Technology Fact Sheet for Mitigation

Technology Name:	**Optimal agro-forestry** [i]
Introduction	
Optimal forest plantation, in the TNA context refers to the agro-forest that promotes in the suitable area and generates maximum benefits and in sustainable manners for the area or land use. However, it lacks of information and assessment of such system in order to define what types of agro-forestry is optimal in the regions. So instead of assessment and describes such optimal agro-forestry system, this factsheet provided information on agro-forestry in general as a mean for further exploration of optimal forest plantation. The agro-forestry is defined differently from one user, practitioner and evaluator to another. Nair 1989 defined that agroforestry is land-use systems and technologies where woody perennials are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. As in the Wikipedia, agro-forestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agriculture and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land-use systems or a trees on farms in short.	
Technology characteristics	
Agro-forestry is an integrated approach which generally, includes composition of trees with crops (agrosilviculture), trees with crops and livestock (agrisilvipasture), trees with pasture and livestock systems (silvopastoral) on the same piece of land. This combination is to maximize the benefits from the system and or	

provide products all year round. So the trees, crops, pasture and/or livestock can be diversified and grown together at the same, mean time, in rotation, or in separate plots but they can be perennial or long term. This depends on design including suitability of the system and location. However, all the compositions suppose to be compatible and benefit one another from interactions. On the other hand, it is necessary to balance and or complimentary between the functional (productive, protective and multi-purpose) and ecological (beneficial composition and interaction) based approach.

Overall, the agro-forestry are developed through the following stages and tasks:

Stage	Basic tasks
Diagnostic	1. Definition of the land-use system, land/site suitability and selection. 1) Setting/Physical characteristics (including altitude, climate mate (temperature, rainfall etc), slopes, water supplies, soil condition, visible erosion) in order for evaluating the need and suitability for agro-forestry system and techniques 2) Existing land use, tenures and agro-forestry systems, technologies, local knowledge and perception on the agro-forestry including its benefits (for suggesting the kind of subsistence products that an agro-forestry system would enhance) 3) Market including sales and purchases of agro-forestry products (fruit, fodder, firewood etc.). This provides data for economic analysis, and indicates opportunities to replace purchased items or to expand sales by raising agro-forestry products. 4) Constraints and opportunity for access to technology and finance, farmer capacities and markets 5) Site selection based on the assessment mentioned above and also other criteria. For example if agro-forestry is designed for carbon sequestration via Clean Development Mechanism (CDM), CDM's specific criteria or requirements are needed to be considered for site selection.
Design and planning	2. How to improve the system or agro-forest could provide? 1) List potential benefits of an agro-forestry system 2) List agro-forestry production needs (meet food security, increase production to meet market demands, conservation, carbon sequestration and so on) 3) Adoptability considerations: social and cultural acceptance; importance of local knowledge, practice and capacity; as well as equity and gender issues 4) Characterise and plan for the compositions or systems (trees, crops, grasses,

	livestock desired by minimum space requirements, water and fertiliser needs, shade tolerance etc). The planning should consider whether the system is temporary or long term/permanent so that the system can be adjusted according to the desire. The design and planning should follow the format or requirements if it is for CDM and REDD+ mechanism. 5) Evaluate the environment, socioeconomic of each system or composition 6) Select the system or composition to be used
Implementation	On-farm trials of proposed agro-forestry models and analyse impacts of the system including testing harvesting regimes
Monitoring and evaluation	1) Measure the inputs and outputs of the system 2) Socio-economic benefit assessment 3) Soil nutrition, moisture, land use/tenure and watershed impacts and carbon sequestration

Source: modified from Raintree, 1986; Martin and Sherman, 1998; FAO, 1991

Potential application in the country

The agro-forestry especially Taungya system would be one of the most potential applications of forest plantation in Laos. First reason is that agriculture production sector is being one heading sector focusing in development by the government. This is in order to have sufficient food for Lao people and increasing agriculture products for exporting. Taungya system is model that grows forest mixed with some shorter rotation cash crops, example, rice, pineapple, pasture, chilli and banana. This system will create local people income for both short and long terms. The short term incomes are from agricultural crops and the big long term benefits are from tree products. Furthermore, 80% of Lao people are still poor and they need income for every day for food and healthcare and by the way, they have limited land for grow tree and plant cash crops, therefore, Taungya system of forest plantation would be a good for the local people. In addition, forest plantation in Laos would be better selected for right species which are suitable growing well in the Laos geographical conditions, and as well as a stable price and both high demand from national and international markets in the future.

Status of technology in the country

The agro-forestry has been applied by Lao famers for years. The practices vary in degrees of intensity which ranges from just a simple to advanced or complicated silvicultural system with different crops and trees.

The Taungya, intercropping, home garden and living fences is also a common practice. The alternative agro-forestry systems that aim for improving plant nutrient management and soil erosion control such as contour hedgerows, alley cropping, and biologically enriched fallows are recently introduced (Hansen P.K and

Sodarak. H, 1996). The main practice are in the form of home gardens, rotational or intercropping systems, NTFP-plantations, improved fallow practices, fishpond systems and livestock grazing practices (Sodarak H et al, 2003). Some of the composition or systems are as described below.

Taungya system, in Lao, has established growing mixed with others term agricultural crops, such maze, chilli, banana and some fruits tree species (Table 1). This system has been practised mainly by private households with small scale areas. The system has also grown mainly with teak and rubber tree species in the northern and central parts of Laos.

Table 1: Teak intercropping plantation system in Laos(Rodew *et al.* 1995)

Teak intercropping with other crops	Percent of respondents (%)			
	Year 1	Year 2	Year 3	Year 4
Rice	52	20	5	-
Banana	5	5	-	-
Rice + Banana	4	5	-	3
Sugar cane	7	16	18	-
Banana + sugar cane	4	5	5	-
Pineapple	3	2	2	-
Fruit trees	2	2	2	3
Other annual crops	9	5	5	-
No inter crop	14	43	63	93

Another form is teak-based rice and paper mulberry cultivation. Most plantation teak intercropping in Laos is conducted in a space of 3 x 3 m. When planting with rice, teak trees are planted one–two months after planting the rice crop. The field preparations for the rice provide a good environment for teak but competition from rice can reduce teak growth rate in the first year. The intercropping system reduces labour required for field preparation as well as weed management. The system also provides extra benefits from short term crop products for farmers and also provides a good opportunity to add more value in the same area (Rodew *et al.* 1995). In contrast, Sihaphon (2007) outlined claims that there is no significant difference between the growth rate of pure plantation teak and plantation mixed with paper mulberry (*Brussonentiapapyrifera Vant*). Details of the study are shown in Table 2.

Table 2: Pure teak and mixed growth rates in Laos after 6 months (Sihaphon (2007)

Plot	Number of trees		Diameter (cm)		Height (cm)	
	Teak + paper mulberry	Teak	Teak + paper mulberry	Teak	Teak + paper mulberry	Teak
1	23	62	0.87	0.68	37.21	30.77
2	32	53	0.62	0.47	40.09	29.30
3	34	58	0.55	0.85	25.88	42.17
4	31	57	0.66	0.55	28.32	28.07
Average:			0.68	0.66	32.87	32.58

Home garden usually mix up of fruit trees such as mango, papaya, banana, citrus, jackfruit, plum, peace, pear, and crops such as sugar cane, eggplants, chilli, cabbage, beans and pineapples. Intercropping includes intercropping among job's tears, paper mulberry, rice, maize, pineapple. Sometime cassava, sesame, banana, chilli and also tree and orchard are planted in proximity. Living fence includes trees and crops such as jastropha, eucalyptus, bamboo, cassava and banana in proximity.

However, in general, the majority is small scales; data on the composition, economic return and environmental and social benefits from each system including good practice is limited and or unclear.

Benefits to Economic development

The economic benefit of the agro-forestry includes:

- Maximizing use of the land and land-use efficiency;
- The productivity of the land can be enhanced as the trees provide forage, firewood and other organic materials that are recycled and used as natural fertilizers;
- Increased yields. For example, millet and sorghum may increase their yields by 50 to 100 per cent when planted directly under Acacia albida (FAO, 1991);
- Promotes year-round and long-term production;
- Employment creation – longer production periods require year-round use of labour;
- Reduce needs for purchased inputs such as fertilizers as nutrient can be maintained by legume; crop diversity, rotation and residues.

Benefits to Social development

Qualitatively social benefits of the agro-forestry can be summarized as following

- Agro-forestry promotes year-round and long-term production.
- Employment creation – longer production periods require year-round use of labour.
- Livelihood diversification.
- Provides construction materials and cheaper and more accessible fuelwood

Benefits to Environment development

Qualitatively environmental benefits of the agro-forestry can be summarized as following; • Protection and improvement of soils (especially when legumes are included) and of water sources. • Conservation of natives species and biodiversity • Can be a good production system for carbon sequestration
Climate change mitigation potential
As for Laos, the actual potential of the agro-forestry have not been explored. However, refers to study elsewhere, agroforestry can play be a key carbon sequestrator (Sharrow and Ismail 2004; Kirby and Potvin 2007; Nair et al. 2009) and it is also perceived applicable to Laos.
Financial requirements and costs
The financial requirement for investment in the agro-forestry though the country is unclear for Laos. This is due to lack of data on the area and agro-forestry system to be promoted including estimate of investment cost. The forestry strategy to the year 2020 of the Lao PDR (MAF, 2005) merely stated that the agro-forestry is the high priority under plantation development and Non-timber forestry product (NTFP) management and required technical and financial support. While an agro-forestry project namely development of agro-forestry for watershed protection and erosion reduction in steep hill with total cost of USD 1.9 million is proposed under National Adaptation Programme of Action (2009). However, compare to an agro-forestry project proposed elsewhere, the proposed agro-forestry under NAPA of Laos is relatively low. An agro-forestry (Silviculture) namely "healthy and well-managed forest plantation" that proposed under NAPA of Eritrea expected that total cost of over US$$5 million, a five-year project included in the NAPA of Senegal aimed at promoting agro-forestry at total budget of US$ 258,000 for establishing community nurseries, plant growing, installation of plantations and rejuvenation of regional forests (UNFCC, 2008a).

[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment Report For Climate Change Mitigation– Laos. You can access the complete report from the TNA project website http://tech-action.org/**