Development of Sustainable Land Use Practices in the Uplands for Food Security

An Array of Field Methods Developed in Vietnam

Edited by
Hoang Fagerstrom, MH
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Contents

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Foreword

Sustainable management of natural resources requires a balancing act between the off-farm development needs of the current generation supported by an agricultural sector producing quality food at low cost, the profitability of farming as a basis of rural livelihoods and the long-term need to sustain a diverse, healthy and resourceful environment for future generations. The Millennium Development Goals can only be met if all three dimensions are taken into account. The new priorities for the Consultative Group of International Agricultural Research (CGIAR), in which international and national research and development organizations work together, reflect these three targets and the policy and institutional environment that can manage the tradeoffs between them. The efforts of the teamwork reported here are aimed at contributing field-tested methods for such an approach, focused on the uplands of Vietnam.

Vietnam has made, and continues to make, remarkable progress in achieving economic development, but there is a risk of a dual economy where progress in the lowland and urban parts of the country is not matched by improvement of livelihoods in the uplands. The current approach, which is based on rules with little space for local re-interpretation, may lead to unjustified constraints to agroforestry activities and thus to inefficient governance of natural resources. Involving multiple stakeholders in the analysis of the tradeoffs between short and long-term benefits and drawing upon their perspectives and knowledge are considered essential in the development of sustainable land use. Furthermore, farmers' knowledge of landscape relationships and their perceptions of an underlying logic play an important role in their management decisions.

The LUSLOF project* **'Sustainable Land Use Practices in the Uplands of Vietnam and Laos - Science and Local Knowledge for Food Security'** took an integrated landscape approach to knowledge systems. Contrasts and similarities between the resource management

** LUSLOF is a collaborative research project between the World Agroforestry Centre (ICRAF) Southeast Asia, the National Institute for Soils and Fertilizers (NISF) in Vietnam, the National Agriculture and Forestry Institute (NAFRI) of Laos, and the Department of Soil Sciences, the Swedish University of Agricultural Sciences (SLU).The project was funded by the Rockefeller Foundation and ICRAF SEA for the period 2002-2005.*

knowledge of upland communities and scientists and the public perceptions that drive government regulations and actions are the basis for the current situation. Development of sustainable land use practices at farm and landscape levels depends on bridging the various perception and communication gaps. In the past, a one-way communication flow ('extension') was seen as the main way to close this gap. However, two-way interactive, participatory and dynamic approaches are needed for real progress. The LUSLOF project team has made progress in filling gaps in the current approach of natural resource management by building bridges between knowledge domains.

This booklet presents a number of approaches and case studies in the uplands of Vietnam and Laos and hopefully contributes research methods and topics that can inspire further progress for Integrated Natural Resources Managements (INRM) in Vietnam, Laos and elsewhere.

Meine van Noordwijk,
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Chapter 1 of this booklet is a synthesis of findings from the workshop 'From Sustainable Farming Systems to Sustainable Landscapes- Local and Scientific Knowledge for Food Security within Rural Development'. It was compiled by van Noordwijk, M., Hoang Fagerström, M.H. and Le Duc Ngoan.

Chapter 2 is a revised version of the article 'How to combine scientific and local knowledge to develop sustainable land use practices in the uplands - A case study from Vietnam and Laos' by Hoang Fagerström, M.H., Tran Duc Toan, Sodarak, H., van Noordwijk, M. & Joshi, L. The article appeared in the proceedings of the NAFRI Upland Workshop Resource, Laos.

Chapter 3 is a revised version of a working paper of ICRAF SEA, by Hoang Fagerström, M.H.

Chapter 4 is the synthesis of an MSc thesis at SLU by La Nguyen

Chapter 5 presents the approach and findings of the FFS activities of the LUSLOF project and the ACIAR project at NISF. This chapter was drafted by Nguyen Cong Vinh, Le Xuan Anh and Hoang Fagerstrom, M.H.

Chapter 6 is a revised version of the article 'Are bamboo-based agroforestry systems sustainable land use options for the uplands of Hoa Binh Province, Vietnam?- An example of a Knowledge-Based System (KBS) approach with market integration' by Hoang Fagerström, M.H; La Nguyen, Roshetko, J.M., Tukan, C.J.M., Tran Dang Tuan, Tran Duc Toan, Nguyen Duy Phuong & Le Xuan Anh. The article appeared in Tran Duc Vien (editor), 2004. Agroforestry Management in Vietnam's Uplands: Marketing, Research and Development'. Pp 355 - 378. Nha Xuat Ban Nong Nghiep.

In Memory of Nguyen Van So,

the Inspirator of Agroforestry Education in Vietnam

Shortly after the national workshop in October 2005 at the Nong Lam University, we learnt with great sadness that Mr. Nguyen Van So, Vice Dean of the Faculty of Forestry, suddenly passed away. His long term commitment to agroforestry in Vietnam, his sense for collaboration across disciplines, cultures and nationalities as well as deep knowledge of the realities of farmers and agroforesters earned him great respect among the research and development community in Vietnam. His inspiration is reflected in colleges and universities throughout Vietnam as he achieved to make agroforestry a respected part of curricula and teaching materials. We dedicate this Array of Field Methods to his lasting memory.

2 The Integrated Landscape Approach to Achieve Sustainable Landscapes with Healthy Farms - A Case Study of the LUSLOF project

There is a need for methods that quantify effects of land use change across a hierarchy of scales. By using a landscape approach, on-site and off-site impacts of land use changes can be mapped. We believe that much of the toolbox developed previously for plot level monitoring and modelling has value at the landscape scale as well. Some such methods were packaged within an Integrated Landscape approach to study land use options and their potential impacts, aiming at the development of sustainable land use options for food security (Fig. 2.1).

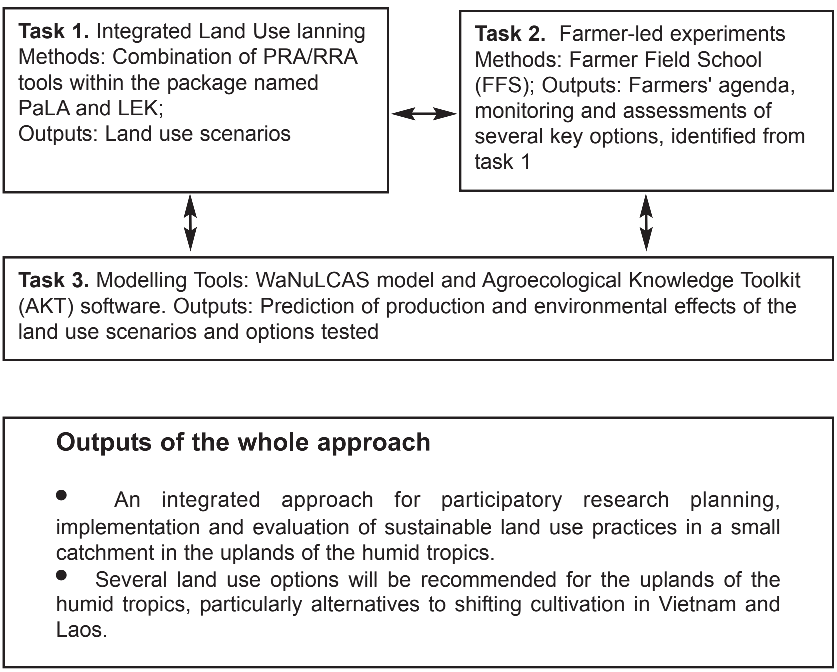


Fig. 2.1. *The integrated landscape approach for development of sustainable land use, tasks and their methods and outputs (WaNuLCAS: Water, Nutrient and Light Capture in Agroforestry Systems; PaLA: Participatory Landscape Analysis; LEK: Local Ecological Knowledge).*

The approach was tested by the LUSLOF project in the Dong Cao catchment (20 58'N, 105 29'E, 60 km from Hanoi), Hoa Binh province, Vietnam, and in Pakou district, Luang Prabang (20 N, 105 E), Laos (Table 2.1 and Fig. 2.2) during the period 2002-2004.

Table 2.1. Some characteristics of the study sites

Study sites	Ethnicity	Average temperature and rainfall	Elevation (m asl), slope	Main soil types	Main land use types
Dong Cao village, Hoa Binh[5,6]	Muong, Kinh	25°C 1500 mm/y	100-700, 15°-40°	Acrisols	Forest and upland crops
Pakchae village, Luang Prabang	Leue	25 °C, 1400 mm/y	320-800	Luvisols	Forest and shifting cultivation

Fig. 2.2. Map of northern Vietnam and Laos, with the study sites marked with red spots (Map by David Thomas).

In the Dong Cao catchment (46 ha), the methods employed to develop land use options were: (i) Field measurements of erosion on a catchment scale (Fig. 2.3); (ii) Application of Participatory Rural Appraisal/Rapid Rural Appraisal (PRA/RRA) tools for the Participatory Landscape Analysis and gathering Local Ecological Knowledge

(Chapter 3); Computer simulations using the WaNuLCAS model (Chapter 4); the Agro-Ecological Knowledge Toolkit for Windows - WinAKT 4.06 for analyses of the LEK[7] gathered, simple household economy analysis - HEA (Chapter 4); Farmers Field School - FFS (Chapter 5) and Rapid Market Appraisal - RMA (Chapter 6).

Fig. 2.3. *Field measurements of erosion on a catchment scale (Carried out by the Managing Soil Erosion Consortium - MSEC Vietnam and IRD).*

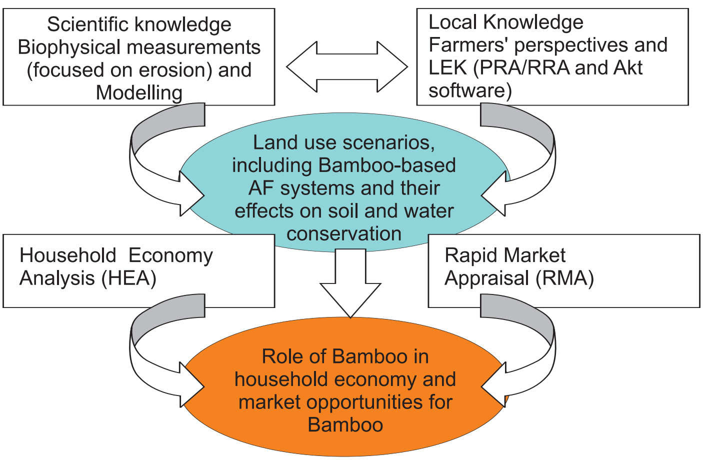


Fig. 2.4. *Research steps and tools used by the LUSLOF project in Hoa Binh province, Vietnam.*

The plot level analysis (LEK and WaNuLCAS) was embedded within a landscape framework provided by the Participatory Landscape Analysis for evaluation of conservation effects. Household economic and market surveys at farm and village scale were used for studying possibilities and constraints of food security, in connection with markets, for the local farmers (Fig. 2.4).

At the Luang Prabang site, the methods employed were field measurements of the effects of improved thinning and pruning techniques on teak in on-farm experiments, PaLA, LEK and RMA surveys. More details about the applied PaLA, WaNuLCAS, simple HEA, RMA, and FFS within the LUSLOF project are presented in the next chapters.

Several filter species were identified, but the focus of the research was on the most promising bamboo-based AF systems in Hoa Binh and the most relevant tree (teak, *Tectona grandis)* in the Luang Prabang landscape.

The findings showed that bamboo-based agroforestry systems are the most promising land use practices in terms of food security and conservation, compared to other tree-based AF systems. The systems provided farmers' households with products and cash (selling stems and bamboo shoots) all year round. Sustainability of different bamboo types in different landscape units was mapped. This finding provides a good basis for recommendations to intensify the bamboo-based AF systems to meet the increased market demand for bamboo as a raw material for furniture and handicraft in both national and international markets.

The findings from the application of the similar landscape approach in Luang Prabang, Laos, showed that improved practices such as thinning and pruning gave better teak wood quality and yield. Teak wood quality provides good opportunities for farmers to get better income if a possibility to sell direct can be created between local teak growers and the Wood Processing Unit (WPU). The entry point for improving food security for the teak growers, therefore, should be policy and regulations, where the direct market between the growers and the processors can be obtained. Since teak is better than shifting cultivation (one of the most common land use systems in the uplands) in terms of soil erosion control, promoting teak growers through better incomes will also improve the environment.

The landscape analysis highlighted in the two case studies in Hoa Binh province in Vietnam and Luang Prabang in Laos proved to be dynamic and system-based. With characteristics such as process-orientated, open-ended, interactive research processes at various scales (plots, landscape, farm, community) the approach allowed high participation from various stakeholders during design, development and dissemination of sustainable land use practices for sloping lands.

3 Participatory Landscape Analysis (PaLA). An Approach for Land Use Scenario Development

3.1. Background

The first ideas for PaLA (Participatory Landscape Analysis) were developed during 1997-1999 on the Loess Plateau in northern China within an EU funded project named EROChina. The approach was an important part of Integrated Participatory Conservation Planning (IPCP) at catchment level*. The objective was to involve farmers as research partners in the whole conservation planning process in order to define relevant alternatives for sustainable land use. The method was developed further within the LUSLOF project in Vietnam and Laos during 2002-2003 and was then named PaLA. PaLA was designed through packaging some appropriate Rapid Rural Appraisal /Participatory Rural Appraisal (RRA/PRA) tools/methods to capture local knowledge at temporal and spatial scales. This was in order to study farmers' perception on the lateral flows and internal filter functions in the landscape, as well as to understand farmer's management options and the actual choices made.

3.2. PaLA process in Dong Cao catchment

During the PaLA survey, farmers' perceptions of current land use, both in time and space, and visions for land use change were investigated using a 3D village model, a village sketch with local names, transects and timelines. We started with the current land use and plot level (village sketch/model). Then we continued at landscape level (transect). For each plot, we looked back in history and forward to find farmers' visions for changes. Starting with simple questions such as What, Why, When and How, in-depth exploration followed in the open-ended interviews.

The research team consisting of three Vietnamese and three Swedish researchers and students, who worked in parallel in the field during nine days. Of those days, five were spent in the field together

* *The method was published in the journal "Catena", special issue volume 54, 2003 (www.elsevier.com/locate/catena)[8].*

with 14 selected local farmers and four were used for indoor work (Table 3.1, Fig. 3.1 and 3.2). Brainstorming was the main tool for the team dynamics and interactions during the whole survey.

All concepts, definitions and methods were discussed and agreed upon by the team members. Rapid Report, where all information obtained during the day was written in a structured form, was completed after each fieldwork day, to make sure that the information gathered was properly documented. The method and checklist to be used for the next day was also agreed upon.

Fig. 3.1. *Team dynamics during the indoor sessions (Photo: Dan Olsson, 2002)*

The open-ended interviews used were aimed at an equal partnership between the team members and the farmers involved. Feedback from the local farmers was asked for during the whole research process.

Fig. 3.2. *Fieldwork and feedback to farmers (Photo: Dan Olsson, 2002).*

Table 3.1. The research steps and outputs of PaLA in Dong Cao

Step	Time	Objectives/ Activities	Methods	Outputs
1	1 day	Development of criteria for the selection of study village and key farmers[7] Study of the village selected in advance using topographical map	Review of relevant reports and maps	Study village selected and criteria for selection of farmers
2	1 day	Introduction to the study with village leaders. The village leaders selected key farmers according to the criteria developed	Group meeting and discussion	Key farmers selected
3	1 day	Team building and dynamic introduction to PaLA	Brain-storming	Concepts and steps of PaLA and village sketch agreed upon by the team
4	1 day	Identification of the land use patterns and focus points in the landscape	Semi-structured interviews with male and female groups for making village sketch/ model	Village sketch/model, showing local names of different areas, distribution of land use plots, and main features such as rivers, streams, mountains, roads, etc.
5	2 days	Understanding the soil-plant-water interactions along a landscape	Transect walks and semi-structured interviews.	Representative transects and sketches of the areas, locations of transects entered on map
6	1 day am	Understanding the land use changes over time	Semi-structured interviews Timelines	Timelines drawn for each field along a transect or/and the fields situated in the representative areas of the catchment
7	pm	Findings reported to the farmers involved to get feedback	Poster using visualised tools Group meeting	Findings confirmed by the farmers involved
8	2 days	Data analysis and Rapid Report Writing	Teamwork	Draft report

3.3. The PRA/RRA methods and tools used during the PaLA process

3.3.1 The main criteria for selection of the study village

The criteria for selecting a study village were that it should be (1) diversified in land use types due to diversified landscape forms; and (2) dominated by farmers with profound knowledge about land use, i.e. the village should have existed for a long time. The key farmers should have experience in cultivation, be currently working with farming and have their plots spread in different landscape units. Two groups of farmers were selected for the survey, one male and one female group. Each group consisted of 7-10 persons. It was shown that farmers' knowledge was generated mainly at plot level. However, dialogues with groups of farmers having their plots spread over the whole village and in different landscape units generated a picture of soil-plant-water interactions at a landscape level.

3.3.2. Method for making village sketch/model

1. Ask the location of the different land plots of each household and put into the basic village sketch with local name of different areas. (plot sketch)

2. Ask the farmers who own fields in different local areas the following questions:

- Which local area is best for cultivation? Why is it good? Try to ask many "whys" to get more reasons/knowledge.

- Which local area is worst for cultivation? Why is it bad? Again, try to ask many "why" questions to get more reasons/knowledge.

The village model was structured as follows: a map with local names was used as a basis so that the farmers could organize and model different areas. Boundaries of the catchment and the gully network were drawn with chalk on the ground. The local names of areas and the homesteads were marked with pieces of paper. A three dimensional model, 1 by 2 m, was constructed by farmers. The materials used were stones to represent bedrock, a soil/water mixture for topography, leaves for woodland and crushed chalk of different colours to show the land use. On another similar model, the farmers indicated the direction of surface runoff during heavy rainfall by placing sticks that were coloured at one end. By using different numbers of sticks, they could also indicate the amount of surface runoff. From these models, two map sketches, describing land use and surface runoff, were drawn (Fig. 3.3).

***Fig. 3.3.** Local farmers making village model (left) and the finished sketch (right) (Photo: Dan Olsson, 2002).*

3.3.3. Method for transect walk

1. Preparation:

a.Select local areas, representative for the whole village/catchment in terms of combinations of different types of land use along a landscape gradient. This can be done using the village sketch and with help from farmers involved.

b.Select the farmers who have fields in the selected representative areas and ask them to join you on the transect walk next day.

2. Transect walk:

c.Ask farmers to guide you to their plots all the way from the foot of the hill to the top. Draw a transect along the path to go up to the top of the hill. Each plot belonging to one owner and having a homogeneous land form and land use type will form one section of the transect (Fig. 3.4).

d.Describe each section in terms of owner, land use, soil, vegetation, water, human impact, slope, length, etc. as you walk. NB! Do not forget to describe the borders between the sections.

***Fig. 3.4.** Transect walk (Photo to the left: La Nguyen, 2004; photo to the right Minh Ha Fagerström, 2002).*

3.3.4. Method for making timelines

1. Draw a line, start with the present at the right part of the line.
2. Ask the plot owner "What did you plant last year on this particular plot?" Please ask for as many years back as the farmers can remember. Put the information on the timeline.
3. Ask the plot owner "What do you plan to plant next year in the plot?" Ask for some years ahead and put on the line.

We showed the timeline to the farmers being interviewed when drawing it and asked for feedback from them, i.e. whether it was correctly drawn or not.

3.3.5. Qualitative data analysis

From the sketch map, timelines and transect walks, a land use map for Dong Cao catchment was compiled using MapInfo 6, Geographical Information Systems (GIS) software (Fig. 3.5).

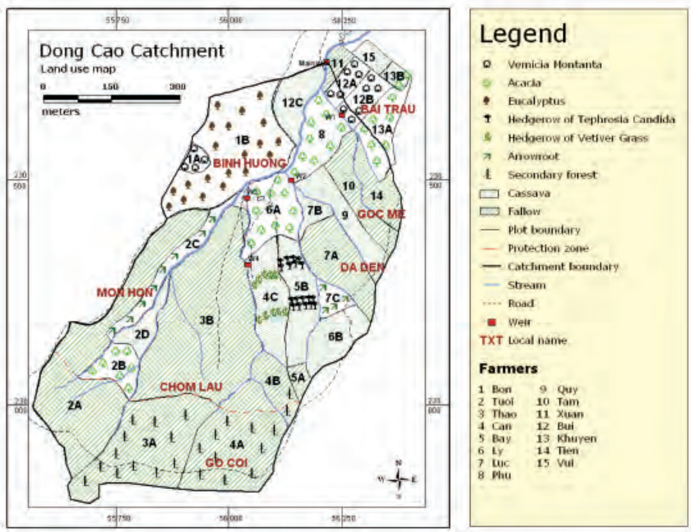


Fig. 3.5. *Simple GIS map of Dong Cao catchment with local names of the fields and list of owners.*

Basic map data, such as catchment boundary, topographical contours, roads, weirs and rivers, were made available in MapInfo-format from the MSEC (Managing Soil Erosion Consortium). These data were geocoded, i.e. scale and coordinate systems were also retrieved from MSEC. Land use data were then digitized as polygons into a new layer using screen digitizing. These symbols were multiplied and edited onto the corresponding fields. Separate layers were also created for local names and field names. The polygons were given different patterns corresponding to their land use. To make a more visually attractive map, symbols were created to describe some types of land use, *e.g.* trees (Fig. 3.5).

A surface water flow map was also produced using MapInfo 6 and the same basic data as mentioned above. The source for this map was the surface water runoff model of the catchment retrieved during the PaLA survey. Land use pattern was identified by matching the transects as well as the timelines drawn. The timelines of all fields 1-15 (GIS map in Fig. 3.5) were later put together in one timeline (Table 3.2). The GIS map and the timeline were then used as tools to facilitate the discussion on land use scenarios among researchers and between researchers, farmers and/or extensionists.

3.4. The filter and weak points in the landscape as identified by PaLA were subjected for more in-depth study on Local Ecological Knowledge (LEK)

The focus points in the landscape - including the weak point, i.e. the sensitivity to erosion, and the filter, i.e. the strategic water supply area in the catchment - were identified, both in the field and on maps. The characteristics of the filter (Field 3) and the weak point (Field 11, Table 3.2) were described in the GIS map (Fig. 3.5) and the timeline (Table 3.2). We believe that land use scenarios developed for these two focus points in the catchment can make large on-site and off-site impacts. This was reflected in the farmers' knowledge gained during the PaLA: 'More trees in the subcatchment (the filter place) cause higher amounts of water in stream'. Therefore the focus points were then subjected to a more in-depth study on Local Ecological Knowledge (LEK), which later helped to formulate hypotheses and explanations for the outputs of the modelling work (Box 4.4 in Chapter 4). Furthermore, the WaNuLCAS simulation (Chapter 4) and the Farmers Field School (FFS) activities (Chapter 5) were also carried out at these focus places.

During the LEK survey, the characteristics of the focus points, including their soil-plant-water-light interactions in space and time, were studied using timelines, brainstorming techniques and AKT software. Farmers' knowledge was analyzed with respect to their understanding of erosion and filter functions in the landscape.

***Table 3.2. Summary of the timelines of all fields within the catchment*[9]**

		Year 1970 ------------------------1980-----------------------------1990--------------------------------2000
Farmer	Field	Crop
1	1l	Forest 100% Forest 50% Forest 20% Vemicia/Tea Cinnamon
	1u	Forest Vemicia/ *Acacia*/Eucalyptus
2	2A	Forest Maize/Arrowroot/Cass ava Fallow Arrowroot
	2B	Forest Maize/Arrowroot/Cassava Fallow Cassava
	2C	Forest Maize/Arrowroot/Cassava Fallow Cassava *Acacia*
	2D	Forest Maize/Arrowroot/Cassava Secondary forest
3	3l	Forest Maize/Arrowroot/Cassava Cassava Fallow
	3u	Forest Maize/Arrowroot/Cassava Secondary fores t
4	4	Forest Arrowroot ? Fallow Cassava Fallow
5	5	Forest Cassava/Arrowroot Fallow Cassava Cassava/ *Acacia*
6	6A	Forest Arrowroot Fallow Cassava/Vemicia/ *Acacia* Vm./Ac.
	6B	Forest Arrowroot Fallow Cassava
7	7A	Forest Forest/Arrowroot/Maize Cassava Fallow Cassava
8	8.1	Forest Rice Eucalyptus
	8.2	Forest Cassava
	8.3	Forest Cassava *Acacia*
9	9	Forest ? Fallow Cassava
10	10	Forest ? Cassava/Rice/Taro/Maize ? Cassava/Rice/Taro/Maize Fallow Cassava Fallow
11	11	Forest Rice Cassava Fallow
12	12B	Forest Cassava Fallow Cassav a Vemicia

Fig. 3.6. *The filter point, i.e. water supplier for the downstream of catchment (Sketch and photo by Olsson, D. & Schwan, K., 2002).*

Table 3.3. Transect of the 'filter' place (Field 3. Farmer Mr. Thao, investigators Nguyen and Johan, 2002-06-08)

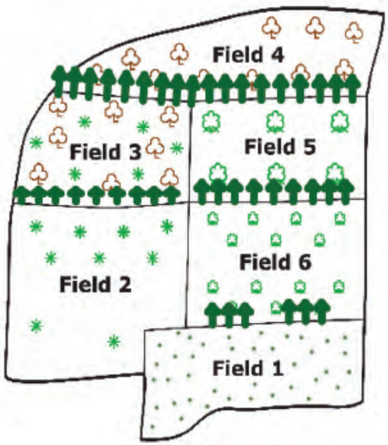
Land use	Old fallow (before 1995) (up hill)	Young fallow (from 1995)	South side: tree plantation (not very dense) of keo (acacia) and trau (vemicia) north side: fallow	Fallow (failed cassava cultivation) (down hill)
Soil	Thick (80-100 cm) topsoil, “more black”, moist, very much earthworm activity, dense litter layer	Topsoil 30-50 cm thick, brown-red, light clay, quite moist, much earthworm activity, good litter layer	Topsoil depth varies from 50 cm to 0 (visible bedrock in exposed places), drier than fields above, less earthworm activity, thin litter layer	?
Topo-graphy	Approximate altitude 460-690 m, slope 45° (convex)	400-460 m 30° (concave)	310-460 m 45° (convex)	270-310 m 30° (concave)
Vegetatio n	Co lau, “special bamboo”, a few bushes and trees, a little co tranh (*Imperata*) leeches (indicate moisture)	Co hoi/cut lon (indicator of good soil), cuc ao (white flower)	Cuc ao	Short (grazed) grasses
Water	Rain infiltrates into the soil and goes out in the streams on the sides of the hill, no surface runoff	All infiltration, no surface runoff (same as old fallow)	Surface runoff in part of the field that was prepared for cassava this year	?
Ero-sion	No erosion	No erosion	Obvious rill erosion in the land-prepared part	?
Human impact	Not much		The land was used for cassava until 2000. The field on the northern side was used by a relative from another village during 1996-2001; it is separated by a ditch and rows of *Tephrosia* and *Vemicia*.	A ground ditch and a fence separate this land from the field above
Other	This fallow would be ready for cultivation, but the land is within the protection zone and its use is restricted.	The fallow will be ready for cultivation when there is a thick, ~1 m high grass/ herb cover (*e.g.* co hoi)	A paper company provides *Acacia* seedlings and fertilizer; the farmers pay back when they harvest the trees after seven years. Many of the acacia seedlings have failed, however.	Cassava was planted this year but destroyed by buffalo

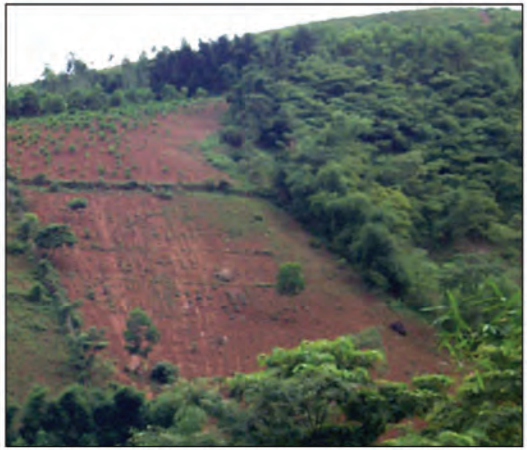
Table 3.4. Transect where the 'weak' point is situated

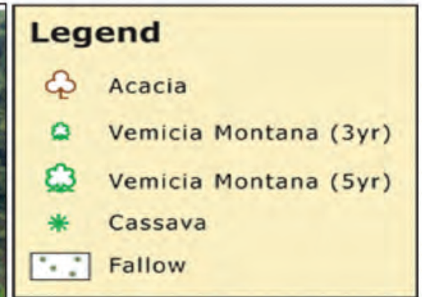
Conducted by Hai & Dan 2002-06-08 in Dong Cao catchment, Hoa Binh province, Vietnam. Participating farmers: Tam, Xuan.

Section	1 (up hill)	2 (next to the top)	3 (middle part)	4 (down hill)
Length	300m	200m	100m	150m
Topography	Slope: 25-30 deg Shape: convex	Slope: 25 deg Shape: straight then sloping	Slope: 20 deg Shape: homogeneous	Slope: 10-15 deg Shape: homogeneous
Soil	Soil moisture: high Soil colour: yellow Soil texture: loam	Soil moisture: high	Soil moisture: high	Soil moisture: high Soil colour: red/brown Big stones "Bad" soil because of erosion
Vegetation	Fallow: Grasses (badao, caype, cho de, co xuoc) of different height 40-120 cm, some bushes, some acacia- and cay mua trees.	Grasses: ba dao, cho de.	Grasses: ba dao, co xuoc, chode. Trees: Trau	Low grasses: ba dao, co xuoc, co hoi, only about 75 % cover. Trees: Xoan
Water & erosion	Serious erosion during heavy rainfalls.	Serious erosion during heavy rainfalls.	Serious erosion during heavy rainfalls.	Serious erosion during heavy rainfalls. Water comes down from the field above. Lots of visible stones of all sizes. Visible bedrock.
Human impact	Ditches, fences to prevent cattle.	Ditches, fences to prevent cattle.	Ditches, fences to prevent cattle.	Terrace where house used to be.
Owner	Tam (Field 10)*	Quy (Field 9)	Bui (Field 12)	Xuan (Field 11)

*****_The fields shown also in the GIS map (Figure 3.5)_







Farmers
Ms. Xuan (the most eroded part), Mr. Vui, Mr. Khuyen
Mr. Bui

Fig. 3.7. *The most eroded part of the catchment with a bamboo hedgerow on the border between fields - the weak point in the landscape (Sketch and photo by Olsson, D. & Schwan, K.)*

3.5. Land use - Erosion Interactions - Farmers' perceptions and knowledge gathered through PaLA as a complementary tool to the scientific erosion measurements

Land use changes in different landscape units in the Dong Cao catchment during the last 30 years were recorded (Table 3.2). Planted trees were mainly Acacia mangium, Cinnamon spp., Eucalyptus spp. and Vernicia montana, which had been planted at different places in the catchment during the last two years. It was found that the high amount of bed load (sediment amount measured at the weirs) did not reflect the effects of the current land use only, but also previous changes in land use (Fig. 3.8). For example, zone 1 (the lower part of the catchment) was the most eroded part due to a long period (30 years) of intensive monocropping of cassava in some fields. The intensive cultivation may be a result of the easy accessibility of this zone. Free grazing was another factor contributing to the high level of erosion in this zone.

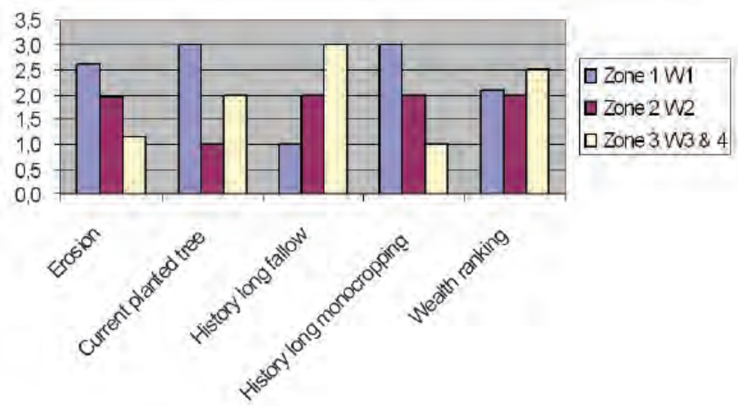


Fig. 3.8. *Matching between erosion measurements and the Participatory Landscape Analysis (PaLA); the data on the Figure are ranking scores; W = gauged weirs, where erosion was measured by MSEC/IRD Vietnam.*

On the other hand, zone 3 (the upper part of the catchment) had a smaller number of planted trees compared to zone 1. However, due to the long history of fallow (16 years), the erosion was less than in zone 1. This shows that the planting of trees may have a retarding effect on erosion, but it takes some time before the effect becomes apparent.

Different ways of cultivating *Cassava* affect the erosion differently. Cassava in a rotation with long fallow (taungya system) did not lead to obvious erosion hazards. The reasons for planting *Cassava* or trees did not seem to be connected to the household economy, since both rich and poor farmers planted *Cassava.*

The main factors behind the farmers' decisions seemed to be (1) land quality, (2) imitating their neighbours, (3) the economic benefit of the species and (4) the need for *Cassava* in the taungya system (*Cassava* was considered by farmers to both protect young trees from cattle grazing and trampling and to suppress weeds).

3.6. Role of trees for soil and water conservation - Formulation of hypotheses for simulation work based on LEK and PaLA

When asked about their visions for land use change, the farmers in the Dong Cao catchment mentioned the planting of trees. The role of trees in 'absorbing' and 'releasing water', as well as in providing 'soil softness and dark/fertile soil' was mentioned by the interviewed farmers. Using *Acacia mangium, Vernicia montana,* and *Bamboo spp., i.e.* the most common woody species in the Dong Cao catchment as examples, the farmers explained the mechanisms by which size, colour and density of the leaves, and rooting behaviour of different kinds of vegetation influence soil erosion and soil fertility (Fig. 3.9). Farmers believe that trees retain water during the day and by doing so resist heat from the sun.

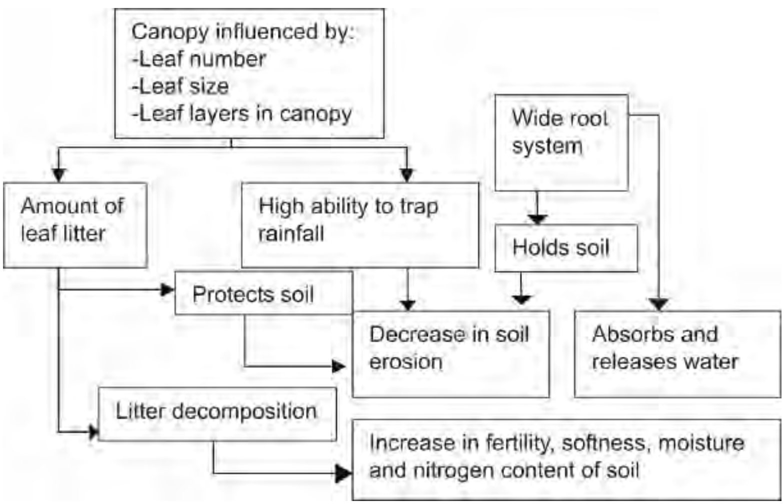


Fig. 3.9. *Dong Cao farmers' understanding of the role of trees in soil erosion and fertility*[7]*.*

The presence of bamboo hedgerows slows the downward movement of soil and the fine and wide spreading roots keep the soil from being washed away. Likewise, leaf litter covers the soil and also absorbs rainwater. Tree crowns also reduce splash erosion by intercepting raindrops before they hit the soil. Where vegetation functions as a living fence along the lower boundaries of the fields, good soil can be retained in the field. Dong Cao farmers perceive that tree roots actually release water into the soil and that leads to a higher and continuous water flow in the streams. The more trees there are in the catchment, the higher the uniformity of water flow and its discharge volume in streams.

Farmers regard bamboo as a very good hedgerow plant along field boundaries. In addition to preventing animals from moving into the field, bamboos trap and retain soil through their dense clumps (locally called boi) and their far-reaching and dense roots. Bamboo stems also reduce water runoff. However, farmers claim that the extensive and fine roots of bamboo also absorb or 'eat' soil fertility, and thereby significantly affect annual crops in its vicinity.

Hypotheses were formulated, based mainly on the farmers' perspective and knowledge collected, and used for the simulation work. This was done in order to predict long-term soil and water conservation effects of tree-based land use options associated with a low cost, *i.e.* no need for long-term erosion measurements. Some examples of such hypotheses are:

For the weak point in the catchment (Table 3.4 and Fig. 3.7):
- Bamboo hedgerows prevent erosion better than *Acacia mangium and Tephrosia candida* hedgerows.
- Improved fallow of T. candida (2 years) in rotation with cassava (2 years) prevents erosion better than bamboo hedgerows intercropped with Cassava

For the strong point in the catchment (Table 3.3 and Fig. 3.6):
- Trees conserve water for the whole catchment.
- Acacia and bamboo species are better than weeds/short natural fallow and monocropping at water conservation.

4 WaNuLCAS Modelling as a Tool for Evaluating Land Use Scenarios

4.1 WaNuLCAS as a tool to predict filter effects

WaNuLCAS (Water, Nutrient and Light Capture in Agroforestry Systems) is a simulation model of tree-soil-crop interactions at plot level, using daily time steps. Spatially, WaNuLCAS represents a typical slice of an agroforestry system as a grid of four horizontal zones with four layers of soil (Fig. 4.1). Zones 2 and 3 are for crop cultivation and zones 1 and 4 can host both trees and crops. The WaNuLCAS model[10] consists of an Excel workbook for parameter libraries and input choices and a dynamic model using the Stella™ software.

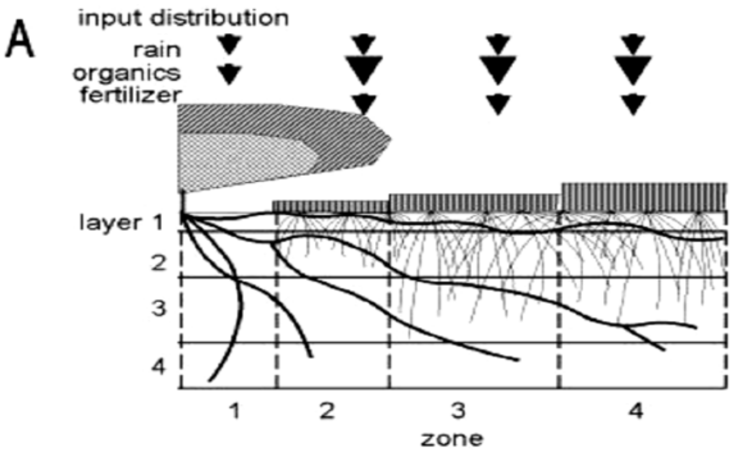


Fig. 4.1. *General layout of zones and layers in the WaNuLCAS model[10].*

This biological model is useful for researchers who are not very familiar with modelling but who want to use the model as a tool for exploring the abilities of different agroforestry systems before they carry out field experiments. Another use of the model is to estimate the effects of different agroforestry systems over longer periods relatively quickly. It can also be useful for modellers who want to edit or add new findings within tree-soil-crop interactions.

The filters preventing run-off and erosion in an area can look very different, which makes it crucial to define and highlight both the weak and the strong points in the field before designing the simulation scenarios for the model. Most often the filter is some kind of perennial tree, shrub or grass. With the model it is possible to simulate and compare different scenarios by changing distances and widths between the highlighted filters and also changing species within the filters.

WaNuLCAS has more than 300 different input parameters that can be adjusted for the site-specific conditions. The outputs relate to both environmental and economic aspects of the agroforestry system. This allows the model user to compare different agroforestry systems in ways that are difficult in field experiments.

4.2 Vietnam case study - Application of WaNuLCAS Modelling as a tool for evaluating land use scenarios at landscape level

The five research steps are illustrated in Fig. 4.2 and explained as follows:

(1) During the PaLA survey (Chapter 3 and the red boxes in Fig. 4.2) the following activities were carried out for use in the WaNuLCAS work: (i) Land use patterns and agroforestry systems in different landscape units (Fig. 4.3) were defined and representative agroforestry systems (current and future options) selected for the modelling. (ii) Weak and strong points in a landscape were identified, where the input collected for WaNuLCAS parameterization was to be treated.

A Local Ecological Knowledge (LEK) survey using PRA/RRA tools and the Agroecological Knowledge Toolkit (AKT) was carried out directly after the PaLA survey to contribute to the WaNuLCAS work with the hypothesis about ecological advantages and disadvantages of species, including *Bambusa blumeana, Acacia mangium* and *Tephrosia candida* found during PaLA. This, together with the review of relevant experiments data, helped to formulate hypotheses as well as to judge the outputs of the modelling (blue boxes in Fig. 4.2).

(2) During the WaNuLCAS survey, information concerning one bamboo species *(Bambusa blumeana), Acacia mangium* and *Tephrosia candida* was gathered. Field measurements were performed to obtain above- and below-ground growth parameters as well as soil physical parameters, which were necessary for the modelling work. The parameters of species were adjusted to give reasonable model outputs compared to observed growth and biomass values (yellow box in Fig. 4.2). An example of parameterization of bamboo species is given in Box 4.1.

(3) Site-specific input data, such as soil physical properties in weak and strong points (defined from first step, see Chapter 3) and tree and crop species parameters were compiled. The WaNuLCAS model contains a tree and crop library in which information about some already parameterized trees and crops is collected. From the information in the library, WaNuLCAS calculates values that are needed as input data when performing simulations with the chosen tree/crop combination. Depending on the local conditions, the parameter data first have to be collected. All input data must be put into the WaNuLCAS model in order to calibrate the model. These, together with parameter values obtained through the surveys, are needed to run the WaNuLCAS model (red boxes in Fig. 4.2). The input parameters to WaNuLCAS are given in Box 4.2.

(4) WaNuLCAS simulation: Site-specific simulations were performed in order to obtain model outputs from different cropping systems on water balance and water runoff, which were further interpreted in terms of erosion. For more details about the scenarios used in the simulation, see Box 4.3.

(5) Data analysis and synthesis: The output from WaNuLCAS simulation was analysed and compared to the findings from the LEK survey and experimental data in Northern Vietnam to evaluate the reliability of the model (green and blue boxes in Fig. 4.2). The validation of the simulated data is given in Box 4.4.

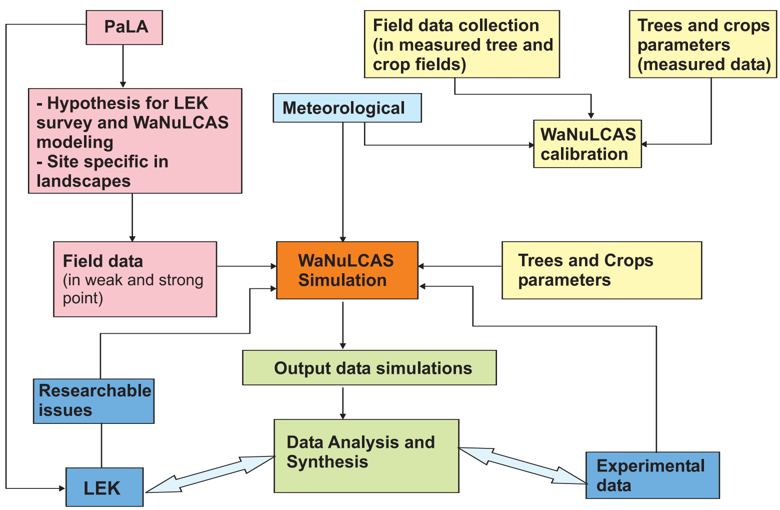
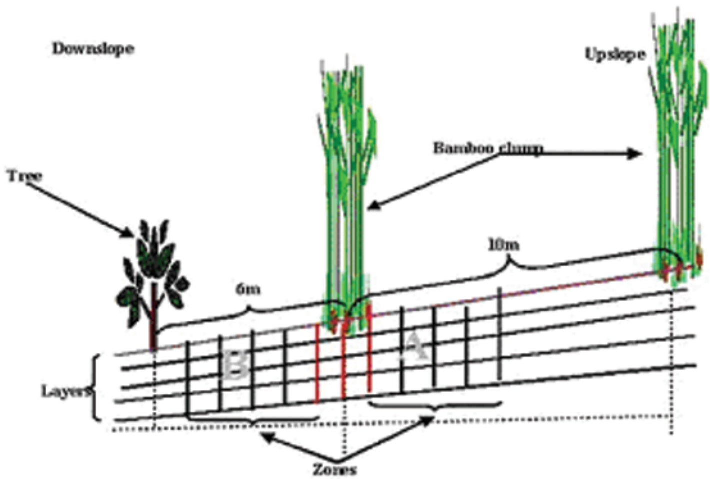


Fig. 4.2. *Research steps when working with WaNuLCAS (Case study in Dong Cao catchment).*

Box 4.1. Parameterisation of bamboo using WaNuLCAS



To prepare data for bamboo parameterizations specific data such as slope, soil texture, bulk density, surface infiltration, soil layer thickness and available phosphorus were measured and analyzed. Soil samples for texture and chemical analyses were collected in the soil profile.

Above-ground biomass was measured for bamboo in the field. These data were compared with the predicted data, which were obtained in the simulations and used to calibrate the bamboo above-ground parameter values. Root-length and -densities were measured and added into the WaNuLCAS model as tree below-ground parameters.

Box 4.2. Input parameters to WaNuLCAS obtained through the survey

The input parameters were collected and put in a WaNuLCAS model for further simulations. The simulation outputs such as runoff, soil loss, water infiltration and water intercepted by the canopy were used to define the filter effects of different woody species and agroforestry systems.

Climate data		Amount of rain per day
		Daily maximum rain intensity
		Daily air temperature
Field data		Slope
Soil data	In Excel	Percentage of clay and silt
		Percentage of soil organic matter
		Bulk density
	In Stella	Surface infiltration
		Soil layer thickness
Tree, crop data	Tree library	Parameters for bamboo, *A. mangium* and *T. candida*
	Management	Planting date for cassava and the woody species

Box 4.3. WaNuLCAS simulation and outputs

4.3.1. The scenarios simulated at the weak and the strong points in the landscape

At the weak point (most eroded part) of the catchment, six representative agroforestry systems, divided into three groups according to spatial/temporal structure, were identified as possible filters and used in the model simulations. They were: Taungya system (BambooTau, AcaciaTau), Hedgerow system (BambooHed, AcaciaHed, TepHed) and Fallow crop rotation system (TepFa)[11]. The distances between two hedgerows in the BambooHed, AcaciaHed and TepHed systems were 66, 8 and 6 m, respectively[11].

At the strong point (filter part), simulations were made for three different cropping systems; (1) monocropping cassava, (2) cropping cassava with hedgerows of Tephrosia candida

(TepHed) and (3) cropping cassava with hedgerows of *Bambusa Blumeana* (BambooHed). In the hedgerow systems (2) and (3), predictions were made with different distances between hedgerows, in order to test whether the distance between the tree rows affected the runoff and soil loss. The set-up in the BambooHed system included the distances of 20, 30 and 40 m, while the TepHed consisted of 6, 20 and 30 m[12].

4.3.2. The output from simulation work

At the weak point, the TepHed gave higher runoff compared to BambooHed and AcaciaHed. The BambooHed system prevented erosion better than TepFa. The runoff was similar between BambooHed and AcaciaHed and lower than TepHed.

At the strong point, the BambooHed generated about the same runoff but less soil loss amounts as the cassava monocropping system. TepHed generated lower quantities of runoff than the BambooHed but generally much greater quantities of soil loss than both the monocropping and Bamboo systems[12].

The different effects of BambooHed and TepHed at the weak point and at the strong point can be explained by the physical properties of the soil in the two places. The fields in the weak point were more intensively cultivated than fields in the strong point. The infiltration was higher in the filter and therefore the soil was less sensitive to erosion compared to the fields in the weak point. The outcome seemed to be that BambooHed is more effective in preventing runoff in the place that is sensitive to erosion.

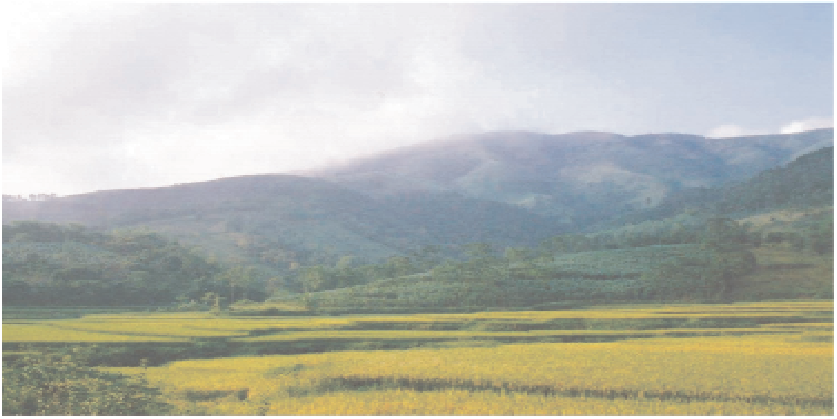


Fig. 4.3. Landscape of simulation area (Photo: La Nguyen).

Box 4.4. Validation of simulated data at the weak point in Dong Cao catchment using experiment data and Local Ecological Knowledge (LEK)

A comparison was made between the simulated results of the weak point and data from field experiments conducted at other sites.

Data from	Simulation	Experiment[13]			
Sites	The weak point in Dong Cao catchment	Ba Vi		Hoa Son	
Slope	22%	10-30%		10-30%	
Rainfall	1900 mm				
		Year	Rainfall (mm)	Year	Rainfall (mm)
		1990	999	1992	768
		1991	1143	1993	977
		1992	476	1994	1901
		1993	886	1995	1051
		1994	2103	1996	2015
				1997	1613
				1998	652
Runoff compared to rainfall	BambooHed: 7% AcaciaHed: 10% TepHed: 14%	Hedgerow systems: 5-20%			

The simulated runoff from the BambooHed, AcaciaHed and TepHed systems at Dong Cao was within the range of the experimental data reported by Nguyen Tu Siem and Thai Phien[13]. It seems as if the simulated run-off at Dong Cao was fairly reasonable[11].

The findings from simulation seemed to agree with farmers' knowledge. The farmers reported many positive effects from bamboo. The presence of bamboo hedgerows, for example, slowed the downward movement of soil and the widespread fine roots kept the soil from being washed away. Moreover, leaf litter covered the soil and also absorbed rainwater. The bamboo canopy reduced splash erosion by intercepting raindrops before they hit the soil. Where vegetation functioned as a living fence along the lower boundaries of the fields, good soil could be retained in the field. Farmers considered bamboo to be a very good living fence along the field boundaries. In addition to preventing animals from moving into the field, bamboo trapped and retained soil through its dense clumps and their far-reaching and dense root system. Bamboo stems also reduced water runoff[7].

5 Application of Farmer Field School (FFS) in Resource Management for Sustainable Land Use in Vietnam

5.1 Introduction

The first farmer field schools (FFS) by that name, conducted in 1989 in the rice fields of Indonesia, had a specific focus, which was Integrated Pest Management (IPM). The increase in popularity of the FFS and its spread over the past decade have been remarkable. In the 1990s, the Vietnamese National IPM Programme scaled up and launched more than a thousand FFS in the whole country for growing rice, vegetables and other crops.

To transfer research results to farmers, the National Institute for Soils and Fertilizers (NISF) efficiently used the FFS approach in both research and extension work. Examples of the application of FFS by NISF given in this chapter are from two projects, LUSLOF and the project *'Soil Fertility Management for Meeting the Nutrient Requirements of Root Crops in Northern Vietnam'* The latter project was carried out by NISF in collaboration with the University of Queensland during the period June 2001 - December 2003.

5.1.1 Definition and purposes of FFS

Based on the principles of adult education, FFS has evolved to become a distinct approach that builds on the processes of group learning and community action[14]. FFSs have established themselves as a process of social learning, negotiation and collective action by and for farmers and their communities[15]. A Farmer Field School is not about technology: it is about people's development[16]. The purposes of FFS are to:

- Respond to the farmers' identified needs and interests and to learn more about management practices of a selected crop.
- Improve farmers' capacity to analyze their crop management practices.
- Identify the main constraints and test the possible solutions in their fields. Eventually the most suitable practices are identified and can be adopted.

- Provide farmers with the opportunity to learn by doing, by being involved in field experimentation and to thereby develop their ability to make critical and informed decisions that render their farming systems more productive, profitable and sustainable.
- Assist farmers to organize themselves and their communities, and to create a strong network with other farmers, extension workers and researchers. In doing so, the role of farmers in the researcher-extension-farmer chain will be strengthened. Through utilization of the skills developed in local analysis, farmers are enabled to adjust input recommendations or technical packages to suit local conditions.

5.3 FFS application within the LUSLOF project

5.3.1. The principles of FFS

The FFS method applied in the LUSLOF project was based on the assumption that the use of knowledge from relevant stakeholders and close links between research and development are suitable for the development of sustainable land and water management at the catchment level. Sustainability here means enhanced production, conservation of soil and water, and improvement of the economic viability of the farmers. The five principles of the FFS approach were followed (Fig. 5.1).

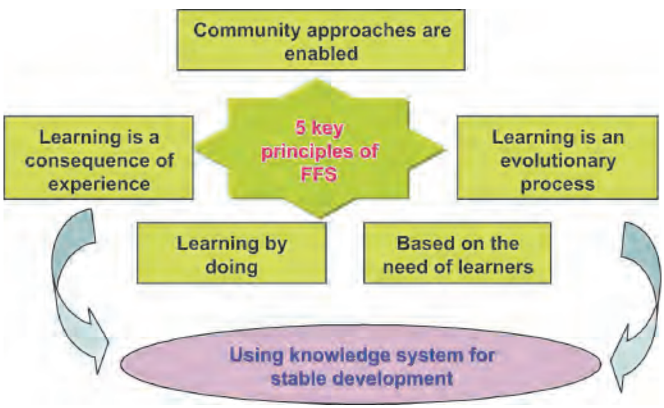


Fig. 5.1. *Five principles of the FFS.*

5.3.2. The Farmer Field School process

The FFS process, including 5 steps (Table 5.1), was carried out during 2003 with facilitation by a researcher from NISF. This was done in dialogue with farmers/landowners, as well as in consultation with researchers from the LUSLOF project, district extensionists, farmers' communities (women's associations, groups of farmers), and communal representatives, such as the representative for the local government (Figure 5.2).

The weak point in the landscape - one of the outputs of the PaLA (Fig. 3.7) - was selected to be the focus place, where negotiation among land users on land use changes was discussed and on-farm experimental plots were set up. By working at the weakest place in the landscape, consensus on the need for changes and suitable options was reached among the stakeholders.

The first topics for FFS were selected based on the need for solutions at the weak point in the landscape. After that, more topics related to solutions for other places within the catchment were identified after visits to different demonstration sites within and outside Hoa Binh province (Fig. 5.3 and 5.4). These visits were organized in accordance with farmers' wishes to learn more to improve their current land use.

Table 5.1. The five steps of the FFS process

	Step 1	Step 2	Step 3	Step 4	Step 5
Aims	To negotiate land use planning	To visit demonstration sites and adjust plans	To present and agree on plan	Negotiation -Site -Investment	Discussion, experiments
Tools	Poster of the PaLA outputs Farmers' group meetings	Field visits	Farmers' workshop	Farmers' group meeting	Indoor discussion, brainstorming and outdoor field work
Time	1 week January	3 days Jan-Feb	1 day 28/2/03	2 days March	4 classes 2003

5.3.3. The activities during classes of FFS

Each class lasted for 1-2 days. It started with indoor activities where group discussion, brainstorming and dialogue between facilitator and learners were the main tools used (Figure 5.5). A half day or a second day was spent in the field (outdoor activities) where farmers practised together at the experimental plots (Figure 5.6).

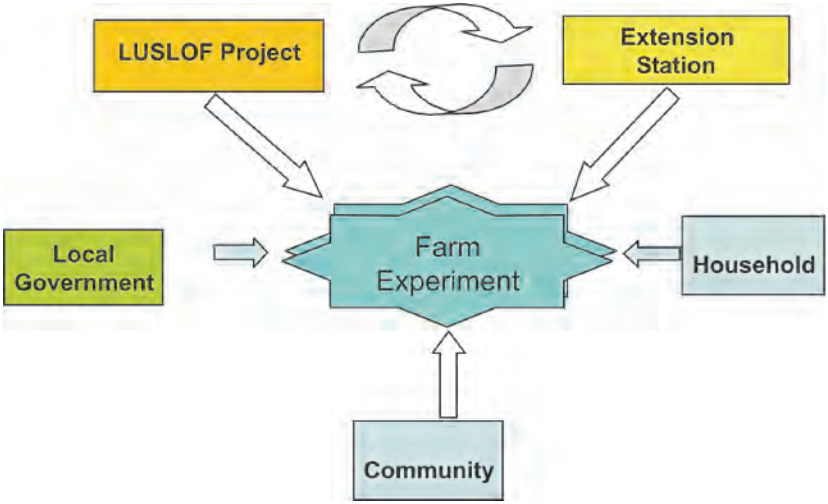


Fig. 5.2. *The stakeholders consulted when on-farm trials were set up*

Fig. 5.3. *A field visit on the effects of hedgerow and mulch of Tephrosia candida on cassava yield to a demonstration site in Luong Son district, Hoa Binh province (Photo: Tran Si Hai, 2003).*

5.3.4. Some findings and recommendations

The FFS during 2003 with local farmers were organized with the purpose of testing the cultivated bamboo species (locally called Tre Bat do) for shoot and soil improvement; the grass species *Brachiaria ruziziensis* and *Stylosanthes guianensis* for fodder and soil improvement; and the small tree/shrub *Tephrosia candida* as a hedgerow to prevent erosion. The species were selected by local farmers and evaluated in the FFS by comparing these 'new' species with local bamboo and grass species in terms of income generation and soil improvement. Land ownership has changed rapidly since 2004 in the catchment. A single entrepreneur - a former extension worker in combination with an investor from Hanoi has taken over most of the land. They have switched most of the catchment to more profitable land uses involving trees and ecotourism. The new land uses, including indigenous trees, grasses for fodder and high economic value crops (e.g. Bat Do bamboo) have replaced some of the cassava and annual crops in Dong Cao catchment as well as in the nearby areas. These changes in land ownership make it difficult to assess the adoption possibility of the options tested among stakeholders involved. The changes in land ownership occurred due to two main factors:

Fig. 5.4. *A field visit to a demonstration site on dairy cows in Ba Vi. This visit was organized in response to farmers' need to plant grass as fodder for dairy cows (Photo: Le Xuan Anh, 2003).*

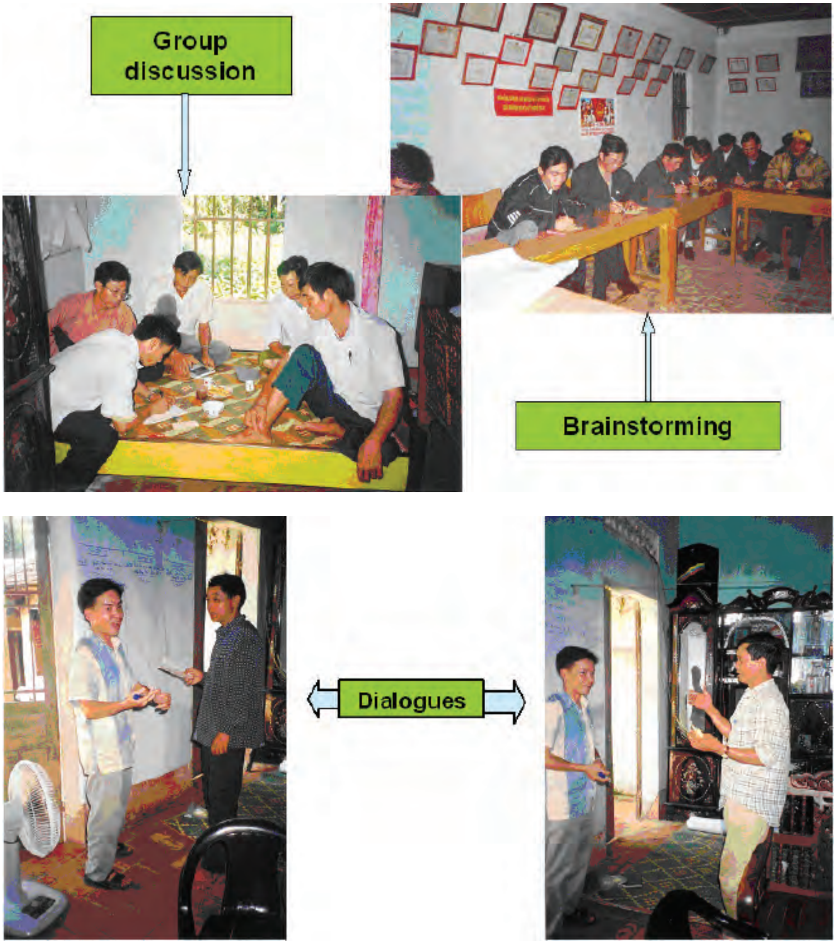


Fig. 5.5. Group discussions, brainstorming and dialogues during the FFS classes (Photo: Le Xuan Anh, 2003).

(1) Farmers have the right to sell their land, many sloping farms with beautiful views and settings have been converted or sold for conversion to ecotourist purposes.

(2) Land and the direct market value of AF products are more highly valued than the soil and water conservation role of AF options.

Our FFS, even though it was run for only one year, probably contributed to this change, which may be positive from both an environmental and economic perspective (assuming the farmers got a fair price for their land). The next topics recommended by local farmers

***Fig.5.6.** 'Out-door' activities of the FFS (Photo: Le Xuan Anh, 2003).*

and facilitators for FFS activities in the area are market information and market-orientated options. We believe that policies and extension activities to facilitate market channels and flows through different levels such as local, regional, national and international are needed to promote environmentally sound land use options. The first step towards this direction was the integration of Rapid Market Appraisal (RMA) into the Knowledge Based System (KBS) approach, developed by the same project (see next chapter). Furthermore, post-harvest processing and packages of products to attract consumers should be other topics for the FFS. Gender balance among FFS participants is recommended.

5.4 FFS in Integrated Soil Management for Sustainable Agriculture Production (CARD)

From July 2001 to December 2003, NISF collaborated with the University of Queensland (UQ) to implement a project entitled *'Soil Fertility Management for Meeting the Nutrient Demand of Root Crops in Northern Vietnam'*, funded by CARD. The project was aimed at improving soil fertility management for production of root crops (sweet potato and cassava).

Activities included (i) a short training of researchers, extensions, academics and farmer leaders in crop nutrition and participatory technology development, (ii) a participatory analysis of the situation for existing sweet potato production practices, (iii) development of a Farmer Field School programme and training of facilitators, (iv) completion of pilot Farmer Field Schools and (v) on-farm research trials, supported by on-station pot trials and laboratory analyses.

5.4.1. The project objectives

- Strengthening the capacity of extension staff and researchers in the area of soil fertility and technology transfer to farmers.
- Training farmers to organize and assess problems and to adapt technologies to their needs.
- Assessing the nutrient status of root crops in the project area and the most appropriate fertilization strategies for improving it.
- Demonstrating how root productivity can be improved by alleviating nutritional stresses.
- Helping farmers to conserve soil fertility under root cropping systems.

We designed the project by diagramming the project activities and appropriateness as shown in Figure 5.7.

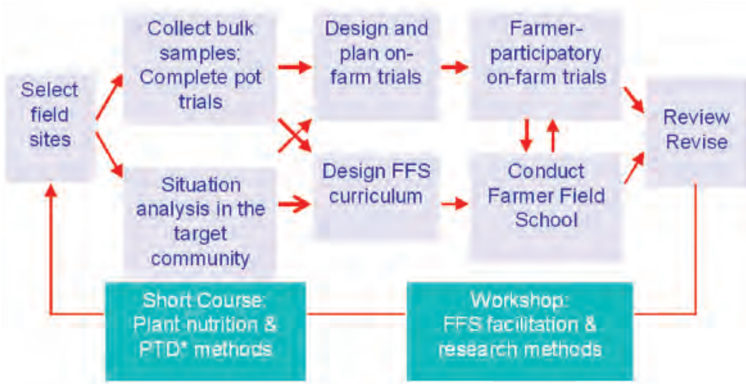


***Fig. 5.7.** Diagram of project activities.*
**PTD (Participatory Technology Development)*

5.4.2. FFS activities

The project activities included two parts: First, training of trainers (ToT). A short course entitled *'Soil Fertility Management and Technology Transfer for Root Crops and Participatory Situation Analysis in the Project Villages'* was held with 32 participants (Fig. 5.8). The participants included researchers, extensionists, academics and farmer leaders. The course was facilitated by experts from UQ and lasted for 2.5 months.


***Fig. 5.8.** Training learners to observe plants and see symptoms of nutrient disorder and to take plant measurements.*

A pot trial on nutrient losses was implemented by participants at NISF during the 2.5 months under the guidance and facilitation of Australian experts in plant nutrients and PTD (Participatory Technology Development). This course included a pot trial aimed at building capacity in observing and taking plant measurements in the field and also at improving confidence to facilitate future work for ToT. After learning the theory, the participants practised in the field (Fig. 5.9), learning and teaching each other with the assistance of the facilitators, to practise being future facilitators. Through the link between plants and animals, the farmers found ways to develop their production.

FFS facilitated the learning of advanced technologies in cultivation and soil improvement. However, during FFS the farmers demanded more information linked to post-harvest activities such as fodder and root crop processing. More knowledge in this field could reduce marketing problems for the farmers. In our project, this link was successfully applied and brought many benefits for the farmers.

Fig. 5.9. *Participants learning and teaching each other with the assistance of experts/facilitators inside and in the field.*

5.4.3. Brief results

In total, nine field trials were carried out. All were associated with fertilization of root crops; six out of the nine trials were either on a new variety of sweet potatoes or on cassava. Different demonstrations compared the application of the new technology with traditional practices at sites for sweet potato cultivation and showed the advantages of the new technology to the participants. By trying the new technology themselves, farmers got higher crop yields from potatoes (15-20%), cassava (20%) and sweet potatoes (35%) compared to traditional practices. Those results attracted the neighbours, who came to visit the demonstration plots and learn about the new technology and better varieties from the FFS. Twenty-five participants in Thanh Xuan commune and 45 participants in Bac Phu commune got more knowledge and experience in root crop production.

- At the end of the project, a workshop was arranged to review the project activities and results.

- Participants were happy with their progress in knowledge improvement and they evaluated the project results (Table 5.2).

- This way of evaluation consolidates the confidence for the farmer.

Table 5.2. A summary of the average evaluation results by participants (written evaluation)

Description of Design Feature	Appropriateness Rating*
Short Course '*Soil Fertility Management and Technology Transfer for Root Crops*, for researchers, extensionists, academics and farmer leaders	5
Participatory situation analysis in the project villages	5
On-station pot trials to characterize soil nutrient requirements	5
Workshop '*Facilitation of Farmer Field Schools*' for researchers and extensionists.	5
Farmer field schools for soil fertility management, for cassava and sweet potato growers	5
Farmer-participatory on-farm field trials	5
Evaluation survey of participating and non-participating farmers	5
National symposium '*Research and Extension for Development of Root Crop Production in Vietnam*'	5

**Rating: 5- Best Practice; 4- Fully Satisfactory; 3- Satisfactory overall; 2- Marginally Satisfactory; 1- Weak*

6 Knowledge-Based System Approach with Market Integration - Case Study of Agroforestry Systems with Bamboo spp.

6.1. Introduction

Sustainable land use practices are defined by us as those practices that aim both to provide livelihood security and to maintain local resources in a sound environmental condition. Land use options will be readily adapted if adequate market opportunities exist or can be identified for the AF products of the land use options. In order to enhance their potential profits from selling products in the market, smallholders should understand market channels, channel components and their interactions[17]*

To enhance farmers' livelihoods and economic status, land use options must be market-orientated. In areas under high urbanization pressure, like our study site in Hoa Binh province, Vietnam, market-based options may differ substantially from past land use. The market study implementation methods learned from ICRAF/Winrock experience in Indonesia[18] were applied for Hoa Binh conditions. Using methods developed by Betser[19], a Rapid Market Appraisal (RMA) was implemented in March 2004, in Que Vai in Tien Xuan commune, Hoa Binh province. The RMA was applied as one further development stage of the Knowledge Based System (KBS) approach developed in Dong Cao village. The main objective of the studies was to scale up the findings on bamboo obtained by the PaLA, WaNuLCAS and LEK surveys in Dong Cao village to a village nearby, which had a similar setting. Based on the Que Vai example, we can see the possibilities of replicating the work done in Dong Cao village in other similar areas in the midlands of Northern Vietnam. The reasons for selecting bamboo as the species for the study are given in Box 6.1.

* *Markets are defined as the demand for one product, in one place at one time under specific conditions. Markets for each product at various places and times are unique and always changing*[17]

Box 6.1. Why bamboo?

Based on the findings of the PaLA, LEK and WaNuLCAS studies (Chapters 3 and 4), the effects of bamboo species alone and in various AF systems (Taungya and hedgerow systems) at plot and landscape level have proved to be very promising in terms of soil and water conservation. The importance of bamboo species to household economies was surveyed using wealth ranking and semi-structured interviews with 12 farmers, representatives of the three common wealth groups of Dong Cao village[11]. From these, the role of bamboo products, with the focus on Tre gai, was identified and accounted for a higher percentage of the income than did trees in the total household economy, making up 7-14% of the income compared to 1-10% from trees. In addition, bamboo is well known as an important 'non-timber forest product' (NTFP) for low-income rural residents in Asia[20]. Furthermore, bamboo offers significant and increasing income-generating opportunities, foreign exchange earnings and highly valued products. As a result, the species provides excellent opportunities for sustainable development to benefit poor people[21].

6.2. Research process and findings in Que Vai village

The RMA and PaLA surveys were carried out in Que Vai village during 9 days in March, 17-25 2004 by a team of five researchers. This survey compiled information on, among other things, identified market information, linkages and opportunities for smallholder-produced bamboo. Policy and strategy for the socio-economic development of the Tien Xuan community were gathered by interviewing communal leaders. Semi-structured interviews were used in two group meetings with six key informants (village leader, party secretary, women's association representative and four knowledgeable farmers), and for the individual interviews of 12 households and 5 traders. The following steps/activities were carried out:

6.2.1. Site selection

Que Vai village was selected due to the following criteria:

(i) Similar bio-physical and socio-economic setting as Dong Cao village (Box 6.2), allowing scaling up of findings from Dong Cao to this village;

(ii) Stable rural development. Since no highway goes near the village, we believe that the impacts of urbanization would be less and options for rural development would be useful both for the short- and long-term in this village. In 2004, despite the fact that many sloping farms have been converted or sold for conversion to eco-tourist purposes in Dong Cao village, farmers in Que Vai still continue their farming;

(iii) Strong community. A lesson learned from the Dong Cao studies was that community actions are important for sustainable landscape management;

(iv) Local farmers and local authority interested in the development of, among other things, more bamboo species in the area. This is in connection with the strategy of the local authority to convert agricultural activities to more off-farm activities such as handicraft.

Box 6.2. Comparison of Que Vai village with Dong Cao

Dong Cao and Que Vai villages are situated in parallel in the southern part of the Tien Xuan commune, with some socio-economic characteristics given below.

Characteristics	Dong Cao	Que Vai
Total land	180 ha	107 ha
Paddy land	15 ha	27ha
Upland*	50 ha	80 ha
Number of households	60	71
Ethnicity	Muong, Kinh	
Main sources of income	Paddy, animal husbandry, silviculture, off-farm	
Main soil types	Ferralsol and Acrisol	
Slope and elevation	100 m to 700m altitude, and slope of 15-60%	

*classified by the state as forest land, named '02' land.

6.2.2. The PaLA: (bio-physical survey)

The PaLA survey was carried out using the following tools: village sketch, transect and timeline. Detailed descriptions of the tools are given in Chapter 3. The general land use patterns of Que Vai village found during the PaLA are given in Box 6.3.

Box 6.3. Land use patterns in space and over time in Que Vai village

The key subsystems include paddy land, upland (forest garden and fallow) and home gardens. Currently farmers use the uplands for tree and food crop cultivation. Common components include indigenous species (*Canarium, Sapindus, Aleurites montana, Melia spp*.); fast-growing species (*A. mangium, Eucalyptus, Styrax*); tea and food crops (cassava, arrowroot, maize). The home gardens are mixed farming systems containing many kinds of fruit trees (such as persimmon, grapefruit), vegetables, livestock and fishponds. Each farmer owns from one to six upland plots that are under different species and management schemes. Before the 1980s, the upland fields were mainly secondary forests or fallows. During 1980s-1990s, the forest land was converted to food crops. Since 2000, the upland areas have mainly been planted with trees. This trend shows the impacts of national policies, including land allocation since the early 1990s, as well as different re-greening programmes such as the '327' and 'PAM' programmes. These re-greening programmes provided local farmers with seedlings of the fast-growing species, as well as payments in the form of rice according to the number of trees they planted. With the establishment of some eco-tourist centres in nearby Co Dung village, grazing lands have been rapidly reduced. This has led to uncontrolled open grazing throughout the study area. As a result of increased threat of livestock damage, farmers report that the area under food crop cultivation has also declined.

In Que Vai village, bamboo also occupies a larger area of land compared to other planted trees. The main bamboo species and their products in Dong Cao and Que Vai villages are shown in table 6.5. It was reported during farmer group meetings in Que Vai that about 20 ha in the village is under bamboo, compared to about 5 ha under Sapindus (Sau) and 1 ha under Canarium (Tram den).

Bamboo-based AF systems (Fig. 6.1) common in the uplands in Que Vai village are: (1) bamboo hedges (BambooHed) along the borders of agricultural fields to delineate the boundaries between land owners and to protect the fields against damage by free-grazing buffalo or cattle; (2) bamboo as a component of mixed forest gardens (resembling natural forests; BambooGard); and (3) bamboo as a uniformly spaced and primary component of Taungya AF systems (resembling plantations; BambooTau). Both BambooHed and BambooGard are found on sloping land. However, BambooHed is found in small field plots of less than 1 ha, while BambooGard is common in larger fields (1 or more ha). A comparison between the three common bamboo-based systems is given in Table 6.1.

Table 6.1. Bamboo-based AF systems in the upland fields in Dong Cao and Que Vai villages and their products

I. The Bamboo-based AF systems in the upland fields			
	BambooHed	BambooTau	BambooGard
System structure	Border markers, filters and protection barriers	Intercropped food crops before the bamboo canopy closes.	Mixed forest garden with four to eight layers. Bamboos planted in the lower locations with more soil moisture.
Common bamboo species	Tre gai (*Bambusa blumeana).*	Tre gai (*Bambusa blumeana)* and hop (*Bambusa multiplex).*	Vau (*Indosasa crassifolia)*, mai (*S. gigantea)*, tre gai (*Bambusa blumeana).*
Condition of different bamboo-based systems	Small pieces of sloping land (less than 1 ha).	Flatter areas on the top of a hill.	Larger pieces of sloping land (often 2-3 ha).
Common intercropped species	Cassava, maize arrowroot, *A. montana A. mangium,* tea.	Cassava.	*Canarium*, *Sapindus, Aleurites montana, Melia* spp*, Styrax.*
Effects on controlling water runoff*	BambooHed = AcaciaHed > TepHed	BambooTau > AcaiaTau	
II. Bamboo products			
Income	Bamboo shoots generate twice the income of stems (from 2 ha of upland, shoots earn 2.5 million and stems only 1 million VND per year**		
Demand for bamboo stems	The demand for stems is higher than current supply***. Stems are primarily sold after the shoot season (from October).		
Season for shoots	During May-June the price for shoots is highest. In July-August the price decreases.		

* Finding from WaNuLCAS simulation[11]. AcaciaHed = Acacia mangium planted as hedgerow species; TepHed = Tephrosia candida as hedgerow species; AcaciaTau = Acacia mangium in a Taugua system.

** From Dinh Cong Hong´s RMA survey for upland systems.

*** According to farmers, suppliers in Que Vai, and the traders in local and Thach That, Ha Tay markets


Fig. 6.1. *Tre Mai (S. gigantea) to the left and Tre gai (Bambusa blumeana) to the right (Photo: La Nguyen, 2003).*

6.2.3. The Rapid Market Appraisal (RMA)

The issues and tools/methods used for the RMA are given in table 6.2. The meetings and interviews were conducted during day and the team compiled and summarized the data in the evenings.

Table 6.2. Issues and tools/methods used for RMA in Que Vai village

Issues for interviews	**PRA/RRA tools and methods used during interviews**		
	For group meeting (supply side)	**For individual farmers (supply side)**	**For market agent (demand side)**
Agricultural products currently produced and/or sold by farmers.	Brainstorm using cards. Analysis and feedback from the results. Key questions: 1: which species, and 2: what products of those species are sold?	Farm sketch maps, identifying all farming system (FS) components. Tables identifying all species, their respective number, farming inputs, and farm outputs for each FS components.	Agricultural product/outputs currently produced and/or sold by farmers.
Bamboo products currently produced and/or sold by farmers.	Brainstorming using cards. In-depth interviews about bamboo cultivation and harvesting.	Table identifying the areas under bamboo cultivation and the number of clumps. Key questions: What, why, when, how, whom.	Table identifying the quantities of bamboo purchased. Key questions: Where, why, how much
How are bamboo products sold?	Key question: Can you sell more? What is required? Are you interested?	Table detailing the possibilities for selling more bamboo Key questions: Where, to whom, when, how.	Table identifying where bamboo products are purchased, in what form, and by whom
When are bamboo products bought and sold?		Timeline	Timeline
Income from selling bamboo products.		Table identifying inputs and products for each type of bamboo.	Table identifying income from trading bamboo products

The main bamboo species and their products in Dong Cao and Que Vai villages are given in Table 6.3. It was found that 90% of the bamboo products in Que Vai village were sold to local traders in the village. Only 3% was sold to users in the village and 7% to outside traders.

Bamboo shoots were collected annually by farmers from April to August. The price of bamboo shoots varied with species and season. It varied from 2500 VND to 4700 VND per kilogram depending on the quantity available in the forest together, with the daily harvest.

Farmers noted that the volume of bamboo shoots in the village is too small for the market demand. Furthermore the prices are different along the market channels of bamboo shoots (Table 6.3). Prices for bamboo shoots sold to local traders at the farm gate (500-700 VND) were often one-tenth of the prices in local markets in the nearby provinces such as Ha Tay and Hanoi (5000-7000 VND per kilogram).

Table 6.3. Market channels for bamboo shoots (Interview findings of 12 individual farms in Que Vai)

Producers-Farmers	Traders from other provinces	Local markets nearby and in Hanoi
	Consumers within the commune	

Bamboo stems are mostly used for house construction and handicraft production. Bamboo stems are sold during the whole year, but mostly in the dry season when weather conditions favour house construction. Bamboo stems are sold to both local and outside traders depending on the quantity of bamboo available in the village and the number of producers who want to sell their products (Table 6.4). The price varies from 7000 (0.5 USD) to 15000 VND (about 1 USD) per stem depending on the dimensions. Small bamboo varieties such as Hop, Nua and Giang are mostly sold to outside traders at the farm gate, at prices from 1000 to 2500 VND.

Table 6.4. Market channels for bamboo stems (interview individual households, groups of farmers and market survey)

Producers	Local traders (8 persons in Que Vai village)	Traders in the areas (inter-communal and districts) (about 20 km from the village) Tràng market (Trang Son commune, Thach That district, Ha Tay province) 4 bamboo traders in this market Huong Khe market in Quoc Oai district, Ha Tay province	Constructors in Hanoi and in the nearby areas
			Local consumers and handicraft workers
		Local consumers and handicraft workers	

Table 6.5. The main bamboo species and their products in Dong Cao and Que Vai villages

Local name	Scientific name	Main Characteristic[11]	Products from bamboo in Que Vai*			
			Products	**Selling**	**Estimated areas**	**Ranking of the economic importance**
Tre gai	*Bambusa blumeana*	Spiny bamboo with very hard, very strong culms used for construction, furniture, kitchen utensils, wattling and basket weaving.	Stems more important than shoots.	100% of stems and shoots.	4 ha	1
Tre Mai	*Sinocalamus gigantea* Munro	Bamboo with straight culms, used for construction and making chopsticks. Produces good quality bamboo shoots.	Shoots more important than stems.	95% of shoots and 100% of stems.	4 ha	3
Hop	*Bambusa multiplex (Lour)* Raeusch	Bamboo with small diameter, straight culms.	Stems more important than shoots.	100% of stems and 95% of shoots.	4 ha	2
Vau	*Indosasa crassifolia* Mc Clure	Bamboo used for construction and making hats.	Stems more important than shoots and sheaths.	90% of stems and shoots. 100% of sheaths.	8ha	4
Luong (Thanh hoa)	*Dendrocalamus membranaceus* Munro	A recently introduced bamboo variety (10 years) mainly used to produce edible bamboo shoots.	Shoots more important than stems.	For household consumption.	80 culms belongs to veteran club	
Tre Bat do	-	A recently introduced variety (3 years) produces excellent quality edible bamboo shoots.	Shoots more important than stems.	95% shoot Stems kept for seedlings.	20 culms	

**compiled during the group meetings of RMA survey.*

6.3. Some findings and discussion

Our study demonstrates that local bamboo-based AF systems are sustainable land use systems. As a hedgerow intercropping system, bamboo prevents erosion and improves soil fertility significantly. The bamboo products (mainly from Tre Gai and Hop) harvested from the hedges provide farmers with important income as well as material for household consumption, mainly for construction purposes. However, due to (1) the high underground competition with the intercropped crops, and (2) the low price of stems, farmers are not willing to expand the areas of bamboo, despite the high demand for the products. A similar phenomenon is observed in Nanggung, West Java, Indonesia, where the average home garden landholding per family is less than 0.5 ha. Nanggung farmers consider bamboo to be the second most important income generator (after banana) of all home garden species. However, farmers are not interested in expanding cultivation of bamboo and some farmers are actually removing bamboo from their farms (Roshetko, personal communication).

In the Taungya or forest garden systems, more bamboo varieties (Tre Mai and Luong) are grown and produce edible shoots that give twice the price of stems. However, these mixed systems require flatter land (such as Taungya) or larger areas to accommodate the many associated species found in these forest garden systems. The soil-plant-water interactions in the mixed Bamboo-based AF system are still a mystery. Understanding these interactions may allow us to scale up the systems.

The paradox of high market demand for bamboo stems but a low incentive for farmers to produce them results from the low price received by farmers. This gap, identified during the RMA, is hypothetically explained by several factors. Farmers have low input/management systems that produce medium to low quantities of medium to low quality products. Farmers are not willing to intensify inputs, capital or management because prices are low and they have almost no access to market information except through traders who are not forthcoming with information. Traders stress that dealing with individual farmers is time-consuming and the quantities/qualities of the bamboo products from farmers are dubious. Traders justify low payments to farmers to cover their high time investment and the risk related to the uncertainty of the products. Experiences in Lampung, West Java, Indonesia, indicate that strengthening links between farmer-producers and traders can help to address the concerns of both parties. Through such links (Fig. 6.2), farmers may learn i) market specifications for the products they are producing, ii) management methods (including post-harvest processes) to improve quality and quantity, and iii) market demand information. Traders may i) identify a group of key farmers, reliable producers of quality products, and ii) develop this group into a network of farmer-producers, which is a more efficient business mechanism than dealing with individual farmers.

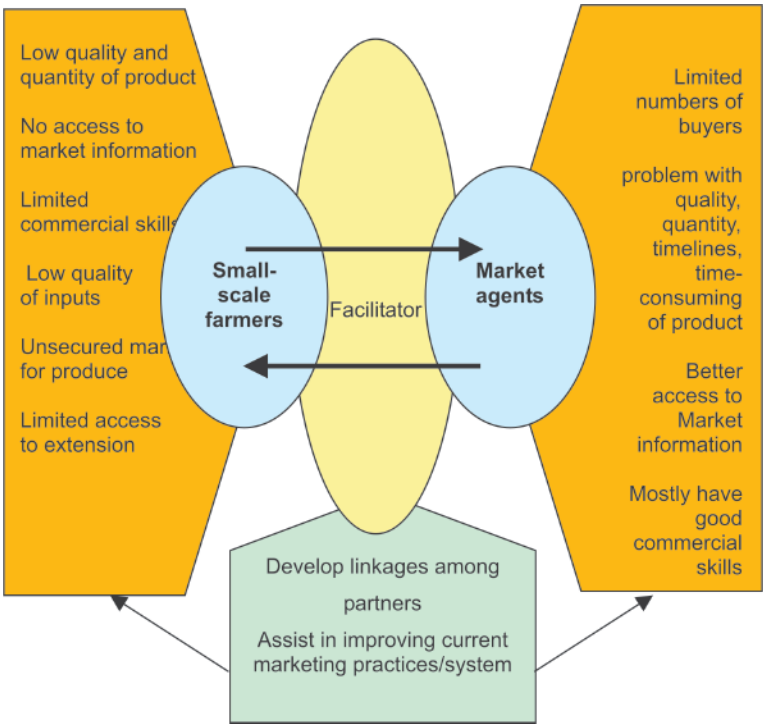


Figure 6.2. *Market Survey Approach*[18].

The possibility for these or similar win-win marketing linkages between farmers and traders should be investigated for Hoa Binh. A first step might be to hold a workshop between researchers, farmers, market agents and other stakeholders to share findings from the recent RMA and exchange views, problems and objectives. Careful preparation for the workshop is required, particularly to identify farmers, traders and local government officials who are interested in the process. It should be clearly indicated to all parties involved that the process will require work from all, but that all will also benefit. The last session of the workshop should seek to draft an action plan to move the process forward.

With the plan of establishing a tourist village in the same commune, bamboo handicrafts may find an attractive and profitable market. To evaluate this potential, a market demand projection should be conducted. If the projection provides positive results, possible follow-up activities might include: i) expanding the current area of bamboo (if the current area of bamboo is found to be insufficient to meet projected demand), and ii) advanced training to enhance farmer skills and efficiencies at producing suitable bamboo handicrafts. It should be emphasized that these steps are not recommended until a tourist trade and demand for bamboo products are established. At the current state of development, these actions may be years in future.

If the area of bamboo is to be expanded, the KBS approach developed can help to identify which areas are most ecologically appropriate. Furthermore, the approach could be validated and later used for improving different bamboo-based AF systems for the low mountain zone of the Vietnam's Northern Mountain Region.

Abbreviations

AcaciaHed	Hedgerows of *Acacia Mangium* in cassava field
AcaciaTau	Taungya system of *Acacia Mangium* and cassava
AF	Agroforestry
AKT	Agro-ecological Knowledge Toolkit
BambooHed	Hedgerows of bamboo in cassava field
BambooTau	Taungya system of bamboo and cassava
CGIAR	Consultative Group on International Agricultural Research
EROChina	Erosion project in China
FFS	Farmer Field Schools
GENDCEN	Centre for Gender, Environment and Sustainable Development Study
GIS	Geographical Information Systems
HEA	Household Economy Analysis
HyFA	Hydrologic Function Assessment
ICRAF-SEA	World Agroforestry Centre Southeast Asia
INRM	Integrated Natural Resources Managements
IPCP	Integrated Participatory Conservation Planning
IPM	Integrated Pest Management
KBS	Knowledge Base System
Ksat	Saturated hydraulic conductivity
LEK	Local Ecological Knowledge
LUSLOF	Sustainable Land Use Practices in the Uplands of Vietnam and Laos - Science and Local Knowledge for Food Security
MARD	Ministry of Agriculture and Rural Development
MSEC	Managing Soil Erosion Consortium
NAFRI	National Agriculture and Forestry Institute
NISF	National Institute of Soils and Fertilisers
NTFP	Non-Timber Forest Product
PaLA	Participatory Landscape Analysis
PRA/RRA	Participatory Rural Appraisal/Rapid Rural Appraisal
RDViet	University Network Rural Development and Environment of Vietnam
RF	Rockefeller Foundation
RMA	Rapid Market Appraisal
RUPES	Reward Upland Poor for the Environmental Services they provide
SAREC	Swedish Agency for Research Corporation
SLU	Swedish University of Agricultural Sciences
TepFa	Improved Tephrosia Candida fallow biomass in rotation with cassava
TepHed	Hedgerows of Tephrosia Candida in cassava field
WaNuLCAS	Water, Nutrient and Light Capture in Agroforestry Systems
WPU	Wood Processing Unit

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