

Climate Change Resilient Agroforestry Systems For Livelihood Improvement Of Smallholders In Vietnam¹

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ABSTRACT

The increased climate variability associated with changing climate patterns is not only aggravating the challenges that farmers are already facing, but also putting people in new situations never faced before. Agroforestry diversifies the environmental and economic functions of small scale farming systems, and is therefore considered more resilient than monocropping to external stress. Up to now most agroforestry research has focused on technical aspects of the systems and while research from the Asian uplands show that agroforestry is environmentally suitable, it is not yet economically attractive for farmers. Moreover, agroforestry research tends to focus on the farm level while there are few studies on the suitability of agroforestry for different agroecological zones.

This paper presents the negative impacts of climate variability on agriculture in two most vulnerable agro-ecological zones, including the central coastal zone versus the Northwest uplands of Vietnam. A novel approach for sustainable development of agroforestry system as one of the most promising options to these negative impacts in the Northwest uplands is also presented. The agroforestry systems developed to address the needs for both environmentally and economically viable diversification and that is resilient to climate stress is done through participatory design (i) where local and scientific knowledge is used to identify the desired species to be added to or improved in existing farming systems, (ii) where farmers and scientists develop indicators to evaluate the systems, and (iii) where scientific experiences are combined with the most sensitive indicators for scaling up the successful agroforestry systems in the zones where they have social acceptance and economic and environmental potential.

Keywords: Vietnam, participatory design, agroforestry systems

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Message 1: The increased climate variability associated with changing climate patterns is not only aggravating the challenges that farmers are already facing, but also putting people in new situations never faced before.

Farmers have over generations collected different strategies to minimize crop failures, and in harmony with local socio-economic and cultural condition, in order to ensure household food security: e.g. shifting cultivation, rotating fields, selecting higher yielding seeds and to safeguard their crops against “bad weather”: building terraces, adjusting seasonal calendar, where irrigation or planting different crops depending on expected weather, as well as planting a second crop if the first is damaged. With climate change, increased intensity of extreme weather events such as more frequent heat waves, droughts, and flooding will accentuate many challenges that farmers are already experiencing. This creates a range of new situations that farmers never have experienced before (Battisti and Naylor 2009). For farmers in southeast Asia this means for example shifts in planting seasons, increasing occurrence of pests, land slides and storm damages, temperature and/or water stress on plants and animals affecting fertility and productivity.

Research clearly shows that climate change and climate variability is likely to have overall negative impacts on many monoculture food crops. In the northwest region, the small areas of paddy fields is one key driver to shifting cultivation of annual staple crops on steep slopes (in particular maize and cassava) with shorter fallow periods that aggravate the impacts from heavy rains as well as droughts (Hoang et al. 2011). Findings from an in-depth survey by ICRAF with 6 farms, represented by three wealth groups rich, average and poor farm in two villages in Cam Xuyen district, Ha Tinh province showed that in 2008, due to prolonged winter for more than a month and two flood events, 70% rice seedlings died, forcing farmers to replant seedlings with short duration but lower yield varieties. Thereafter, the rice yield decreased by 40% and total crop production decreased by 36%, equal to four months' food security in some cases (Nguyen et al. in review).

In contrast, trees generally have better buffers both above and below ground to withstand extreme weather events and in response to long-term climate changes, some tree species are able to migrate to match with new ecozones (Neufeldt et al. 2009). The questionnaire survey with 188 households in Cam Xuyen, Ha Tinh province showed that 100% households get help from trees in home garden or forest garden when rice and rain-fed crops fail due to weather or pests and diseases. The home gardens are diverse with multi-storey combinations around homes, including fruit trees, herbaceous (crop) species and animals. Besides, for those who have forest in village 4, 87% of them develop forest farm with multispecies of fruit trees, wooden trees, industrial trees, and food crops together with animal raising in forest land. In south Asia, about 80% farmers are smallholder with average acreage of less than 0.6 ha, and one or more forms of mixed species garden are often present on these smallholdings (Kumar, 2006). Many of these systems provide subsistence food (fruits, vegetables and spices), fodder and fuel, and thus also enhance the economic returns and food security under climate variability .

We can learn from how trees and animals have adapted to changing climates in the past, either by moving polewards or by elevation to remain in similar temperature zones or by changing biological functions, such as regulating stomata which also affects water-use efficiency.

The magnitude of these “new” types of exposures leaves us all - farmers, extension workers, policy makers – and scientists – with having to make uninformed decisions, i.e. manage risk.

Message 2: Agroforestry diversifies the environmental and economic functions of small-scale farming systems, and is therefore considered more resilient than monocropping to external stress.

Agricultural diversification is generally considered the smallholder's strategy to reduce both environmental and economic risks by spreading harvests and income throughout the year as compared to monocropping.

One approach to diversify livelihood sources is agroforestry. A potential cost-benefit estimate from agroforestry system versus monocropping maize on slopes in northwest Vietnam shows that keeping maize on 80% of the area while adding fruit trees, sweet bamboo and strips of grass can increase the economic return by 65%. Furthermore, reduction in soil erosion may lead to higher nutrient retention, thus higher maize yields (Hoang et al. 2011).

The environmental benefits of agroforestry is reported at both plot and landscape levels. At the plot level, agroforestry systems capitalize on the synergy between the different functions of species and the system as a whole, such as improving degraded soils by increasing soil organic matter content and fixing nitrogen, providing shade for plants and animals. At the landscape level, there is emerging evidence that agroforestry can contribute to a range of environmental services, in particular, watershed protection (reducing sedimentation by binding erosive soils and reducing land slides), maintain larger biodiversity than monocropping agriculture, carbon sequestration in soils and trees. This means that agroforestry systems are going to be increasingly important for buffering soil moisture during dry periods and shading during heat waves.

Message 3: Up to now, most agroforestry research has focused on technical aspects of the systems and while research from the Asian uplands show that agroforestry is environmentally suitable, it is not yet economically attractive for farmers.

By making farmers less dependent on simply one or two annual crops, agroforestry systems can provide stable income and food sources. In mountainous areas in Vietnam and other parts of Southeast Asia, agroforestry has been introduced as an alternative to shifting cultivation of annual crops on steep slopes, such as maize and hill rice for subsistence. Some of the first improved agroforestry projects in Vietnam were introduced in the 1980/90s as part of the national reforestation programmes. And although many were successful, especially homegardens and circular agriculture with homegarden, pond and livestock, state-supported programmes were carried out in a top-down fashion and the uptake and spread was not great. Still in 2011, a large share of upland farmers, particularly the poorest, make their livelihoods from annual crops.

Meanwhile, evidences from around the world showed that agroforestry can help break the vicious circle between poverty and environmental degradation. Farms in the northern uplands of Vietnam that started with agroforestry in the 1990s and still are running successfully have some factors in common:

- (1) First, they generate economic return so that they continue to develop after project completion. Two key factors that make them profitable are:

- **The new trees and plants need to be suitable for the local environment.** This point seems self-evident, nevertheless we keep coming across villages where acacias died because of cold spells, cardamom trees did not develop fruits.
 - **Products need a market.** Plants may grow well but if the products could not be sold farmers give up. Results from reforestation projects also show that trees are likely to do better when farmers are familiar with the trees and have preferred species.
- (2) **Second, smallholders** generally depend on land for household food security and cannot afford to invest a couple of years reduced production during the establishment phase of perennial species. Ways to overcome the harvest losses during the first years of establishment are:
- Making credits available for investments. When agroforestry systems spin off, they raise farmers' demand for quality of germplasm and products and can generate new rural enterprises from nurseries to processing. There is a risk that systems fail and farmers become indebted, agriculture insurance can be explored for such purposes. Farmers' access to credit may be particularly important for upscaling pilot projects.
 - Using multipurpose trees that produce fruits or nuts before eventually becoming timber. Popular ways to speed up the process include starting with fast-growing timber species and using technology such as grafting, which can reduce the time to the first fruit from 7 to 3 years for domestic species, such as *Docynia indica*.

Some success factors are cross-cutting: With longer term land use rights, farmers are more likely to invest in soil-improving measures and maintain planted trees. A sufficient land area could be an important factor, the surviving model agroforestry farmers often have a couple of hectares, however it may equally be the type of production that determines such thresholds.

Message 4: Agroforestry research tends to focus on the farm level while there are few studies on the suitability of agroforestry for different agroecological zones.

Much of agroforestry research has been plot and farm oriented and resulted in sufficient technical knowledge about different AF systems. The key research gaps are within replication and upscaling. For example, plot and farm scale impacts of AFS may be different at another scale. An evaluation of the Vietnam-Sweden Mountain Rural Development Programme (Berlekom, 2004) shows that the reforestation and agroforestry systems they introduced had overall socioeconomic gains but both environmental losses (lost biodiversity and agro-diversity as too few species and varieties were introduced) and environmental gains (watershed protection and reduced soil erosion).

Similarly, case studies from across the world show that people living in the uplands maintain watersheds that provide water for people downstream. Preliminary results on diversification pathways from focus group meetings in six villages in Bac Kan province suggest that rice-fish cultivation had been practised "as long as anyone can remember" and without any external incentives in all villages. All key informant farmers (n=20) were aware that this practice has numerous economic and environmental advantages: e.g. reducing or removing the need for fertilizer, pesticides and weeding, fish sells at a higher price than pond fish and most agree that the rice yields increase compared to

monocropping. However, the main threat to this practice is extreme weather events: when water levels are too low or water temperature gets too cold or too hot farmers may move the fish to a pond (farmers' coping strategy). A small provincial project in one of the villages aims to show farmers how to dig a deeper trench for fish (planned adaptation).

What is needed in addition to the plot and farm level case studies, is to better understand agroforestry's contributions or potentials at a landscape scale, in Payments/Rewards for Environmental Services and emissions trading schemes like REDD. The rice-fish cultivation is an example of where Rewards from Environmental Services (RES) could serve several purposes: rice fish farmers supply downstream people with clean water and in reward RES scheme could enhance the resilience of this system to climate variability with technical support (irrigation and training). ICRAF's long-term project RUPES, Rewarding Upland Poor for Environmental Services (RUPES I) is an ambitious attempt to reduce poverty while improving the biophysical environment and reduce carbon emissions. In the second phase of this project is piloting new ways of Rewards for, Use of and shared investment in Pro-poor Environmental Services (RUPES II), included various degrees of compliance and forms of payments. However, such reward schemes require that agroforestry is implemented and evaluated at larger geographical areas, or domains of similar ecological and socioeconomic characteristics.

Agroforestry at the landscape perspective sits within a debate on land use and food security where some scientists argue whether:

Organic agriculture alone can feed the world's growing population. This debate often stretches to a debate on the ethics of genetically modified crops. Some argue that more intensive agriculture on productive land with high input and high-yielding varieties could reduce the need for agriculture on unsuitable land, such as sloping land. This debate often overlooks the reality of many smallholders in developing countries.

- Agriculture is taking place for other reasons than maximizing profits of single crops, and in places where access to agriculture inputs and information is limited. Moreover, shifting cultivation and subsistence farming on sloping land in Southeast Asia is a tradition in environments with limited alternatives besides subsidized reforestation programmes. Here, agroforestry such as intercropping mixes of annual and perennial multipurpose plants is a more sustainable alternative to annual crops.
- Organic agriculture and agroforestry can be labour and training intensive to start-up while fertilizers and seeds for conventional agriculture are more easily distributed and enables production at a lower cost. However, smallholders making a living from agriculture or forestry, who operate near markets, are easily outcompeted by bigger farms due to economy of scale. Solutions to smallholders challenges include certification procedures through which they could gain access to new markets and informed prices (Hoang et al., 2011).
- There is a great potential to reduce the yield gap. Some propose that doubling the yields of the low-producing farmers would be easier and could achieve more in terms of total production and of livelihood improvements, than increasing yields of those with high-input and intensive cultivation who already are near yield potentials (Fedoroff et al., 2010). This can be achieved with careful selection of local mother trees to generate higher quality germplasm.
- Some argue that reducing the yield gap to meet the food demand of 9 billion people by 2050 will require advancements in biotechnology to increase yields, enhance crops' tolerance to biotic and abiotic stress etc. (Science and Nature Special issues on Food Security, 2010). Therefore, one argument is that

intensified land use can be offset by conservation activities elsewhere – a strategy referred to as *land sparing*. Another strategy is *land sharing*, meaning conserving wild habitats and growing crops on the same piece of land.

The sparing-sharing debate often results in discussions over what mix of land uses is more sustainable and efficient: e.g. checkerboard design (what size), patches, corridors, and socioeconomic and environmental trade-offs between production and protection. A recent paper in *Science* (Phalan et al. 2011) shows that forests provide better habitats than “wildlife-friendly” farmland, suggesting that agroforestry is a useful land sparing strategy that reduces the adverse effects of chemical inputs. There is no one-solution and it is probably more relevant to find effective solutions of sparing and sharing.

Message 5: Climate-smart agriculture, a novel approach for sustainable development in the uplands that addresses the needs for both environmentally and economically viable diversification and that is resilient to climate stress.

The FAO, WB, CGIAR and other organisations (FAO 2010⁴) have recently launched “climate-smart agriculture,” defined as “agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals.” (ibid. p ii). CSA resembles “sustainable agriculture” practices, its soil management objectives include “conservation agriculture,” and puts additional stress on low-carbon agriculture (mitigation aspects) and plants that can reduce vulnerability to climate change (adaptation aspects). CSA focuses on technical solutions to the GHG and energy intensive types of agriculture, e.g. rice cultivation, livestock and aquaculture, as well as land use solutions e.g. balancing food and energy crops, local peri-urban agriculture, and agroforestry. CSA also can be considered a reaction to the slow progress on including agriculture in the UNFCCC negotiations taking REDD (forest emissions) to REDD++ (forest and agriculture emissions). Smith and Olesen (2009) list a number of measures where there are obvious synergies between adaptation and mitigation: (1) reduce soil erosion, (2) reduce leaching of nitrogen and phosphorus, (3) conserving soil moisture, (4) increasing the diversity of crop rotations by choices of species or varieties, (5) modification of microclimate to reduce temperature extremes and provide shelter, (6) land use change involving abandonment or extensification of existing agricultural land, or avoidance of the cultivation of new land.

One of the objectives of the CSA concept is to mobilize funds for (sustainable) agriculture development in developing countries through the Global Adaptation Fund, Clean Development Mechanism (CDM), Payments for Environmental Services (PES), etc. The concept is now taken up in a number of economies that depend on agriculture, e.g. Philippines, Peru, Egypt. Specifically, the Government of Vietnam has embraced this approach in the Action Plan on climate change response of agriculture and rural development for 2011-2015, which aims to reduce the agriculture sectors’ CO₂-emissions by 20% while reducing poverty by 20% over the next decade (MARD 2011). There are several ways in which agroforestry research can contribute to climate-smart agriculture.

Vietnam has also passed one of the world’s first decrees on Payments for Forest Environmental Services (Decree 99) that specifies payments for watershed protection, carbon and landscape beauty, administered through a Forest Protection Fund. ICRAF

⁴ <http://www.fao.org/climatechange/climatesmart/66248/en/>

and IFAD act as the intermediaries in three pilot districts in Bac Kan province with the aim to enhance forest protection and upgrade degraded forests over 50 years – this generates watershed protection, carbon sequestration and landscape beauty (ecotourism) where the largest share of the funds are likely to come from voluntary carbon markets. The payments for each individual service will be low, and instead it is proposed that the environmental services are bundled, and that farmer groups are compensated instead of individual farmers in the form of rewards rather than payments.

Message 6: Needs for climate-smart agroforestry systems in the northwest Vietnam context

Although mitigation plays an important role here, the 50-year time perspective requires consideration of species with regard to climate change. For example, some species that are unsuitable in the lower end of the temperature range under current climate conditions may become important species in the future. Introducing agroforestry and enhancing adaptive and mitigation capacity of agriculture are all likely to be learning intensive. A first step in research, is therefore to build on existing systems and collaborate with farmers and local partners who know the area.

A new research project funded by ACIAR and ICRAF (total 2 million AUD over 2011-2015; Hoang et al 2011) takes a holistic approach to address many of the shortcomings listed above. The region is northwest uplands of Vietnam with three provinces Son La, Dien Bien and Yen Bai, where the biophysical context is complex topography that has lost much of the forest areas over the past decades and limited area for paddy rice production which leaves few options than sloping cultivation which results in soil degradation and household food insecurity. In terms of climate stress, this region has been particularly struck by short periods of cold spells – a few days with below seven degrees killed acacia as well as cows and buffalos; flashfloods resulting in landslides on steep deforested slopes and droughts both cause crop failures. The project will monitor soil erosion and document trees survival to generate information on the resilience that the AFS buffers to climate stresses.

The socioeconomic context consists of different ethnic groups who are disadvantaged in terms of education, with restricted market opportunities and income generating resources to invest in their farms or other activities. Each community has one extension worker, however they may not speak ethnic languages. And since they cover agriculture, forestry and livestock extension, they find it difficult to keep updated in all sectors.

The project hypothesis is that agroforestry systems with improved technology that match the biophysical and socioeconomic conditions can improve the livelihoods and therefore will be accepted and disseminated in the region. By the holistic approach, it is understood that agroforestry systems cannot exist in isolation of markets. In this project smallholder nurseries play an important role in making suitable seedlings accessible at the local level; that a careful selection of high quality germplasm can improve the quality and/or the quantity of the product; that higher quality creates a demand for both seedlings and agroforestry products.

Message 7: Establishing climate-smart agroforestry systems is done through participatory design

(i) where local and scientific knowledges are used to identify the desired species to be added to or improved in existing farming systems,

(1) The participatory approach started already at the scoping study for the research project. To understand the social and environmental contexts, we trained local research partners on using participatory tools such as Participatory Landscape Appraisal (PaLa) and Participatory Analysis of Poverty, Livelihoods and Environment Dynamics (PAPOLD) (Hoang and Nguyen 2011) so that all together identified ecozones, preferred and non-preferred tree species, potential sites for on-farm trials.

(2) Instead of starting AF systems from scratch, we start with what farmers grow and bring in trees to these systems, or, where farmers already grow trees we bring in improved germplasm. The “new” trees already exist in the nearby environment, and have been identified by both farmers and local research partners as having a comparative geographic and economic advantage, e.g. temperate fruits rather than tropical fruits that can be grown more productively in other parts of the country, and that can be marketed and potentially used for regional branding. The trees are multi-purpose and add value to the current farm system, e.g. produce fruit, shade or nitrogen-fixing and eventually wood. Project staff cooperate with a nearby animal husbandry research project to produce cut-carry grass to feed livestock. Better feeding habits can make cattle more resilient particularly during cold spells. The parallel cooperation between the research project and a long-term development project carried out by another organization is expected to promote the upscaling of the project.

Our research is designed so that over the project duration over 3-4 years (in effect) we can follow a sequence of AF systems, where we start with some systems with young trees (0-4 years old), other systems with established (4-7 years) and mature trees (>7 years). To speed up the time from new planting to harvesting of fruits, we test grafted trees.

(ii) where farmers and scientists develop indicators to evaluate the systems,

Alongside scientific indicators we use criteria that are important for farmers, to monitor and evaluate the impact of the system. Farmers and extension workers will be involved with national research partners in this activity. The potential of the systems will also be screened at Farmer Field Schools and extension dissemination activities.

(iii) where scientific experiences are combined with the most sensitive indicators for scaling up the successful agroforestry systems in the zones where they have a social acceptance and economic and environmental potential.

Here we go beyond plot scale, we do not consider administrative borders like village or district, instead we trial models that have the potential to be up-scaled in similar agroecological conditions in the whole NW region. Here, we consider the whole NW region as three potential domains for upscaling. This approach benefits climate adaptation strategies by recognizing temperature as a limiting factor of the domains.

SUMMARY

Trees on farms, such as in agroforestry systems, provide socioeconomic and environmental resilience during periods of external stress, such as extreme weather events. Agroforestry is a learning intensive practice that can be introduced as a step-wise diversification to match local contexts. As one type of climate-smart agriculture, it has the potential to capitalize on reward mechanisms to meet multiple objectives of climate adaptation and mitigation, e.g., PES, REDD schemes, while providing food security and developing sustainable livelihoods.

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