earth's surface. A rising concentration of GHGs in the atmosphere could lead to changes in the world's climate and the consequences could be disastrous.

Among the GHGs, carbon dioxide (CO_2) is the most important by weight and is released mainly by the combustion of fossil fuels, burning or decay of vegetation, and by flux with oceans (Moura-Costa 1996). The single most important contribution to climate change originating from the world's forests is the release of CO_2 from deforestation. Of the 7 to 8 billion tonnes of total carbon (C) released into the atmosphere in 1988, deforestation, mainly in tropical countries, accounted for 1.6 billion tonnes (Trexler and Haugen 1995).

However, tropical forests can play an important mitigating role in climate change because they can be both sources and sinks of CO_2. At present, tropical forests are estimated to be a net source of C, primarily because of deforestation, harvesting, and forest degradation. But tropical forests represent 80% of the world's total forests, and they have the biggest long-term potential to sequester C. This can be achieved by protecting forested lands, slowing deforestation, reforestation, and agroforestry (IPCC 1996).

Like forests in general, agroforestry systems can be sources or sinks of GHGs. It is estimated that agrosilvicultural systems in the humid tropics can store between 12 and 228 tonnes C/ha (Dixon 1996). However, there is very little information on the C release and sequestration of specific agroforestry systems.

This chapter, therefore, has a dual purpose. First, it describes the indigenous Naalad improved fallow system. Second, it will attempt to estimate its C-sequestration ability.

Study Site and Methodology

The village of Naalad is located in the municipality of Naga, in the central Philippines province of Cebu. It is about 23 km southeast of Cebu City, at 10°12' north latitude and 123°45' east longitude, with an elevation of up to 300 m above sea

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level (asl). Annual rainfall in central Cebu ranges from 1,600 mm to 2,000 mm. The area has very mountainous terrain with farms located on slopes of more than 100%.

This chapter uses data from two studies conducted in the area, both to describe the Naalad system and to estimate its C-sequestration ability. The description of the farming system is based on a study conducted from 1990 to 1993 (Lasco and Suson 1997). It documented and evaluated the Naalad system and gathered data on changes in soil properties and crop yields. The second study, by Kung'u (1993), measured biomass accumulation under different fallow ages.

The Naalad Improved Fallow System

Like most traditional fallow practices, the Naalad system has two basic components: the fallow field and the cultivated field. However, there are two vital differences: the use of *Leucaena leucocephala* in the fallow fields and the construction of fascine-like structures to minimize soil erosion in the cultivated fields (see color plate 35). The following discussion is based on Lasco and Suson (1997).

In traditional shifting cultivation, the fallow period is typically much longer than the cropping period. In the Naalad system, farmers discovered more than 100 years ago that by introducing *L. leucocephala* they could shorten the fallow period to just five to six years. When it is time to fallow, *Leucaena* seeds are sown into the fields. In addition, surviving stumps of *Leucaena* are allowed to sprout.

It is worth pointing out that, in economic terms, the fallow field is not entirely unproductive. Farmers gather foliage from the *Leucaena* trees and carry it to their cattle, providing an important source of fodder. It has been suggested that the functions of the fallow, aside from improving soil fertility, are often overlooked (Ohler 1985). Therefore, the functions of the Naalad fallow should be further investigated.

Construction of Fascine-Like Structures in Cultivated Fields

At the end of the fallow, the *Leucaena* trees are slashed. But in contrast to traditional shifting cultivation, they are not burned. Instead, stakes of *Leucaena* about 30 cm long are driven into the ground at regular intervals along the contours. Smaller branches, with a maximum diameter of about two centimeters, are piled against the uphill side of the stakes so that a fascine-like structure is formed. (A fascine was a military defense formed by bundles of sticks). The Cebu farmers call it a *balabag*, or *babag* in their local dialect, which means obstruction. The main function of these structures is to control erosion. In fact, as sediment collects behind the balabags, small terraces are formed after a few years.

The balabags are spaced between one and two meters apart, based on horizontal distance, and crops are planted between them, just like in alley cropping. Farmers recall that in the early years of the system, the space between balabags was much wider. There used to be up to five rows of corn within each alley, but over the years, the number of corn rows has been progressively reduced so that now there are usually only one or two rows of corn between the balabags. The reason for this is that the corn plants nearest to the balabags reportedly grow better than the plants in the middle of the alley. If this is true, then it suggests that the balabags, aside from minimizing soil erosion, also help improve soil properties. Presumably this could be due to nutrient contribution as the balabags decay and to the accumulation of more fertile soil sediments. The favorable microclimate around the balabags could also provide habitat for soil organisms, such as earthworms, resulting in improved physical and chemical properties.

Initially, researchers believed there was a flaw in the system: the decay of the dead *Leucaena* branches. It was feared that with the collapse of the balabags, there would be very high erosion rates, considering the steep slopes of the farms. However, it has been found that farmers use the collapse of the balabags as a key indicator of when a field should be fallowed. Generally, they begin to totally collapse about five

Therefore, after six years, there were 31.8 tonnes C/ha in aboveground biomass of *Leucaena*. It could be assumed that C storage in the understory, soils, and woody debris was 25% of the aboveground storage (IPCC 1996). Thus, total C storage in the *Leucaena* fallow system amounted to about 40 tonne/ha at the end of the fallow period. On average, there were 16 t C/ha in any given *Leucaena* fallow.

The mean C stored is lower than my initial estimate of 22 t C/ha for Philippine agroforestry systems (Lasco 1997). However, it is within the lower range of 12 to 228 t C/ha stored by agrosilvicultural farms in Southeast Asia, a figure reported by Dixon in 1996. The total C storage of Naalad farms is, therefore, much lower than those of natural tropical forests in the Philippines, which store between 175 and 350 t C/ha, and tree plantations, which store between 29 and 102 t C/ha (Lasco 1997).

On an annual basis, *Leucaena* fallows accumulate 5.3 t C/ha/yr (see Table 27-1). This rate is comparable to tree plantations in the Philippines with annual C-sequestration rates between 3 and 5.4 t/ha (Lasco 1997). As expected, the annual accumulation rate is much higher than the 1 to 2 t/ha estimated for natural old-growth tropical forests (IPCC 1996).

The C stored in the biomass is released when the fields are opened for cultivation. The leaves all go to the soil while the smaller branches become the balabags. However, the larger branches are used for firewood and therefore represent the main loss of C from the system. No quantification of these losses is presently available.

In contrast to traditional shifting cultivators, the Naalad farmers do not burn their fields. This prevents any massive release of C to the atmosphere. The cultivated fields are planted with maize and tobacco. There is no burning of biomass involved in producing maize. However, tobacco leaves are eventually burned, thereby releasing C into the atmosphere. Quantification of the C balance is not possible because data is lacking.

Conclusions

The Naalad improved fallow system has the potential to mitigate global warming through its ability to sequester C in fallow fields. This is primarily because there is no burning after the fallow. This practice should be encouraged in other fallow systems.

The main C loss from the fallowed fields comes from burning *Leucaena* firewood. While this contributes to global warming, there is little that can be done to eliminate it. The alternative, which is to use fossil fuels, would have the same effect.

Tobacco leaf burning is the main C loss from the cultivated fields. Crops other than tobacco should be considered to help reduce C emissions from the system.

References

Dixon, R.K. 1996. Agroforestry Systems and Greenhouse Gases. *Agroforestry Today* 8(1), 11–14.

IPCC (Intergovernmental Panel on Climate Change). 1996. *Climate Change.* Cambridge, UK: Cambridge University Press.

Kung'u, J.B. 1993. Biomass Production and Some Soil Properties under a *Leucaena leucocephala* Fallow System in Cebu, Philippines. Unpublished MS thesis. University of the Philippines, Los Baños, Laguna, Philippines.

Lasco, R.D. 1997. Management of Philippine Tropical Forests: Implications to Global Warming. Paper presented at the 8th Global Warming Conference, May 28, 1997, Columbia University, New York.

———, and P.D. Suson. 1997. A *Leucaena leucocephala*-Based Improved Fallow System in Central Philippines: The Naalad System. Paper presented at an international conference on Short-term Improved Fallow Systems, March 1997, Lilongwe, Malawi.

Moura-Costa, P. 1996. Tropical Forestry Practices for Carbon Sequestration. In: *Dipterocarp Forest Ecosystems: Towards Sustainable Management*, edited by A. Zchulte and D. Schone. Singapore: World Scientific, 308–334.

Ohler, F.M.J. 1985. The Fuelwood Production of Wooded Savanna Fallows in Sudan Zone of Mali. *Agroforestry Systems* 3, 15–23.

to six years after construction. In traditional shifting cultivation, declining yields and weed problems are the main reasons for fallowing land and shifting elsewhere (Sanchez 1976). In Naalad, it is possible that the decay and collapse of the balabags coincides with unacceptably low yields or weed problems.

Cropping and Organic Fertilization

Corn is planted during the wet season from June to October, mainly for the subsistence needs of farmers. After the corn, a dry season crop of tobacco is grown from November to May. The tobacco leaves are dried and sold to meet the farmers' cash needs. During the third year of cultivation, farmers apply a small amount of chicken manure to their fields. This could be an additional reason why they are able to maintain yield levels. Typically no chemical fertilizers are applied.

Length of Cultivation

Just like the fallow phase, cultivation usually lasts for five to six years. Since the length of fallow period is equal to the length of cultivation period, farmers theoretically need only two parcels of land to make the system ecologically sustainable. Since Cebu is one of the most densely populated islands in the Philippines, the Naalad system was most likely developed by farmers to overcome land-use pressures from a rising population.

On some farms, the length of the cultivation or fallow periods may be shorter or longer than the "normal" five to six years. One factor determining the length of the cycle is the availability of labor, because most farm households have members working at nonfarm jobs to provide additional sources of income.

C–Sequestration Capacity of the Naalad System

Data gathered by Kung'u in 1993 showed that the dry weight of *Leucaena*'s above ground biomass increased from 4.3 t/ha in the first year of fallow to 63.6 t/ha by the end of a six-year fallow (see Table 27-1). In estimating the C content of the *Leucaena* biomass, the following formula was used: C content = biomass dry weight/ha x 0.5. The assumption was that the C content of the biomass = 50%.

Table 27-1. C–Sequestration Ability of *L. leucocephala* Fallows

Years under Fallow	*Mean Dry Weight of Aboveground Biomass (t/ha)*	*Percentage of Leaves*	*Biomass C (t/ha)*	*Annual Rate of C Accumulation (t/ha)*
1	4.3 d	36.5	2.2	2.2
2	16.1 cd	13.8	8.1	5.9
3	17.6 cd	8.9	8.8	0.7
4	36.4 bc	7.4	18.2	9.4
5	53.8 ab	5.3	26.9	8.7
6	63.6 a	6.1	31.8	4.9
Mean	32		16	5.3

Note: Means in a column with the same letter are not significantly different using DMRT at 0.05.

Sanchez, P.A. 1976. *Properties and Management of Soils in the Tropics*. New York: John Wiley and Sons, 618.

Trexler, M.C., and C. Haugen. 1995. *Keeping it Green: Tropical Forestry Opportunities for Mitigating Climate Change*. Washington, DC: World Resources Institute, 52.