Upland Agro-Ecology Research and Development in Vietnam

Le Quoc Doanh, Ha Dinh Tuan
Vietnam Agricultural Science Institute (VASI)
Andre Chabanne (CIRAD)

Mountainous regions are diverse and fragile ecological systems. However, these regions are becoming home to more people due to the trend of moving to the uplands where one can find new agricultural lands or exploit natural resources for livelihoods. With such a mechanical and natural population increase, arable resources, mainly on sloping land, are becoming depleted. Land degradation is an inevitable result of continuing shifting cultivation under these circumstances. There is an urgent need to change existing sloping land use by smallholder mountainous farmers to prevent potentially disastrous consequences. In a small country with high population density, like Vietnam, the problems are particularly serious.

In recent years, concern about sustainable land use has become a worldwide issue. Seeking ways of achieving simultaneous increase in food production and preservation of natural resources requires the world's united efforts. In this context, the upland agro-ecology approach has become the most promising way of maintaining sustainable agricultural production. In Vietnam, intensive research into agro-ecology started with small-scale farmers in the northern mountains in 1998. This research has been jointly implemented by the Vietnam Agricultural Science Institute (VASI) and CIRAD. The results are very promising and the scaling up process is quite intensive. This paper deals with some methods and techniques that have been developed or modified to rehabilitate degraded lands and increase sloping land productivity in Vietnam.

I. Background

Sloping Land Use in Vietnam

Mountainous and hilly lands occupy three-quarters of Vietnam's natural inland territory. In general, these lands are not favourable for agricultural production, especially those stripped of vegetal cover. Available data shows that in the 1940s forest cover in Vietnam was 43%, which had dropped to 25% by the 1980s. Now, thanks to the reforestation efforts of Vietnamese people, with invaluable support from the international community, forest cover has reached 32%.

Sloping lands are distributed in all nine ecological regions of Vietnam, but are mostly in the Northern mountainous, Central and Tay Nguyen regions. Most gentle slopes of less than 15^o (accounting for 21.9%) are used for agricultural and forestry production. Land with an incline of 15^o to 25^o accounts for 16.4% of the slopes, while the remaining 61.7% of slopes are very steep, at more than 25^o. Due to the lack of production land, mountainous farmers have to cultivate food crops in very steep slopes of more than 25^o. On such slopes, soil erosion occurs at very high speed, so the time for productive cultivation is short. Commonly only two or three seasons of short-cycle crops are grown, followed by cassava planted as the last crop of a cultivation cycle. Due to population pressure, the traditional fallow periods of more than 25 years are commonly now reduced to five or even three years. This is not long enough for soil fertility to be recovered and crop yields are generally low. Most of the gentle slopes have passed through too many crop-fallow cycles with soil being reduced after each cycle. The constraints on these slopes now include not only poor nutrition, but also soil toxicity and compaction. They are visible as bare hills with very poor vegetal cover. The area of bare hills and lands reached 10 million hectares in the 1980s, a figure reduced to 8.5 million hectares in 2003 mainly thanks to extensive investment in reforestation. Agricultural activities in bare hills and lands seem impossible or ineffective.

In short, sloping areas in Vietnam can be characterised as follows: diversified in (a) Natural and agro-ecological conditions; (b) Cultures associated with rich indigenous knowledge; (c) Natural resources and biodiversity.

In other words, there is rich development potential in:
- Human and cultural resources;
- Land and water resources;
- Forest and associated resources;
- Cash crop genetic resources;
- Energy resources;
- Animal husbandry options.

However, there are also a lot of constraints, including:
In natural conditions:
- Difficulties in climatic conditions;
- Natural resources are being overused;
- Severe soil erosion (100–200 t/ha of lost soil) and land degradation (8.5 million ha of bare land);
- Difficulties in water resources management (drought in dry season, flooding in rainy season);
- Weed and pest infestation;
- Frequent natural hazards;
- Negative impacts on sustainability in the lowlands.

In agricultural production:
- Low, unstable and decreasing productivity (Maize: 1.5-2.0 t/ha; Upland rice: 0.8-1.5 t/ha; Cassava: 10-14 t/ha);
- Poor post-harvest storage and processing development;
- Considerable conflict between crop, animal and forest production (free grazing of animals).

In socio-economic conditions:
- Remoteness and isolation (limited access to public services and markets);
- Low education levels (affecting planning, management and adoption of advanced technologies);
- Poor infrastructure development;
- Hunger and poverty are still prevalent.

General challenge for upland agricultural development
Harmonised development of crop production and animal husbandry along with improvement in forestry and natural resources and environmental protection.

General goal of upland agricultural development
Hunger eradication and poverty reduction towards achieving and sustaining economic, political, social and ecological (environmental) stability.

Main concrete goals:
1. Food security and stability for upland farmers;
2. Improved natural resources and environmental protection.;
3. Social equity: reduced disparity between lowland and upland; rural and urban areas; ethnic groups.

Strategies to achieve the goals:

1. Food security and stability for upland farmers:

- Improvement of varieties and seed technologies plus integrated crop management;
- More effective use of water resources;
- Development of commercial products with high cash value;
- Development of intensive animal husbandry;
- Development of ecological approaches to promote conservation agriculture.

2. Improved natural resources and environmental protection:

- Research and development of sustainable agricultural technologies for sloping land cultivation (preventing soil erosion and degradation, improving soil infiltration capacity, water holding, soil fertility);
- Rehabilitation of bare land/hills (cover crops, green manure, organic fertilizers, reforestation);
- Development of highly productive but environmentally friendly agro-forestry production technologies.

3. Social equity:

- Development of lowland economy to support upland rural development;
- Capacity building (physical and mental capacity, manpower and facilities, equipment);
- Infrastructure construction (roads, dispensaries/hospitals, schools, universities, information/mass media facilities);
- Other institutional and social changes.

II. Research and Development of Upland Agro-Ecology in Vietnam

To contribute to achieving the above goals, over the past five years, the Vietnam Agricultural Science Institute (VASI) and the Centre for International Cooperation in Agricultural Research for Development (CIRAD – France) have been jointly implementing a research project (SAM) in agricultural systems in the northern mountainous region of Vietnam. The main activities of the SAM project are to test, improve, adapt and disseminate techniques suitable to the diverse agro-ecological conditions of this area.

In addition, national agricultural institutions such as the National Institute of Soil and Fertilizers (NISF), Hanoi Agricultural University (HAU), Thai Nguyen Agriculture and Forestry University, Hué Agro-Forestry College and other members of the Vietnam Agro-Forestry Capacity Building Network (VACB) are taking active part in research and development of soil conservation technologies for the uplands. The most recent programme, entitled Science and Technological Research for Upland Agriculture and Rural Development, has launched large-scale activities concerning development and scaling up of effective and sustainable technologies for upland agriculture.

Main objective of upland agro-ecology research and development:
Sustainability of upland agriculture (including integration of animal husbandry) and forestry development with special emphasis on soil, water and other resource protection and enrichment.

Main principles of upland agro-ecology:

- Permanent soil cover;
- Direct sowing with minimum soil disturbance;
- Cropping pattern diversification: intercropping, crop rotation, relay cropping, cover crops, animal fodder crops, etc.

Research and development of agro-ecological technologies in Vietnam
Started in 1999 with support and cooperation from CIRAD, then from IRRI and IRD:

- Test and development of different soil mulching and direct sowing techniques;
- Fast soil improvement by soil smouldering;
- Making miniterraces combined with soil much and DMC on steep slopes of more than 20º;
- Integration with animal husbandry: fodder grass and cover crops testing and planting;
- Testing crop species and their varietal improvement;
- Cooperation with development projects like the EU Son La – Lai Chau Rural Development Project to scale up innovative technologies in the uplands;
- Cooperation with Laos in agro-ecology research and development;
- Creating a basis to extend this cooperation to Cambodia and Thailand;
- Establishment of NOMARC as an Agro-ecology research, development and training centre for mountainous regions in 2003; and
- Establishment of the Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) in December 2005.

Main achievements:
Agro-ecological research and development in Vietnam are still in the infancy stage. However, we have achieved the following:

- Average yield increase of 72-75% across more than 25 sites;
- Reduction in soil erosion by more than 70%;
- Increased animal production with less pressure from free grazing;
- More than 1,500 ha under DMC in most of the mountainous provinces including the central high plateau;
- More than 2000 farmers involved in DMC.

Table 1**.** Impacts of Stylo living mulch on cassava yield

Crop	Replication	Cassava + Stylo	Cassava without Stylo	Yield increase (%)
Cassava	1	26.9	18.6	44
Cassava	2	29.7	20.0	49
Cassava	3	24.0	1.65	45

Table 2**.** Impacts of soil mulch on maize yield

	Yields (T/ha)			Location	Source	Note
	Control	Mulched	Increase by %			
DK888	2.20	3.46	57.27	Na Ri	H.M.Tam	
LVN10	2.86	4.04	42.26	Na Ri	H.M.Tam	Miniterrace
CP	6.49	8.48	30.66	Mai Son	L.Q. Thanh	
LVN10	3.73	5.95	59.52	Song Ma	EU SLLC RDP and VASI, 2004	
LVN10	1.33	2.11	59.28	Song Ma	EU SLLC RDP and VASI, 2004	Miniterrace
LVN10	2.49	4.00	60.64	Tuan Giao	EU SLLC RDP and VASI, 2004	
LVN10	1.41	4.87	245.39	Tuan Giao	EU SLLC RDP and VASI, 2004	Terrace
LVN10	3.03	4.90	61.72	Dien Bien Dong	EU SLLC RDP and VASI, 2004	
LVN10	3.50	4.77	36.29	Dien Bien Dong	EU SLLC RDP and VASI, 2004	Terrace
LVN10	1.28	3.73	191.40	Phong Tho	EU SLLC RDP and VASI, 2004	
LVN10	3.48	6.75	93.97	Song Ma	EU SLLC RDP and VASI, 2004	
LVN10	4.00	6.48	62.00	Song Ma	EU SLLC RDP and VASI, 2004	Miniterrace
CP 888	4.75	7.75	63.16	Song Ma	EU SLLC RDP and VASI, 2004	
CP 888	4.78	7.00	46.44	Song Ma	EU SLLC RDP and VASI, 2004	Miniterrace
LVN10	2.11	5.95	81.99	Song Ma	EU SLLC RDP and VASI, 2004	Terrace
LVN10	1.32	3.72	81.82	Song Ma	EU SLLC RDP and VASI, 2004	Terrace
LVN10	2.61	3.71	42.21	Song Ma	EU SLLC RDP and VASI, 2004	Terrace
LVN10	1.50	2.50	66.67	Song Ma	EU SLLC RDP and VASI, 2004	Terrace
LVN10	3.12	4.01	28.52	Song Ma	EU SLLC RDP and VASI, 2004	Terrace
LVN10	1.58	2.10	32.91	Phong Tho	EU SLLC RDP and VASI, 2004	Terrace
Average yield increase (%)			72.21			

Table 3. Impacts of soil mulch on upland rice yield

	Yields (T/ha)			Location	Source	Note
	Control	Mulched	Increase by %			
Dam Bao	1.25	2.25	80.00	Song Ma	EU SLLC RDP and VASI, 2004	
Dam Bao	1.55	2.14	38.06	Song Ma	EU SLLC RDP and VASI, 2004	Terrace
CIRAD141	0.75	1.26	68.40	Song Ma	EU SLLC RDP and VASI, 2004	
Te Do	1.12	3.15	181.25	Van Chan	NOMARC, 2004	
CIRAD141	1.80	3.20	77.78	Van Chan	NOMARC, 2003	
Bao Dam	10.70	14.97	39.91	Tua Chua	NOMARC-DANIDA, 2004	
CIRAD 141	9.62	15.51	61.23	Tua Chua	NOMARC-DANIDA, 2004	
LC 93-1	7.54	11.19	48.41	Tua Chua	NOMARC-DANIDA, 2004	
Ma Cha	7.52	11.51	53.06	Tua Chua	NOMARC-DANIDA, 2004	
Average			72.01			

Table 4. Economic effects of soil mulch on maize (a case study by SAM-1 in ChoDon, 2001)

Items	Field land preparation 1000 VND/ha	Chemicals for seed treatment and herbicides 1000 VND/ha	Weeding 1000 VND/ha	Total 1000 VND/ha	Yield T/ha Output 1000 VND/ha	Net benefits 1000 VND/ha
No mulch	600	0	1200	1800	4200	2400
With mulch	240	300	300	840	8400	7560

Remaining Questions

- Lower germination of crop seeds under mulch;
- More labour may be required due to a lack of mulch materials (labour pressure at sowing/planting period);
- Band mulch or full surface mulch?
- Applicability of post-germinate mulch?
- Disease transmission through mulch?
- Allelopathy?
- Soil biology research? (Big gap)
- Capacity strengthening.

Requests

- Continued cooperation with CIRAD research to promote DMC in Vietnam and to answer the above mentioned questions;
- Continued cooperation with CIRAD in capacity building (both manpower and equipment) for young NOMARC to become a research, extension and training centre in DMC, not only for Vietnam, but also for other countries in the region.

What Vietnam can offer to the agro-ecology network in Southeast Asia:

- Some SAM staff have been trained directly on the job, and now they can work well in the field with DMC, so Vietnam can share experts and experience with neighbours;
- Expertise in DMC;
- Cover crop and crop germplasm.

III Conclusion

Agro-ecological technologies like soil mulching and related techniques are simple and cost effective. Soil vegetal mulch is really a multi-purpose tool capable of achieving multifaceted benefits, such as:

- Stopping soil erosion by rain and wind;
- Increasing soil porosity and infiltration, decreasing runoff;
- Reducing evaporation and keeping soil moist;
- Buffering surface temperature;
- Maintaining a soft surface texture;
- Suppressing weed growth;
- Reducing input: less weeding, less labour and energy in land preparation (replacing mechanical ploughing with biological through the deep and strong roots of plant species and soil fauna/flora); then less mineral fertilizers thanks to increased OM and nutrients from the mulch decomposition;
- Creating good conditions for seed germination and root development; this facilitates plant growth and development resulting in high, stable and durable yield;
- Facilitating natural resources management and environmental protection.

Due to all the above advantages, more than 2,000 farmers in the northern mountainous regions of Vietnam are applying DMC techniques across over 1500 ha. Agricultural systems that integrate crop production, animal husbandry and forestry are very useful in sustaining balanced economic development in the uplands. Although this is not a true agro-forestry approach, many things are related to agro-forestry development like conservation and rehabilitation of degraded soil, integrated management of natural resources and environmental production.

The positive impacts on improvement of land and labour productivity are clear. However, scaling up these activities will require proper training of farmers and concerned personnel. In addition, seed/planting materials must be made available for users.

The techniques tested and recommended are environmentally friendly and do not require high input, so they are suitable to smallholder farmers. At present, the techniques should be introduced to mountainous provinces all over the country. As yet, the technical support is not sufficient for this: it is very important to have support from policy and decision makers.

The role of CIRAD-CA has been crucial in the research and development of agro-ecology, especially in bringing Southeast Asian and GMS countries together to work on these aspects. It is now high time to form a regional network on agro-ecology development. This would bring more support and benefits to all participating parties and so improve agricultural productivity for the sake of household food security, natural resources preservation, and protection of our environment.