

I. Summary

Alternative to Slash and Burn (ASB), phase 3: Facilitating the development of agroforestry systems

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Background and objectives

Conversion of tropical rain forest to other land uses is a major concern at global level. Loss of globally unique biodiversity, release of large amounts of stored carbon to the atmosphere, immediate health and visibility problems caused by the haze during forest conversion are only part of the story. The loss of forests as a regulator of water flows and as provider of local income are a concern at more local scales. The 'Alternatives to Slash and Burn' (ASB) program was started to test ways to reduce the loss of tropical forests, by enhancing the intensity of agricultural use in already converted lands, and/or to reduce the loss of 'forest functions' in land uses that qualify as 'modified' or 'domesticated' forests. The first approach came to be known as a 'segregate' approach (intensive agriculture + forest), the second as an 'integrate' pathway of development. The ASB program started activities in Indonesia in 1993 and first embarked on a diagnostic phase, to characterize land use and the type of problems that are perceived by various stakeholders. In the second phase a more detailed analysis was made of the trade-offs between local and global concerns. In between local stakeholders concerns (income, food security) and global concerns (biodiversity, carbon stocks), a 'missing middle' was identified: impacts on what is broadly called 'watershed functions'.

In phase 1 and 2 of the Alternatives to Slash and Burn program in Indonesia a number of farmer-developed land use practices were described and analyzed for benchmark areas in Lampung and Jambi that developed as alternative to annual-crop-based agriculture. These systems, broadly indicated as 'agroforests' provide income from domesticated forest and tree systems, with returns to labour exceeding those for upland annual crops, and with environmental values (carbon stocks, biodiversity) that are superior to short rotation crop/fallow systems. In the research, however, little attention was given to the broad category of 'watershed functions', while the main emphasis was on the lowland penepain and lower foothills where erosion is not a major issue. To complement the Phase 1 and 2 results, a further effort was made to better understand the relationship between forests and derived land uses and these watershed functions - aiming again for a combination of a diagnostic phase ('what if any are the real problems?') and one aimed at practical solutions at farm level, in the context of existing policies for the forest-agriculture interface.

As part of the agenda for phase 3 a new benchmark area in the mountain zone of Sumatra was selected (in Sumberjaya, West Lampung Province, Indonesia) where conflicts between farmers and state forestry officials had led to large scale evictions. After the political change ('reformasi') farmers returned to the area. As the conflicts had been articulated on the basis of concerns over watershed functions of conversion to coffee-based production systems, the main issue was to analyze the relationship between land use and watershed functions. The research approach chosen for the area is based on a 'negotiation support' system (NSS), that combines *tools* for predicting the impacts of land use and landscape configuration on multistakeholder criteria and quantifiable indicators, with a *process* of negotiation between stakeholders of spatial land use plans and generic regulation and incentive systems.

The research reported here focuses on the options farmers have for improving their farms and recovering forest functions, by enhancing 'landscape filters' and increasing agrodiversity. Land use practices and technologies that generate income as well as manage the natural resources are needed. The Sumberjaya site has a complex settlement history, with phases of active government involvement in settling farmers (as a demobilization site for the army of Indonesians struggle for independence), phases of spontaneous migration and phases of eviction of 'squatters' from state forest lands. While some of this historical context is unique to the site, the ambivalent views of government on agricultural development in former forest areas are widespread - and reflect the problem of providing income opportunities for a large population, along with maintenance of essential environmental services such as water flows and the opportunities to use hydro-power. The situation in Sumberjaya reached an open conflict stage in the early 1990's, when the government started a forceful eviction program affecting farmers (a mix of spontaneous migrants from densely populated Java and official settlement programs) and uprooting their well-developed coffee trees to replace them with Calliandra shrubs for 'reforestation'. A substantial part of the land in Sumberjaya is classified as 'protection forest' zone, and the perception was that reforestation would secure water flows that the coffee gardens could not provide.

Coffee has been a primary agricultural product of Sumberjaya farmers for nearly a century. The success of coffee plantation in this area is indicated by the expansion of cultivated land for coffee. In 1970, about 60% of the area coverage was still natural forest. But by the early 1990's only some 15% of forest cover was left, at the start of the eviction period. Much of the later coffee expansion occurred on land registered as protection forest. The shift in utilization from forest to coffee-based farming systems has raised concern among many stakeholders that it may create serious impact to the deterioration of forest functions, declining of soil productivity, land degradation, and severe soil erosion. The government that holds the land title evicted people who farmed and lived in the protection forest to neighboring sub-districts (the infertile lowland penneplain of the northern Lampung ASB benchmark area or the swamp forest zone where land clearing fires cause intensive smoke/haze issues.

After the political transition from the New Order Government in 1997 to the 'Reformation' period, resettled farmers returned to Sumberjaya and reclaimed their right to use the land, replanting the areas with new coffee trees and/or grafted the still active stumps of the old coffee. In the new political reality and after a substantial devolution of government authority to the district level, an approach based on negotiation and accommodation of multiple perspectives was needed.

In the context of the new forestry law, a Ministerial Decree of the Minister of Forestry (No. 31, issued in February 2001) on Community Forest created the option of granting farmers semi permanent (could be as long as 25-30 years) land title to utilize forest land

provided that they can propose and implement judicious land management systems for restoring the forest function. This decree provided an excellent basis for the negotiations in Sumberjaya to operate, although special permission was needed to apply this process on degraded 'protection forest' lands.

The Sumberjaya case this became an example of how the lack of negotiation among stakeholders in the tropics led to conflicts over land use in the past, and how new approaches could lead to a 'win-win' for environment and development, relative to that low baseline. ICRAF Southeast Asia, in collaboration with National Agricultural Research Services (NARS) and Non Government Organizations (NGOs), facilitated the negotiations in both the technical and institutional aspects, and the research reported here is part of that larger process of understanding the options and consequences of land use decisions.

This research was designed to address the following objectives:

- (i) evaluation of promising management practices that meet farmers' preferences while lowering soil loss to tolerable level,
- (ii) validation and refinement of the management practices considered in the first objective,
- (iii) evaluation of the role of litter layers, as generated from different stages and systems of coffee farm, on soil structure, run-off and soil loss, and
- (iv) delineation of areas in the Way Besai Watershed based on the levels of susceptibility to erosion.

This series of research was conducted in *Way Besai* watershed, with borders that almost coincide with that of Sumberjaya Sub district, West Lampung District, Lampung Province, Indonesia (4°45' to 5°15' S and 104°15' to 104°45' E). The elevation of Sumberjaya ranges from 700 to 1,700 m asl, but our research was conducted in the sites with 750 to 900 m asl elevation. Soils were predominated by Inceptisols (Humitropepts, Dystropepts, Dystrandeps, and Tropaquepts) and to a lesser extent, Ultisols (Hapludults) and Entisols (Troporthents). This research includes plot and micro catchment scale erosion measurement, evaluation of tree contribution to litter and soil fertility rejuvenation, and farmer-led test of soil conservation treatments in coffee-based farming systems.

Results

Results show that coffee trees can make a significant contribution to controlling erosion. Its effectiveness is maximized when the coffee is planted in combination with other trees in a multistrata system because of a complex canopy architecture that protects soil surface against heavy raindrops and the formation of tree litter on the floor of the garden or when additional conservation measures such as cover crops are used on young coffee farms.

Agroforestry/soil conservation options articles and booklets and the map of soil erosion susceptibility are among the key deliverables that this research can offer in the negotiation. Moreover, several research papers have been and will be contributing to agroforestry-related literatures.

Activity A (Table 1) has summarized background information of the case study site and provided a range of conservation options in coffee based agroforestry systems which are very central in the NSS. Farmers will know wider options than what they have been exposed to and practicing in their localities while the local forestry and agricultural services will also have reference of wider conservation options that can provide environmental services.

Plot and micro catchment scales measurements (activities B and C3) have produced convincing relationship of the effects of different stages of coffee growth and different soil conservation treatments on soil erosion and runoff. Soil loss in the Bodong site was the highest (about 85 t ha⁻¹ yr⁻¹) under 1 year old coffee and sharply dropped as coffee canopy developed (coffee gets older). Under 5 year or older coffee, soil loss was basically within the tolerable level and multistrata coffee tended to be more protective against soil loss than monoculture coffee. Under 12 years old or multistrata coffee (which generally also coincides with 8 years or older coffee), soil loss was basically as low as that under forest. Thus additional soil conservation measures do not reduce soil loss any further.

Equally important, these activities have given information of how wide the variation of soil properties was and how important it was in influencing soil susceptibility to erosion. For instance, under 3 to 4 year coffee stand and about 500 mm of rainfall in 3 to 3,5 months period of measurement, soil loss was negligible (<2 t ha⁻¹) in Tepus and Laksana sites, but it was about 37 t ha⁻¹ in Bodong site. This difference was attributed to distinct differences in soil structure. Drainage pore for 0 to 20 cm soil layer, for example, was between 6 to 12 % (v/v) in Bodong and about 23 to 32 % in Tepus and Laksana sites.

Because of the variation, we developed a map of soil susceptibility to erosion (Activity B.2.1.a, Table 1). This map can support the local government in prioritizing areas for implementing soil conservation.

Under Activity C3 we have learned the importance of tree litters produced by old and/or multistrata coffee in protecting soil surface against soil loss, reducing runoff, increasing soil organic carbon and increasing soil macropores. These qualities are close to that provided by the natural forest, suggesting that facilitating the local farmers to maintain tree based, multistrata land use system on the steep forest margin, is a judicious option and this will speed up the recovery of forest functions.

Implications and Benefits of Research

These findings implied that the intervention made by the government in mid 1990s by eviction of the farmers and replacement of coffee to *Calliandra callothirsus* was out of focus and only harmed the farmers, because, they in general, had almost no choice to earn a living in other sectors. Erosion and runoff reduction, the two forest functions most commonly voiced by the government have been clearly reduced as coffee (and other trees in the multistrata system) canopy and litter on the coffee floor develop. Additional conservation intervention is necessary only for selected sites with low infiltration capacity/low porosity. Multistrata coffee system is the closest to forest in its performance and in providing environmental services. Facilitation of the development of multistrata systems appears to be the wisest way the government should do forward.

This research also suggest that there are options of two-pronged soil conservation options that not only provide services to the public, but also promise private benefits important for farmers such as improvement or sustainability of soil fertility. These options include the use of cover crops, the use of shade legume trees and multistrata coffee systems. Both community and government efforts should prioritize in facilitation of these two-pronged interventions for smoother negotiation.

At the end of this three year implementation, this research has delivered not only scientific explanations for getting to grips with some of the deeprooted myths about forests and water,

but also provided a range of wider options in soil conservation as well as delineation of the 'hot spots' in the watershed where extra efforts for soil conservation are actually needed.

Likely Direction of Future Research and Development

The most logical follow-up of the current research findings is integration these finding into existing development projects such as the GNRHL (Gerakan Nasional Rehabilitasi Hutan dan Lahan; the national level watershed management program, focused on reforestation and conservation) and HKm (Hutan Kemasyarakatan; Community Forest Program); both are under the Ministry of Forestry. This integration should be using the farmer-led approach, in which farmers and the rest of the community, with facilitation from researchers and local extension and NGO, will take initiatives in voicing the local natural resource problems, develop alternatives of problem solving, implement and evaluate the performance of natural resource management. The results of research presented in this report (erosion susceptibility map and technology options) could be used to assist farmers in their selection of technology and the facilitating agencies (government and non-government) in assisting the farmers. This approach, if successful, will revamp the current, mostly blanket recommendation implemented in the two programs.

Furthermore, valuation of environmental services from different management systems, and formulation of reward mechanisms for the service providers, will also be a very important aspect to study.

Collaborating Research Institutions

This research is implemented by NARS under the coordination of ASB-Indonesia (ICRAF SE Asia). The collaborating NARS and the research topics undertaken are listed in Table 1.

Table 1. Activities and implementing institutions.

Title	Implementing Institution/evolution
Identification and selection of profitable and environmentally-benign conservation measures.	ICRAF (2001). The results was published in a booklet, Agus, Gintings and van Noordwijk (eds.) (2002).
Validation and refinement of conservation/agroforestry practices	
Paired plot farmer participatory trials	SRI (Aug'01-Aug 04)
Validation of soil erosion prediction and refinement of conservation measures	
Plot scale soil erosion measurement under different conservation systems	SRI (Aug'01-Aug. '03)
Delineation of erosion prone areas in Sumberjaya	SRI (Aug'03-Aug '04)
Micro-catchment scale soil loss as affected by soil conservation practices	Unila (Aug'01-July 04)
Evaluation of resource use, sustainability, and profitability of tree crop production systems	
Village-level production of quality planting material	Tree domestication program, conducted by under ICRAF-Winrock collaboration
Interaction of tree crops with existing crops	Unila (Aug'01-July 02)
Tree diversity in the resilience of multi-strata agroforestry systems (litter function under different coffee systems)	Unibraw (Aug'01-Aug'04)

Remarks: SRI = Soil Research Institute, Bogor; Unibraw = University of Brawijaya, Malang, East Java ; Unila = Universitas Lampung, Bandar Lampung.

Publications Based on ASB3 Research in Indonesia:

Proceedings

Agus F, and van Noordwijk M (eds.). 2005. Alternatives to Slash and Burn in Indonesia: Facilitating the development of agroforestry systems, Phase 3 Synthesis and Summary Report. Proceedings of a Workshop held in Bogor, Indonesia 16 August 2004. World Agroforestry Centre, Southeast Asia. Bogor, Indonesia. (This volume).

Scientific Article

Ai Dariah. 2004. Erosi dan Aliran Permukaan pada Lahan Pertanian berbasis Kopi di Sumberjaya, Lampung Barat (Erosion and Runoff in Coffee Based System in Sumberjaya, West Lampung. PhD Dissertation. Bogor Agricultural University, Indonesia. (*In Indonesian with English Summary*).

Ai Dariah, Agus F, Arsyad S, Sudarsono, and Maswar, 2004. Erosi dan aliran permukaan pada lahan pertanian berbasis tanaman kopi di Sumberjaya, Lampung Barat (Soil loss and runoff on coffee based farmland in Sumberjaya, West Lampung). *Agrivita* 26(1):52-60. (*In Indonesian*)

Hairiah K, Suprayogo, D, Widiyanto, Berlian, Suhara, Mardiasuning A, Widodo RH, Prayogo C, and Rahayu S. 2004. Alih guna lahan hutan menjadi lahan agroforestri berbasis kopi: ketebalan seresah, populasi cacing tanah dan makroporositas tanah (Land use conversion from forest to coffee based agroforestry: litter thickness, earth worm population, and soil macroporosity). *Agrivita* 26(1):68-80. (*In Indonesian*)

Hairiah K, Suprayogo D, Widiyanto, Widodo R H, Van Noordwijk M, 2004. 'Conversion of forest to coffee-based Agroforestry in Sumberjaya, West Lampung, Indonesia: Litter layer, population density of earthworm and soil macroporosity'. Paper presented in a workshop of the International Union of Forest Research Organizations (IUFRO). Forests and Water in Warm, Humid Asia. July 10-12, 2004, Kota Kinabalu, Sabah, Malaysia.

Hairiah K, Sulistyani H, Suprayogo D, Widiyanto, Purnomosidhi P, Widodo R H, and Van Noordwijk M, 2004. Litter layer residence time in forest and coffee agroforestry systems in Sumberjaya, West Lampung. *Forest Ecology and Management (Submitted to Forest Ecology and Management)*.

Suprayogo D, Widiyanto, Purnomosidi P, Widodo RH, Rusiana F, Aini ZZ, Khasanah N, and Kusuma Z. 2004. Degradasi sifat fisik tanah sebagai akibat alih guna lahan hutan menjadi sistem kopi monokultur: kajian perubahan makroporositas tanah (*Degradation of soil physical properties as caused by land use conversion from forest to monoculture coffee farm: a macroporosity study*). *Agrivita* 26(1):60-68. (*In Indonesian*).

Widiyanto, Suprayogo D, Noveras D, Widodo R H, Purnomosidhi P dan Van Noordwijk M, 2004. Alih guna lahan hutan menjadi lahan pertanian : Apakah fungsi hidrologis hutan dapat digantikan sistem kopi monokultur? (*Land use conversion from forest to coffee farm: Can monoculture coffee restore the forest functions?*) *Agrivita* 26 (1) : 47-52. (*In Indonesian*)

Booklet

Agus F, Gintings ANg dan van Noordwijk M. 2002. Pilihan teknologi Agroforestri/ konservasi tanah untuk areal pertanian berbasis kopi di Sumberjaya, Lampung Barat (*Agroforestry/soil conservation technology options for coffee based farming area in Sumberjaya,Lampung*). International Centre for Research in Agroforestry, Southeast Asia Regional Research Programme, Bogor. (www.worldagroforestrycentre.org/sea). (*In Indonesian*).

Hairiah K, Widiyanto, Suprayogo D, Widodo, RH, Purnomosidhi P, Rahayu S, and van Noordwijk M. 2004. Ketebalan Seresah sebagai Indikator Daerah Aliran Sungai (DAS) Sehat (*Litter thickness as an indicator of healthy watershed*). 41 p. World Agroforestry Centre, South East Asia, Bogor. Indonesia. (www.worldagroforestrycentre.org/sea). (*In Indonesian*)

Related Proceedings

Agus F, van Noordwijk M, and Farida. 2004. Hydrological Impact of Forest, Agroforestry and Upland Cropping as a Basis for Rewarding Environmental Service Providers, Proceedings, Roundtable Discussion in Padang and Field Trip to the catchments of Singkarak and Maninjau Lakes, West Sumatra, Indonesia, 26-28 February 2004. World Agroforestry Centre, South East Asia, Bogor, Indonesia.

Agus F, van Noordwijk M, and Farida. 2004. Dampak Hidrologis Hutan, Agroforestri, dan Pertanian Lahan Kering sebagai Dasar Pemberian Imbalan kepada Penghasil Jasa Lingkungan. Prosiding Lokakarya di Padang/Singkarak, Sumatera Barat, Indonesia, 25-28 Pebruari 2004. World Agroforestry Centre, South East Asia, Bogor, Indonesia. (*Indonesian version*).