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project

Improved market engagement for sustainable upland production systems in the North West Highlands of Vietnam

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1 Acknowledgments

This report represents the process and outcomes of extensive collaboration of researchers, extension staff and farmers in Vietnam and Australia over a period of four and a half years, from 2009 to 2013. The institutions and researchers collaborating in this project are reflected in the long list of contributing authors.The work, however, would not have been possible without the active involvement of the farmer researchers at the project sites who were actively engaged in identifying their production problems, reviewing and testing solutions, and working out the actual benefits for them of the innovations tested. Over the project period they became increasingly influential in determining trial designs and interpreting the data to ensure the results would suit their conditions.

In addition, the involvement of the extension and technical personnel from the various divisions of the Son La and Lai Chau Departments of Agriculture and Rural Development (DARD) at commune, district and province level was crucial in guaranteeing that the project was developing a model that could be taken over by the respective government departments. Their critical notes in the design process and committed engagement during the pilot roll-out phase were instrumental in successfully linking the research process with the local government extension processes.

We convey our appreciation to ACIAR staff who have been supporting project implementation financially, logistically and conceptually, in particular Mr David Shearer and Dr Rodd Dyers, the Research Program Managers, and Mr Geoff Morris, Ms Nguyen Thi Thanh An and Ms Vu Thi Hau from the ACIAR Vietnam Office. Lastly, we express our gratitude to the drivers of NOMAFSI, PPRI, CASRAD and ACIAR Vietnam Office who spent long hours on bumpy roads to safely drive the team around to the remote project locations.

2 Executive summary

The North West Highlands of Vietnam has been an important focus for the Vietnamese Government development program since the 2000s, and one of two geographical focus areas for ACIAR's program in Vietnam. Following a scoping study in 2008, the '*Improved market engagement for sustainable upland production systems in the North West Highlands of Vietnam*' project was designed for implementation from 2009-13 by an interdisciplinary and inter-institutional team of researchers from Australia and Vietnam. The team was coordinated by The University of Queensland (UQ) and the Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI), and involved the Plant Protection Research Institute (PPRI), the Centre for Agrarian Systems Research and Development (CASRAD), Hanoi Agricultural University (HUA, later renamed Vietnam National University of Agriculture – VNUA), Tai Bac University (TBU), the Rural Development Center (RUDEC) of the Institute of Policy and Strategy for Agriculture and Rural Development, and local government departments in the provinces of Son La and Lai Chau. The project's activities were geographically located in Mai Son and Moc Chau districts in Son La Province and Tam Duong and Sin Ho districts in Lai Chau Province, which are all areas characterised by high ethnic diversity and high rates of poverty. At the start of the project, Son La had relatively well-established market linkages and infrastructure support, while Lai Chau was one of the poorest and least connected provinces in the North West Highlands.

As ACIAR's overall strategy in Vietnam was to enhance smallholder incomes through both technical and agribusiness research and the target area was characterised by complex environmental, cultural and economic challenges, the project applied a transdisciplinary and participatory approach. The aim of the project was to increase smallholder engagement in competitive value chains associated with maize and temperate fruit based farming system and to use this engagement to improve land and crop management in these rapidly transforming sectors. Specific objectives of the project were:

1. To establish an understanding of constraints in maize and temperate fruit based farming systems that limit smallholder engagement in profitable markets and identify opportunities to overcome these constraints.
2. To develop improved farm and value chain management practices to optimise sustainability and profitability in smallholder maize and fruit based farming systems.
3. To build competitive value chain models that engage smallholders with more profitable markets in support of improved land and crop management.
4. To evaluate value chain interventions and improved land and crop management techniques to support scale out of successful technologies into government and non-government development strategies

This approach was expected to generate farm management solutions for smallholder upland farmers that suit their needs under prevailing socio-economic and enviromental conditions and deliver outcomes through to the market to eventually benefit the livelihoods of rural communities. As a result, project activities strongly linked management of the natural resource base to market opportunities, and developed the mechanisms to promote practice change by farmers through the existing service providers.

The project's methodology contained four research phases: diagnostic, applied, adaptive and evaluation research. The diagnostic phase involved a community-based diagnostic study involving a range of participatory consultation and situation analysis methods that were conducted in eight selected communities over a period of five months in 2009. Assessment of existing supply chains was done through a Rapid Value Chain Analysis (RVCA) throughout 2009-10 and a scenario analysis in 2011. The applied research phase mainly focused on erosion management involving two longitudinal erosion trials conducted

throughout 2011-13. Adaptive research contained two distinguishable but interrelated components: (1) innovation adaptations involving a large number of field trials testing promising innovations with intensive farmer decision making and evaluation during 2012-13, and (2) the design, testing and evaluation of an outreach strategy for proven land and crop management innovations and value chain models throughout 2012-13, with offspin activities in Son La beyond the project after conducting Training of Trainers of local government officials in the two target provinces. Evaluation research was embedded in a Participatory Monitoring and Evaluation (PM&E) system, involving Reflection and Planning workshops, Innovation Workshops, and routing????? field-based research design, monitoring and analysis workshops with farmers, extension officers and researchers. The PM&E system provided the key mechanism to operationalise the transdisciplinary Research for Development approach.

The project achieved a wide range of outcomes and impacts. In terms of scientific impact, it contributed to the introduction of a transdisciplinary and collaborative research framework in the Vietnamese research for development arena, the advancement of the Conservation Agriculture in Southeast Asia (CANSEA) network, and the establishment of the usefulness of the “pin” method (a modified profile meter method) to measure soil erosion under Vietnamese highland soil conditions.

The project had a significant focus on capacity building in order to draw together different Vietnamese organisations, target communities, practitioners and researchers from different disciplines as to foster collaborative work leading to tangible and sustainable impacts in the field. Capacity impacts resulting from the intensely collaborative approach and numerous training events were particularly apparent among project’s field researchers from partner organisations and farmer researchers.

Adaptive trials in farmers’ fields and under farmers’ management demonstrated positive potential economic impacts of minimum tillage combined with use of mulch which resulted in an overall higher net income per labour-day. In particular, the introduction of two crop growing cycles per rainy season resulted in significant initial acceptance by farmers due to high economic benefits on specific areas with gentle slopes.

An increasingly active participation of community representatives at most of the project sites was observed during the last two years of the project, once some research results had become more evident to farmers, trust had been sufficiently built up between field researchers and farmer researchers, and the field researchers’ capacity to facilitate participatory monitoring and evaluation activities had visibly increased. As this primarily hinged on the local actors in the project, it can be assumed that social capital was built up in the project sites that will continue to benefit the communities beyond the project.

Environmental impacts were evident as a result of better erosion management practices that were acceptable by farmers, i.e. minimum tillage and mulching. Acceptability was determined by the very undemanding nature of the practices, which had the added advantage of reducing labour input for soil preparation.

Outreach of the project’s research outcomes was facilitated by community feedback sessions in the six project villages and the production of photo stories by the farmer researchers to support dialogue within their community, but more substantially by the development and testing of a comprehensive outreach strategy. This involved a Farmer Field School (FFS) model on sustainable maize-based system management, including technical and facilitator manuals, a series of awareness raising and educational videos, leaflets and the implementation of a four-day Training of Facilitators and four pilot FFS units engaging 83 farmers. Outreach beyond the project was funded by the Son La provincial government and involved over 4,000 farmers participating in FFS events organised over 2014-15. Further activity beyond 2015 has not been followed.

From the project’s research outcomes and experiences, the following conclusions were drawn:

1. Considerable soil erosion was measured, although the use of mineral fertilisers and the deposition of soil on fields on the lower slopes from higher fields were masking observable effects on yields. Farmers were found to be aware of, but not very concerned about, soil erosion as they were still able to obtain good yields and good prices for their produce. Consequently, there was generally low motivation to implement soil erosion management practices if it did not result in immediate higher return of investment or reduction in labour input.
2. The application of good soil erosion management practices was shown to make crop cultivation on sloping land more profitable and sustainable. These practices were only acceptable to farmers if implementation did not require additional labour or inputs that would not demonstrably be recovered. Minimum tillage in combination with mulching appeared to be an acceptable practice to farmers and after receiving training to better understand the long-term implications of soil erosion and gain the skills to implement the practices. It was assessed that in the year after completion of the project over 50% of farming households in the project sites practised minimum tillage and applied mulch on their lands.
3. The introduction of two crop-growing cycles per rainy season on project sites with active engagement of communities and local government in planning and evaluating of outcomes resulted in significant initial acceptance by farmers. All successful second crops were grown without any irrigation on gentle slopes of 5-10 degrees and even though in the Northwest of Vietnam the majority of maize is grown on steeper slopes the economic benefits of growing a second crop on limited areas of gentle slopes are very high.
4. Current temperate fruit industry is based on only one variety of plum (Tam Hoa) and, from a market perspective, any further increase in production is unsustainable.
5. Plum orchard and canopy management are not adjusted to targeted markets. Geographic areas with unfavourable natural conditions can be planned for production of processing quality plums, which under current market conditions still brings higher income to smallholders than most broad-acre crops, including maize. Orchard management for processing plum should include higher density planting, minimum pruning but moderate to high fertilizer input to encourage high fruit load. Moderate pruning is recommended for areas producing plum for fresh traditional market, while open canopy that maximize sunlight exposure and consequently has light to moderate crop load with larger size and better colour of the fruit should be only used if access to supermarkets and high-end speciality safe food shops are guaranteed.
6. Collaborative development of the value chain of Tam Hoa plum provided a good balance between return and investment in inputs and labour maximising return with low inputs.
7. The project focused on development of value chain to modern retailers, in particular to safe fruit/vegetable shops. This market segment is extremely small with the throughput of plums representing less than 0.1% of Moc Chau harvest. This low capacity to absorb any significant volume casts doubt on justification of project interventions. However, other potential outcomes should be considered based on the fact that these retailers offer much higher prices to the farmers and actively promote the product and Moc Chau origin on varies online platforms including social media. This can lead in more enabling environment for technical and marketing innovations and upgrading of fruit quality.
8. The careful and participatory design and piloting of an outreach strategy, in the form of a Farmer Field School on sustainable upland maize production systems with supporting materials (trainer manuals, leaflets, videos), and the development of facilitator capacity through a Training of Trainers, appeared vital in the scaling up of the project's research outcomes upon completion of the project. Over 4,000 farmers in the two project provinces (Son La and Lai Chai) plus one neighbouring province (Yen

Bai) were trained in FFSs by local government staff who had participated in the Training of Trainers in the two years following the project completion (2014-15), which was all funded from local government funds.

9. The active involvement of all relevant stakeholders, especially farmers and local extension officer, is crucial in adaptive research for development that addresses complex issues, such as soil erosion and value chains. To engage in transdisciplinary collaboration, however, requires collective understanding of the direction and approach of the project, and the development of skills to engage in dialogue and negotiate research design and conclusions. It took about two years into the project, involving a diagnostic phase allowing everyone to analyse the situation from their own perspective, before the collaboration became more balanced. Farmers and extension officers began to function as co-researchers, and the disciplinary boundaries among the researchers from different institutes were acknowledged and a well-coordinated interdisciplinary mode of operation evolved.
10. Institutional cultures and existing inter-institutional relationships need to be recognised and understood before deciding the level of disciplinary integration to commence at. In our case we tried to operate within a transdisciplinary framework, which was not feasible given the existing institutional arrangements and mindset of Vietnamese and Australian researchers involved.
11. A participatory monitoring and evaluation system can serve as an effective communication mechanism for researchers, farmers and extension officers to negotiate the direction of research activities, conduct the analysis of research results considering both scientific and practical parameters, and formulate innovations systems that can be implemented in the local farming context.

The research outcomes and collaborative experiences led to the formulation of the following recommendations:

Relating to maize-based farming systems on sloping lands:

1. Biophysical research into sustainable soil and nutrient management options is needed to enable the transition from tillage-based maize production to minimum soil disturbance. This research should increase understanding of the impact of rotation, intercrop and relay crops on soil fertility.
2. Comprehensive follow-up evaluation research of maize-based farming systems that includes livestock management should be conducted. It is recommended that such research incorporates socioeconomic, farming system and market analyses of crops that have the potential to replace maize, or at least be accompanied by maize, as inter- or rotational crops.

Relating to temperate fruit-based farming systems in the North West of Vietnam:

3. Temperate fruits are a viable alternative to broad-acre crops, especially on steep slopes where legume cultivation is difficult. However, due to the long-term nature of fruit tree cultivation, there should be (1) coordination of government programs and private sector initiatives, and (2) comprehensive planning based on market research and multi-stakeholder consultation, both facilitated through province-based industry associations. The associations should lead activities that introduce new varieties based on market demand and establish modern nurseries across high elevation (temperate climate) regions of North West Vietnam.
4. Before attempting any further value chain analysis, comprehensive market research should be conducted that examines (1) the retail segment in major demand centres, and (2) the demand, seasonality, supply (including fruit import from China) and price trends of major temperate fruit species.

5. Future value chain projects based in smallholder production systems should pay particular attention to the ‘collectors’ and ‘aggregators’ in the system; that is, those who gather the produce from the numerous small producers. These actors can play a major role in coordination of production by providing information about market demand and retailers’ requirements to farmers. They have the capacity to gain access to retailers with high quality and food safety standards.

Relating to the planning and implementation of Research for Development:

6. Research for development projects that attempt to address complex agricultural systems and livelihood issues require an approach to planning, implementation and evaluation that is transdisciplinary and participatory. As such, project design and funding should allow for adequate time and resources to (1) establish and facilitate a research team that is committed to and capable of conducting this type of research, and (2) incorporate proper diagnostic and PM&E phases that not only help direct the research agenda towards farmers’ needs and conditions but also strengthen stakeholder capacity to collaborate effectively.
7. Effective outreach of research outcomes enabling community-based impact requires adaptive research activity to design and pilot a suitable and scalable outreach strategy and develop outreach materials and mechanisms. This should be factored in project design and resourcing but operationalised flexibly, based on emerging needs and opportunities throughout the phases of diagnostic, applied and adaptive research.

3 Background

The North West Highlands region is recognised as the poorest in Vietnam. At the scoping of the project in 2008, the region's poverty rate was 25.1% compared to a 13.4% average across the entire country. In 2013, these statistics were lower but the disparity was still great, with a poverty rate of 21.9% in the highlands and 9.8% nationally (General Statistics Office of Vietnam 2015). Although increased integration into the world's trading systems has been broadly beneficial for Vietnam, with poverty rates falling from 61% in 1993 (Warwick Commission 2008), approximately 75% of the ethnic minority people, who dominate the North West Highlands region, remain below the international poverty line (UN 2002). These higher rates of poverty can partly be attributed to lack of access to profitable markets in comparison with other regions of Vietnam. The lack of market access relates to both limited infrastructure to link smallholders to markets, and a poor level of government and non-government service. This poor service level also limits the development of more sustainable and profitable farming systems.

The North West Highlands is an important focus for the Vietnamese Government development program, and one of two geographical focus areas for ACIAR's agricultural engagement in Vietnam (the other being the South Central Coast). This project's activities were geographically located in Mai Son and Moc Chau districts in Son La Province and Tam Duong and Sin Ho districts in Lai Chau Province (Figure 1). Son La has relatively well-established market linkages and infrastructure support as a consequence of the construction of the Son La dam. Lai Chau is acknowledged as one of the poorest provinces in the North West Highlands, with very poor infrastructure and a high level of disconnection from markets. These provincial differences represented an area of research interest in this project as they provided an opportunity to explore and demonstrate the differences created when the market is used as a driver for change. This specifically delivered on the objectives of ACIAR's Subprogram 5, which has the intent to develop market opportunities for communities in the North West Highlands. ACIAR's overall strategy in Vietnam is to emphasise both technical and agribusiness research to enhance smallholder incomes and families.

Figure 1: Location of provinces in the northern regions of Vietnam (area 2 = Hanoi)

The maize-based agricultural system, and specifically maize and temperate fruit cropping within this system, was selected as a focus for the research for reasons of rapid market transformation for these enterprises and impacts on both smallholder producers' economies and the environment. Maize is the second most important crop in Vietnam, after rice, with increased production recently occurring in the North West Highlands to service the rapidly expanding animal feed industry. The rapid expansion of the maize sector has been accompanied by poor land management practices, such as cultivation on steep slopes with high probability of erosion, making the industry unsustainable. The

resource deterioration was initially masked by other productivity improvements such as the use of hybrids and chemical fertilisers. For the development of a more sustainable industry that continues to benefit smallholders in the long term, more appropriate natural resource management practices needed to be developed and adapted to the smallholder maize based system in the North West Highlands.

In terms of the role of temperate fruit in the farming system of smallholders in the North West Highlands, fruit production appeared an important source of income for smallholders. At the time of project scoping (2008), temperate fruit provided 62% of smallholders' annual income. However, the temperate fruit industry was characterised by poor market engagement, low yields, high postharvest losses (25-40%) and poor profitability, all in a context of continual pressure from surrounding competing countries such as China and Thailand, which resulted in limited investment by farmers in production and marketing practices. For smallholders to continue to gain benefit from temperate fruit based systems, a much greater understanding of chain competitiveness needed to be developed, with the integration of smallholders into these more competitive chains

ACIAR's previous engagement within the North West Highlands focused on supporting the development of the temperate stone fruit industry. Many technical projects[1] introduced best harvest management practices and varieties that improved fruit quality, as well as good soil management techniques on sloping lands where soils are prone to erosion and degradation[2]. CP/2002/086 improved fruit quality management in Son La and Lao Cai, but did not address issues associated with market engagement and smallholder practice change. One project, ADP/2001/066, did conduct a case study of the value chain for plum from Lao Cai province, but primarily focused on understanding the smallholder position, not the entire value chain. However, recommendations were not adopted, nor did any smallholder based agribusiness change occur. The reasons for this were not fully understood.

The need for the development of 'best practice' for the cultivation of food and cash crops on sloping lands, on the one hand, and market analysis to identify opportunities for profitability, on the other, were identified through a scoping study commissioned by ACIAR in 2008[3], which provided the basis of planning a future agricultural research program in the North West Highlands. The complexity of issues to be addressed in the North West Highlands, as identified in the scoping study (Van de Fliert, 2008) and subsequent stakeholder engagement through a workshop in Sapa on 20–21 September 2008, indicated that an interdisciplinary approach was required to eventually effect practice change under the very challenging agro-ecological and socioeconomic conditions. While limiting smallholders to enjoy profitable agricultural enterprises, these conditions are also directly the reason for reluctance towards practice change, as they cause reduced ability of smallholders to absorb risk. This is compounded by the limited capacity of service providers to provide an enabling environment for practice change. It was perceived that the most likely approach for producing an impact on alleviating constraints to maize and temperate fruit production systems in the North West Highlands would be to actively engage all stakeholders in the system in all stages of research planning, implementation, evaluation, and pilot roll-out, which is the underlying approach of this project.

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[1] *Improving post-harvest quality of temperate fruits in Vietnam and Australia* (CP/2002/086, later AGB/2002/086): *Adaptation of low-chill temperate fruits to Australia* (CP/2001/027); *Improving productivity and fruit quality of sweet persimmon in Vietnam and Australia* (CP/2006/066); *Managing pest fruit flies to increase production of fruit and vegetable crops in Vietnam* (CS2/1998/005).

[2] *Utilising basic soil data for the sustainable management of upland soils in Australia and Vietnam* (LWR/2002/085); *Evaluation and adoption of improved farming practices on soil and water resources, Bohol Island, The Philippines* (SMCN/2004/078).

[3] *Scoping Study to Identify Agricultural R&D Needs and Opportunities of Rural Upland Communities in North-western Vietnam* (CP/2007/123)

4 Objectives

The aim of the project was to increase smallholder engagement in competitive value chains associated with maize and temperate fruit based farming system and to use this engagement to improve land and crop management in these rapidly transforming sectors.

A market-driven and integrated approach to improved farm management, involving more sustainable and profitable farming systems, was assumed to benefit the livelihoods of rural communities in the North West Highlands. Improved market linkages that are best suited to the agroecological and socio-economic conditions were expected to be a strong driver for sustainable smallholder practice change.

Specific objectives of the project were:

1. To establish an understanding of constraints in maize and temperate fruit based farming systems that limit smallholder engagement in profitable markets and identify opportunities to overcome these constraints.
2. To develop improved farm and value chain management practices to optimise sustainability and profitability in smallholder maize and fruit based farming systems.
3. To build competitive value chain models that engage smallholders with more profitable markets in support of improved land and crop management.
4. To evaluate value chain interventions and improved land and crop management techniques to support scale out of successful technologies into government and non-government development strategies

This approach was expected to generate farm management solutions for smallholder upland farmers that suit their needs under prevailing conditions and deliver outcomes through to the market to eventually benefit the livelihoods of rural communities. As a result, project activities strongly linked management of the natural resource base to market opportunities, and developed the mechanisms to promote practice change by farmers through the existing service providers.

5 Methodology

5.1 Project framework and outline

The project was designed based on a framework for Research for Sustainable Development as presented in Figure 2 and operated mainly in the diagnostic, applied and adaptive realms of the framework. This framework recognises that to ensure successful community development outcomes, both content and process of the research and development processes need to suit the specific local conditions and capacities. This relates to:

- The suitability of the innovations to be developed and introduced. Consequently, diagnostic research needs to inform the agenda setting of the applied and adaptive research
- The nature of the innovation and the implications for farmers to implement those innovations (knowledge, skills, investment funds and access to inputs and markets).

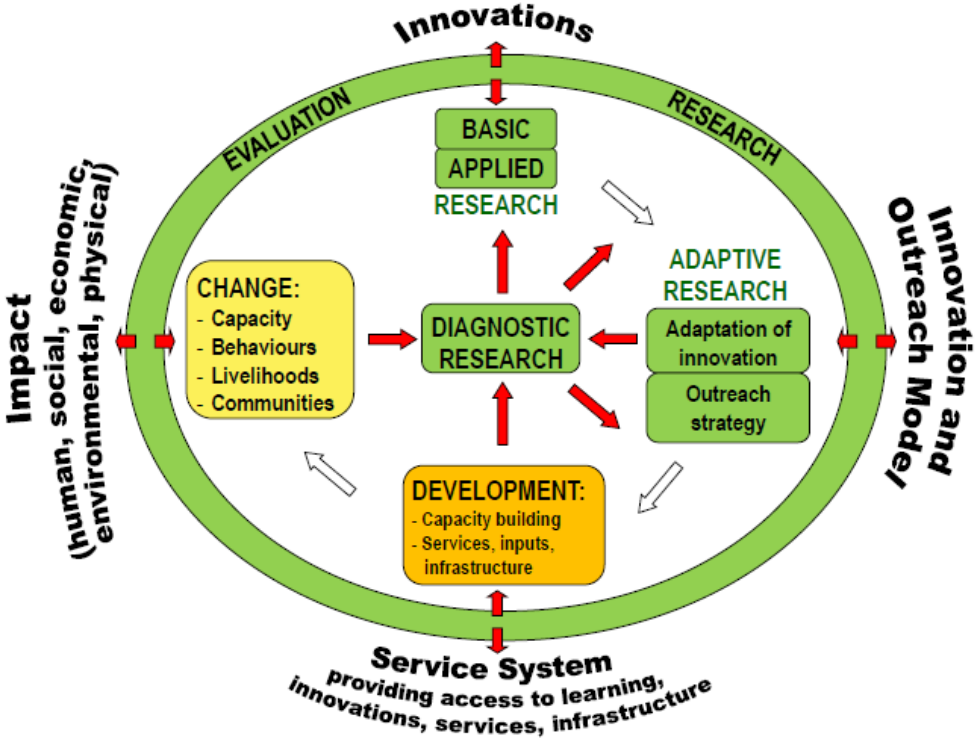

Figure 2: Framework for Research for Sustainable Development (after Van de Fliert et al., 2010[4])

[4] Van de Fliert, E., E. Jamal and B. Christiana (2010). The Do-It-Yourself formula – Internalising participatory communication principles to support rural development in Eastern Indonesia. In: Darnhofer, Ika and Michaela Grötzer, *Building sustainable rural futures. The added value of systems approaches in times of change and uncertainty.* 9th European IFSA Symposium, Vienna Austria, 4-7 July 2010, p. 585-593, http://ifsa.boku.ac.at/cms/fileadmin/Proceeding2010/2010_WS1.6_vanDeFliert.pdf (Appendix 8).

- The nature of the communication processes facilitating research and development activities to suit the abilities of the targeted stakeholders (e.g., level of education, language ability, cultural values, indigenous knowledge and practices).
- The capacities and resources of the system to carry the process at a substantial scale.

The project methodology was based on a participatory approach that required the project team to:

- Work in a transdisciplinary partnerships across project stakeholders.
- Understand the constraint and opportunities faced by farm families in the Northwest Highlands, and reasons for their lack of adoption of innovations to date.
- Determine the suitability of the innovations to be developed and introduced.
- Assess the implications for farmers to implement those innovations.
- Ensure the project methodology allowed the project stakeholders to effectively engage with each other and with community groups of diverse ethnic backgrounds, considering their varying level of education, language ability, cultural values, and indigenous knowledge and practices.
- Determine the capacity and resources of the service system to carry out the process at a substantial scale.

The project focused the research activities in maize based farming systems located in Mai Son and Moc Chau Districts in Son La Province, and Tam Duong and Sin Ho Districts in Lai Chau Province, but anticipated to develop approaches suitable for wider application in highland areas in Vietnam. Consequently, the selected locations had to be characterised by recently improved market connectivity and the presence of the two farming systems with high potential for improved market engagement and resource management.

The section below lists the phases and sets of activities as implemented over the project life, while a detailed set of activities and milestones can be found in the project document (variation 2) and in the milestones table in Chapter 6 below.

5.2 Research activities

5.2.1 Diagnostic research phase (year 1)

The first phase assessed the needs and opportunities of smallholders in the maize-based system and existing supply chains within the project area through a series of diagnostic studies and review of literature, as a basis for further research planning (Project objective 1). Activities contributed to the following outputs:

1.1 Profiling of market mechanisms, constraints and opportunities for more profitable farming systems for smallholders in the North West Highlands.

1.2 Identification of current resource constraints and opportunities to improve management practices.

A major activity during this phase was a Community-based Diagnostic Study, which was conducted from August - December 2009 in the eight selected communities in the project area (for detailed guidelines see Appendix 4[5]). The study, involving a range of methods such as participant observation, focus group discussions and semi-structured interviews, served the following two main objectives:

- To profile the communities of the selected project sites and identify needs and opportunities with regards to:

[5] Please note that the appendices are numbered based on the sequence they appear in the milestones table in Chapter 6 (with a few exceptions where some reports needed to stay together).

  - Biophysical conditions occurring in maize and temperate fruit based production systems.
  - Marketing of agricultural produce from maize and temperate fruit based production systems.
  - Agricultural production and marketing practices and perceptions of smallholder farm families.
  - Indigenous knowledge and practices relating to maize and temperate fruit based production systems.
  - Socio-economic, ethnic and gender-specific context relating to the transition from subsistence to commercial farming in maize and temperate fruit based systems.
  - Maize and temperate fruit products suitable for value chain development with potential to serve as demonstration chains.
  - Access to information and services relating to commercial farming in maize and temperate fruit based systems.
- To establish collaborative relationship between the communities, local organisations and research institutes.

Table 1 provides an overview of locations, dates and study teams of the community-based diagnostic study.

Assessment of existing supply chains (Step 2) was done through a Rapid Value Chain Analysis (RVCA) approach throughout 2009-10. The RVCA was designed as an integrative activity, linking both farming and business communities in the project area. It involved workshops with priority setting and mapping exercises, wholesaler, trader and retailer interviews, analysis and community feedback meetings. The workbook for the RVCA is provided in Appendix 5.

In addition, a scenario analysis was conducted in 2011 that served to compare scientist and farmer mental models of perceptions of soil erosion as risks to farmer livelihoods. The results of this study particularly informed the design of the outreach strategy. It was presented as a conference paper at the 3rd International Conference on Conservation Agriculture in Southeast Asia, Hanoi, 2012 (see Appendix 22).

Table 1: Overview of locations, dates and study teams of the community-based diagnostic study.

Province	District (distance to province)	Commune (distance to district)	Village (distance to commune)	Ethnic group	Step 1: Community diagnosis (mid Aug-mid Dec 2009) Research teams and dates					Step 2: RVCA (Sep-Dec 2009) Research teams, dates, activities		
					Com-mune	District level	Prov-ince	Coordi-nation	Dates	District level	Coordi-nation	Dates Activities
Lai Chau	Sin Ho 64 km	Ta Ngao 15 km	Lung Su Phin 6 km	Hmong 100%	8 farmer researchers	DARD, PPRI, HUA, NOMAFSI	PPSD	NOMAFSI	19 Oct onwards	PPSD, DARD, CASRAD	NOMAFSI, UQ	22-27 Nov Prioritizing value chain for district
		Lang Mo 27 km	Lang Mo 8 km	Hmong 95%								22-27 Nov Prioritizing value chain for district
	Tam Duong 30 km	Giang Ma LC 15 km TD 20 km	Giang Ma 1 km	Hmong 90%		DARD, PPRI, CASRAD			24 Aug onwards	PPSD, DARD, CASRAD		22-27 Nov Prioritizing value chain for district and maize RVCA
		Ban Bo LC 42 km TD12 km	Hung Phong 1 km	Kinh 70%								22-27 Nov Prioritizing value chain for district and maize RVCA
Son La	Moc Chau 100 km	Muong Sang 4 km	La Nga 4 km	Thai 98%		DARD, PPRI, CASRAD	DARD		7-12 Sep	DARD, NOMAFSI, CASRAD, PPRI		19-25 Oct Maize RVCA
		Phieng Luong 20 km	Pieng Sang 5 km	Dao 89%					11-14 Aug			20-27 Sep Plum RVCA
	Mai Son 30 km	Na Ot 31 km	Na Ha 4 km	Thai 100%		DARD, NOMAFSI, HUA			16 Nov onwards	DARD, HUA, PPRI		5-11 Oct Prioritizing value chain and Maize RVCA
		Chieng Chan 25 km	Ta Chan 14 km	Thai 100%								2-8 Nov Custard apple RVCA

5.2.2 Applied research phase (year 1-3)

The applied research phase involved the development of land/crop management practices and value chain innovations suitable for maize and temperate fruit farming systems in the North West Highlands with intensive involvement of relevant stakeholders (Objective 2). Activities in this research phase contributed to the following output:

2.1 Identification and prioritisation of market opportunities for improved smallholder profitability with associated market information requirements.

2.2 Evaluation of different management practices best suited to local conditions for increasing production and sustaining resource base.

While most crop management field trials were more of an adaptive nature, blurring the boundaries with the adaptive research phase and presented in section 5.2.3, the erosion trials were considered part of the applied research. Table 2 presents the outline of the two longitudinal erosion trials that were conducted troughout 2011-13 in two locations in Son La province, i.e. Na Ot commune (Mai Son district) and La Nga village, Muong Sang commune (Moc Chau district).

Table 2: Erosion trials in Na Ot and La Nga, 2011-13

Na Ot	La Nga	Comments
(i) Control	(iv) Control	The normal farmer practice was slash and burn before cultivation. But in 2011 the farmer at La Nga decided not to burn. Due to animal grazing in La Nga, mulch was imported in 2011.
(ii) Minimum Tillage	(ii) Minimum Tillage	Residue retained, cultivation of one row where maize was sown
	(iii) Minimum Tillage, rice bean intercrop	Different row spacing but same plant density. Rice bean did not grow in 2011 and 2012, hence this treatment in La Nga is the same as Minimum Tillage except for the different row spacing.
(iii) Mini-terraces		Built in 2011 and reshaped in 2012 and 2103, residue retained.
(iv) No-tillage	(i) No tillage	Residue retained and maize planted in small hole.
No free grazing	*Free grazing*	*Due to the difference in animal management between sites, the La Nga site was fenced off in years 2012 and 13.*

Adaptive research phase - innovations (year 2-4)

The innovation adaptation component of the adaptive research phase involved field trials testing promising innovations on a larger scale with intensive farmer decision making and evaluation (Objective 3). These activities contributed to the following outputs:

3.1 Development of competitive value chains through implementation of intervention strategies that effectively engage smallholders in the fruit and maize based systems and overcome current value chain constraints.

3.2 Identification of best bet management practices and design of associated communication methods and materials in maize and temperate fruit based farming systems that engage the market.

Outlines of the experiments in Gieng Ma (2012-13), Ban Bo (2012-13) and Pieng Sang (2012) are provided in Tables 3, 4 and 5, respectively.

Provincial extension centres of Son La and Lai Chau managed participatory demonstration plots that were part of the adaptive research activities. In each site, up to five households with appropriate land areas, ranging between 0.5 – 1.0 ha, were selected to take part in developing the demonstration plots. The technical options tested in these trials were evaluated in a participatory way with farmers and local staff, who then recommended the appropriate options for upscaling.

Table 3: Treatments and major cultivation information for experiments in Gieng Ma – Tam Duong – Lai Chau in 2012 and 2013

Experiment	Farmer name	Land area (m^2)	Treatment	Crop	Sowing density (m)	Fertiliser (kg)	Sowing/harvest
Erosion management (no soil loss measurements) Non-replicated experiment.	1. Do	1,500	T1 B& P T2 MT+ RB sown same time as MZ (2012 only) T3 MT+RB sowing after weeding (approximately 30 days after MZ) T4 Guatemala grass hedgerows + RB sowing after weeding	MZ Bioseed 9698 all treatments RB local variety Guatemala grass	MZ 0.7x0.3 T2:RB sown in same row as maize at distance of 0.5 m between plants T3: RB sown between rows of maize at 0.5 m between RB plants. Guatemala grass sown at 5 m.	**At sowing:** 500 NPK **1st dressing:** 100 Urea 50 Kaliclorua **2nd dressing:** 100 Urea 50 Kaliclorua	**2012:** **MZ** 28 March/23 July **RB** 28/03 not harvested **Guatemala grass** Transplanted 28/03 and continuously harvested in 2012 and 2013. **2013:** **MZ** 3 April/30 July
Demonstration Guatemala grass	1. Do	3,500	Guatemala grass hedgerows	MZ Bioseed 9698	0.7x0.4	**At sowing:** 500 NPK **1st dressing:** 100 Urea 50 Kaliclorua **2nd dressing:** 100 Urea 50 Kaliclorua	

Table 4: Treatments and major cultivation information for experiments in Ban Bo – Tam Duong – Lai Chau in 2012 and 2013

Experiment	Farmer name	Land area (m^2)	Treatment	First crop	Sowing density (m) and sowing/ harvest dates	Fertiliser (kg)	Second crop	Sowing density (m) and sowing/ harvest dates	Fertiliser (kg)
2 crops/year over 2 years on sloping and flat land **Design:** Replicated complete block with 3 replications, replicated over 2 years	Slope: Min terraces: 1. Liem Terraces: 2. Khe Flat: 3. Nam	1. 2,000 2. 2,000 3. 2,000	First crop: T1 Maize T2 Maize + mulch T3 Maize T4 Maize + mulch Second crop: T1 Maize T2 Maize + mulch T3 Soya T4 Soya + mulch	MZ CP999 all treatments	0.7x0.3 **2012:** 1 April/21 July **2013:** 14-21 April/ 30 July	**At sowing:** 500 NPK **1st dressing:** 180 Urea 90 Kaliclorua **2nd dressing:** 180 Urea 90 Kaliclorua	**2012:** MZ NK4300 (T1&T2) SB DT 84 (T3&T4) **2013:** MZ CP333 (T1&T2) SB DT 08 (T3&T4)	MZ 0.7x0.3 SB 0.4x0.15 **2012:** **MZ** 4-12 Aug/ 24-28 Nov **SB** 4-8 Aug/ 28 Oct-2 Nov **2013:** **MZ** 9-11 Aug/ 26 Nov **SB** 9-11 Aug/ 1-3 No	**MZ** as per first crop **SB:** **At sowing:** 500 NPK **1st dressing:** 65 Urea 50 Kaliclorua **2st dressing:** 65 Urea 50 Kaliclorua
Demonstration trials 2 crop per year (MZ intercropped with SB in second crop) (2012 only)	1. Hien 2. Dung 3. Ly 4. Dien 5. Thinh	2,000 each Total: 10,000	Maize and soya bean intercrop	CP999, no plough, no mulch.	0.7x0.3	**At sowing:** 500 NPK **1st dressing:** 150 Urea 50 Kaliclorua **2nd dressing:** 150 Urea 50 Kaliclorua	CP999 Soya DT 12 Mulch	MZ 0.7x0.3 SB only 1 row between MZ rows 0.15 between plants in row (0.7x0.15)	**At sowing:** 500 NPK **1st dressing:** 150 Urea 50 Kaliclorua **2nd dressing:** 150 Urea 50 Kaliclorua

Table 5: Treatments and major cultivation information for experiments in Pieng Sang- Moc Chau 2012 in fields in flat areas

Experiment	Farmer name	Land area (m^2)	Treatment	First crop	Sowing density (m) and sowing/ harvest date	Fertiliser (kg)	Second crop	Sowing density (m)	Fertiliser (kg)
2 crops per year **Design:** Replicated complete block with 6 replications	1. Song	4,000	First crop: T1 Maize T2 Maize + mulch T3 Pumpkin T4 Pumpkin + mulch Second crop: T1 Maize T2 Maize + mulch T3 Maize inter-cropped with soya T4 Maize inter-cropped with soya + mulch T5 Maize inter-cropped with peanut T6 Maize inter-cropped with peanut+ mulch	Maize AG 59 (T1&T2) Pumpkin Long (T3&T4) Pumpkin Round (T5&T6)	MZ 0.7x0.3 24 Feb/05 July Pum. 2x2 Sowing: 24Feb 1st harv. 21 Jun 2nd harv. 5 July	**MZ:** **At sowing:** 750 NPK **1st dressing:** 150 Urea 50 Kaliclorua **2nd dressing:** 150 Urea 50 Kaliclorua **Pumpkin:** **At sowing:** 500 NPK **1st dressing:** 50 Urea **2nd dressing:** 50 Urea	MZ AG 59 Mono-crop (T1&T2) MZ AG59 SB D8 (T3&T4) MZ AG59 Peanut Red local. (T5&T6) All crops: 6 July/ 8-13 Oct	MZ 0.7x0.3 for mono-cropping Re-spacing: Maize strip 0.4x0.3 Between strips 1 m Soya bean and peanut one row between maize 0.3x1.4m	**MZ:** **At sowing:** 750 NPK **1st dressing:** 150 Urea 50 Kaliclorua **2nd dressing:** 150 Urea 50 Kaliclorua **Soya bean and penut:** **At sowing:** 400 superP 30 Urea 50 Kaliclorua **1st dressing:** 30 Urea 50 Kaliclorua

5.2.3 Adaptive research phase – outreach strategy (year 2-4)

The second component of the adaptive research phase involved the development, testing and evaluation of an outreach strategy for proven land and crop management innovations and value chain models (Objective 4). These activities contributed to the following output:

4.1 Identification, design and piloting of effective mechanisms of value chain engagement that improve stakeholder profitability.

The following activities were conducted during this research phase:

- Outreach strategy design workshop and follow-up meetings with DARD staff, February-March 2012. This resulted in a pilot curriculum for a Farmer Field and Business School (FF&BS) model on Sustainable Management of Integrated Upland Maize Systems.
- Development of manuals for trainers and FF&BS facilitators throughout 2012-13:
  - A technical manual for Master Trainers (in Vietnamese) was written by the researcher team.
  - Facilitation guide for FF&BS facilitators was developed by a team of Master Trainers from the PPSD and DARD and with guidance from the project researchers.
  - A table of content (in English) is available as an addendum in Appendix 19.
- Development of videos throughout 2012-13 as support materials for the FF&BS planning and implementation:
  - Three videos were produced:
    - Promotional film to introduce the issues and opportunities to local policy makers ((DVD format and available at https://vimeo.com/135539202).
    - Technical module “Managing diversified farming systems on sloping lands” (DVD format and available at https://vimeo.com/256700835).
    - Technical module “Managing soil erosion on sloping lands” (DVD format and available at https://vimeo.com/256700894).
  - Production was done with the involvement of a professional filmmaker, Mr Timothy London of “Wolf and Lamb Productions” (http://www.wolfandlamb.co/), who trained two Vietnamese project staff to become part of the crew.
  - Around 1,000 DVDs containing the three films were distributed to farmers and government staff through the Son La and Lai Chau Extensions Centre.
- Training of Trainers on “Facilitation of FF&BS Sustainable Management of Integrated Upland Maize Systems” for 17 extension personnel from Son La and Lai Chau, conducted at Son La on 17-20 September 2012.
- Pilot FF&BS in four locations in Son La and Lai Chau, involving 83 farmers and facilitated by the ToT graduates in the following locations:
  - 20 farmers in Ta Leng village (Ho Thau, Tam Duong, Lai Chau)
  - 20 farmers in Na Van village (Ban Bo, Tam Duong, Lai Chau)
  - 23 farmers in Suoi Khem village (Phieng Luong, Moc Chau, Son La)
  - 20 farmers in Noong Luong village (Co Noi, Mai Son, Son La).
- Although the detailed content of each training curriculum varied across sites to suit the local conditions, the FFS model consisted of nine sessions covering all necessary steps from land and seed preparation to harvest and postharvest and concentrating on sustainable practices.

- The outreach model including the FFS program was adapted and then implemented on a large scale by the provincial extension centres of Son La and Lai Chau provinces. Follow-up FFS programs included simultaneous participatory research and learning activities on both FFS plots (0.5-1.0 ha in area) and trial plots (minimum 500 m^2) on farmers' own land. The technical options tested in these adaptive trials were evaluated in a participatory way during FFS sessions. Farmers then up-scaled the techniques that they had found to be suitable on larger areas of their land.
- In addition to the main outreach strategy targeting the eventual development of a service system in the two project provinces and beyond, minor activities were conducted in the project village throughout the project duration to actively engage the community. These activities included:
    - Photo stories made by farmer researchers who were provided with a pocket camera to document elements of change that was happening in their villages as a result of project activities. The photos were put together into stories around a certain theme with the support of the project field researchers. The farmers received a hard copy of their stories that they often put up in a public place and served as a trigger for discussions in the community. A selection of photo stories were compiled in a booklet for distribution among diverse stakeholder groups (see Appendix 20).
    - Field days and cross visits: From 2011, field days were organised for the community at the participatory trial and demonstration sites during a time of the season with the appropriate stage of plant growth and development to demonstrate the results of good management practices. Before harvesting the crops, cross visits for farmer researchers among different project sites within a district were organised. Farmers as well as commune, village and district leaders, extension officers, provincial extension centre and DARD officers, were invited and encouraged to exchange ideas on all related issues. See Appendix 19 for further details.
- An overall assessment of the adoption of recommended sustainable land use practices in maize-based systems resulting from NOMAFSI's collaborative research programs in the northwest of Vietnam funded by both ACIAR and CIRAD was compiled and presented by NOMAFSI in 2016 (see Appendix 26).

5.2.4 Evaluation research phase (year 1-4)

Activities as part of the Pilot FF&BS in four locations in Son La and Lai Chau contributed to the following output:

4.2 Evaluation of effectiveness and impacts of collaborative mechanisms for improved farming systems and value chain development on smallholders' livelihood.

Evaluation served both formative and summative purposes and was woven through all other research and capacity building activities through two main mechanisms:

- A Participatory Monitoring and Evaluation (PM&E) system (for detailed guidelines see Appendix 18).
- Annual reflection and planning workshops: this involved a series of workshops at the end of every year, starting with the farmer group researchers at the field sites (as part of the PM&E), then the province level and eventually central level. At central level workshops, in addition to presentations and discussions about research activities, all project partners were asked to fill out a questionnaire

covering topics ranging from self-assessment of their capacities to their opinions about project activities and management. Reflection results were used to guide planning of research and project management activities for the next year.

The evaluation mechanisms appeared crucial to materialise a certain level of transdisciplinary collaboration in project implementation.

5.3 Reflections on the transdisciplinary approach to R4D

Agricultural research in Vietnam is typically disciplinary in nature and determined by research agendas set by national priorities. This approach has appeared not very successful in dealing with complex issues of farming on steep slopes practised in the mountainous North West Highlands of Vietnam, a region characterised by an ethnically diverse population with a large proportion living below the poverty line. To address this serious natural resource management issue within the complex socioeconomic context, this project adopted a transdisciplinary and development oriented approach. The transdisciplinary team consisted of a range of Vietnamese and Australian researchers with backgrounds in soil science, agronomy, pest management, agribusiness, social science and communication, who worked in close consultation and collaboration with farmers, local government and practitioners from district/province government departments.

The Participatory Monitoring and Evaluation system together with the annual Reflection and Planning events provided the key mechanism to operationalise the transdisciplinary Research for Development approach. It provided researchers with the opportunity to experience how farmers make decisions and manage the system as a whole rather than in fragments. It also allowed researchers and farmers to better value their own and each other's expertise and disciplinary views in their quest to develop sustainable farming systems.

The Northwest Vietnam Project was the first joint attempt by ACIAR and MARD to implement a participatory and transdisciplinary research project. The integrated and transdisciplinary nature of the project required strong collaboration among the five research institutes involved and between these research institutes and the provincial Departments for Agriculture and Rural Development (DARD) and associated provincial extension centres. It was planned that researchers and field staff would be allocated to project activities across the partner institutions in order to maintain adequate levels of a transdisciplinary perspective in each component. It was envisioned that detailed methods and protocols for agronomic experiments, which would reconcile with market and value chain development opportunities, would be developed and refined at the Inception Workshop and subsequent annual Reflection and Planning Workshops. However, after the initial two workshops it became apparent that this approach was not working because the attempt to change a disciplinary research tradition that had been institutionalised for a long time into a transdisciplinary research culture was too sudden and too ambitious. Over time, however, and after several Innovation workshops that introduced different concepts and research paradigms to the team, this integration began to occur more naturally and was highly appreciated by the majority of the team. The promotional video, "Learning with Farmers" (https://vimeo.com/135539202) contains several statements by farmers, field researchers and the national program coordinator (currently a vice-minister at MARD) confirming this.

Evaluation questionnaires were commissioned among project partners to gauge their ideas and experiences relating to the collaborative mechanisms and transdisciplinary research approach during the Innovation Workshops in 2010 and 2013, at the start and the end of the project. A comparative analysis is summarised in Section 8.2 below and presented in detail in Appendix 27.

6 Achievements against activities and outputs/milestones

Preparation

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
0.1	Inception workshop	Common understanding of project aims and agreement reached	13-15 May 09	The Project Inception Workshop was held in May 2009 and provided the first opportunity for the Project to bring all of the project partners together. A common understanding was only partially achieved
0.2	Site selection	Project sites selected	May 09	One of the activities of the Inception Workshop was to develop site selection criteria. A team of PPRI and NOMAFSI partners conducted site visits and discussed site selection with local government and DARD. The team selected 8 villages. These were located in 8 communes in 4 districts in 2 provinces. Some sites did not conform to site selection criteria and it was difficult to implement the project in them. While selection was based on pre-determined criteria, local advice and negotiations, it appeared that these get interpreted and prioritised in different ways by different people with different interests. More time should have been allocated to this process.

Objective 1: Establish an understanding of constraints in maize and temperate fruit based farming systems that limit smallholder engagement in profitable markets and identify opportunities to overcome these constraints.

1.1 Profiling of market mechanisms, constraints and opportunities for more profitable farming systems for smallholders

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
1.1.1	Review of previous market based projects to understand existing market knowledge and analytical capability	Document detailing current market information and outcomes of previous value chain studies	Apr 10	A review of relevant literature and documents of previous value chain studies was undertaken and documented in a report (Appendix 1).
		Methodology design for diagnostic study workshop	Nov 09	See 1.1.4 below.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
		Review report on limitation of adoption of previous related ACIAR projects	Partially completed in May 10, finalised in Jan 11	A review of related previous projects was conducted based on available documentation and discussions with project leaders, and documented in an internal report (Appendix 2).
1.1.2	Profiling of communities and identification of farm family needs and opportunities	Document detailing conditions, needs and opportunities of target communities	July 10	A detailed report of the diagnostic studies carried out in 8 villages of Moc Chau and Lai Chau Provinces was finalised in June 2010 (Appendix 3). The study provided in-depth insights into the community characteristics, land use patterns, cultivation and marketing practices, information sources and perceived constraints and opportunities at the selected project sites, which informed subsequent research agenda setting. The participatory diagnostic study brought researcher from PPRI, NOMAFSI, CASRAD and UQ, and local government partners (DARD and extension workers) and farmers together as a project team. It also: • recognised that site selection had been sub-optimal in terms of importance of fruit trees and market linkages. • found that there was limited overlap between fruit trees and maize-based systems • identified farmer researchers and experimental sites • agreed on treatments for field experiments in 2010
		Inventory and analysis of existing R&D and impacts of R&D by DANIDA, ADDA, World Vision and other relevant programs		A report describing relevant past and current projects was produced in April 2010 (Appendix 2). The report highlighted several technologies and methods (FFS for ethnic minority groups, poverty assessment) that were considered for the Project. An update of the status of relevant on-going projects through which research outputs could possibly be disseminated in the Northwest was not conducted due to difficulties to engage the DARDs with other initiatives, and to some organisational changes that occurred in potential outreach programs: – DANIDA: The Agriculture and Rural Development Sector Program Support (ARD SPS, 2007 to 2012) changed its modus operandi in 2009 by transferring Danish funds through the state treasury, merging the monies with state budget funds for use on general allocations in the provincial agricultural and rural development plans in the five program provinces (including Lai Chau). – ADDA's Community Development Project is conducted in collaboration with the Vietnam Farmer Union (VFU). Phase I (2006-09) had an initial focus on Maize ICM FFS, and Phase II (2010-2014) on climate change adaptation. The project operates strongly through a project based network of VFU representatives and facilitators, without tangible ties with the DARDs and Extension Service. The project collaborated closely with related projects such as the ADAM project of CIRAD. No other programs have been identified as suitable for outreach functions.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
1.1.3	Value Chain Management Principles and Practices workshop	Establish common understanding in team, process guidelines, evaluation strategy	May 09	A Principles and Practice workshop was conducted back to back with the Inception Workshop in May 2009. The workshop provided a basis for mutual understanding of approaches previously applied by CIAT, CASRAD and UQ, and further RVCA methodology development.
1.1.4	Innovation workshop (II)	Develop methodology for diagnostic studies	Aug 09	Project site selection: Criteria for site selection were formulated during the Inception Workshop in May 2009, based on guidelines developed with the PPRI team. PPRI and NOMAFSI staff conducted site selection visits to the four project districts, and facilitated the village selection process involving local governments and DARDs. Not all selected project villages fully complied with the selection criterion of recent market connection, as it was defined by the team. This criterion particularly identifies communities that are in the transition from subsistence to commercial agriculture, which is the main target of the project. Particularly in the case of Moc Chau district, Vietnamese partners gave higher priority to some of the other indicators (erosion constraints, temperate fruit availability), and in all cases political considerations influenced the final decision. The diversity of the study sites, however, provided a unique opportunity for the team to learn to apply adaptive strategies towards innovation, which is considered one of the key factors for large scale impact as a result of research for development.
			Sep 09	A diagnostic study methodology development workshop was conducted for four days in August 2009, involving representatives from all partner organisations and some target communities. The workshop served to design, pre-test and produce protocols for the diagnostic research activities, build capacity in participatory research approaches and establish/enhance field team collaboration. A comprehensive methodology for the community based diagnostic studies was documented in English and Vietnamese for internal use by the research team (Appendix 4).
1.1.5	Training workshop for Rapid Value Chain Appraisal (RVCA)	Team members competent in Rapid Value Chain Appraisal	Sep 09	A training workshop on RVCA was conducted in September 2009, involving UQ, CASRAD, HUA and TBU staff, which resulted in a project specific RVCA Workbook (Appendix 5).
		Appraisal principles and applications documented in RVCA workbook		The RVCA workbook was developed and published for internal use (Appendix 5). The workbook served as a guideline for field implementation of the Rapid Value Chain Appraisal.
		Learning case studies		Learning case studies were conducted in Moc Chau as part of the RVCA workshop to develop capacity of the team and pre-test the methods (reported in Appendix 5).

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
		Criteria and selection of products for RVCA		Criteria and selection of products for RVCA were determined during the RVCA workshop and reported in the Workbook (Appendix 5).
		RVCA workbook revised and updated	Jun 13	See 3.1.1.
1.1.6	Rapid Value Chain Appraisal (RVCA) within provincial locations through to market	RVCA for selected products	May 10	RVCAs were conducted on maize and pigs in Lai Chau province and maize and plums in Son La province in 2010. Based on the RVCA results, the conclusion was drawn that the maize value chain is well developed and improvements will not significantly contribute to erosion prevention or improved farmer income. Consequently, the focus in the second year of project was on alternatives to maize. Studies of complimentary crops (as second crop following maize, or intercropped) in maize based systems were conducted. The RVCA results also indicated that pig production can significantly improve household income but pig production is not the immediate target of this project. The plum RVCA in Moc Chau showed that plum VC could be improved through quality management of the fruits for products that can attract higher prices, such as sweeter and bigger fresh plums or plum brandy. This finding informed the direction of subsequent VC research activities. Reports of RVCA activities are provided in Appendix 6 (a, b, c).

1.2 Identification of current resource constraints and opportunities to improve management practices

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
1.2.1	Review and analysis of existing literature and databases to produce a baseline dataset of natural resource constraints	Summary report	Dec 09	A review on the Vietnamese and international literature English language and relevant to NRM in North West Vietnam was completed and reported (Appendix 7a). The report highlights the importance of minimum tillage, mulch and intercropping, and reiterated the importance of immediate benefits (higher yields, multiple benefits such as feeds or reduced labour) for farmers to achieve adoption of soil conservation technologies. The Vietnamese NRM literature (in Vietnamese language) was also reviewed and written up in English (Appendix 7b).
		Methodology design for diagnostic study workshop		See 1.1.4

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
		Review report on limitation of adoption of previous related ACIAR projects	May 12	A review of related previous projects was conducted based on available documentation and discussions with project leaders, and documented in an internal report (Appendix 2).
1.2.2	Identification of biophysical constraints, socio-economic context of production, practices and perceptions, indigenous knowledge/ practices	Methodology documented	Jan 10 Sep 09 Jul 09	A conference paper outlining the context and underlying approach of the project was submitted to and accepted by the 9th European Integrated Farming Systems Association (IFSA) Symposium, 4-7 July 2010, Vienna (Appendix 8). Methodology for identification of socio-economic aspects of NRM is contained in Appendix 4. A new (for Vietnam) erosion assessment methodology (pin method) was documented for implementation under the NW Vietnam conditions and used to train a field team (Appendix 9).
		Engagement of stakeholders in participatory processes	Ongoing	Stakeholders in the diagnostic research phase included farmers in selected communities, local governments, district extension officers and DARD/PPS staff, provincial government and DARD/PPSD staff, and all research partners at NOMAFSI, CASRAD, PPRI, HUA, TBU and UQ. Each stakeholder group/organisation had representatives participating in the community based diagnostic studies, which allowed them to understand the selected project locations from a system's perspective and to build up collaborative field research teams. Through the methodology development and field-based pretesting, in which all stakeholder groups were represented, capacity was built at all levels and relationships were established, as evidenced by the successful implementation by the field teams of the methodology. A Participatory Monitoring and Evaluation system was designed, and capacity to implement it was built among field researchers. See 3.2.1 for more detail.
		Written report detailing findings	May 10	A detailed report describing the profiles, needs, opportunities and plans for collaborative research of the eight participating village was produced (Appendix 3). This report served as a reference for the project team to understand the relations between the various components of the system in each of the locations. The findings provided crucial input into the design of applied research activities in the 2010 planting seasons and onwards.
		Inventory and analysis of existing R&D and impacts of R&D by DANIDA, ADDA, World Vision and other relevant programs	May 10	See 1.1.2.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
		Report on farmers' and researchers' perception on ero-sion and its impact on farmers' liveli-hood.	Nov 2013	A scenario analysis was conducted in 2011 that served to compare scientist and farmer mental models of perceptions of soil erosion as risk to farmer livelihoods. A report was written and transformed to a conference paper for the 3rd International Conference on Conservation Agriculture in Southeast Asia, Hanoi, 2012 (Appendix 22).
1.2.3	Benchmarking of current soil fertility status and erosion rates in project sites through soil and plant tissue analysis	Preliminary report detailing results of basic soil and plant tissue analysis	Apr 10	Field trials measuring soil erosion under different soil management practices set up in 2010 using a pin method. There is controversy among the project team on its merits. However, the method has shown one very important issue: There is considerable soil movement down the slope but, at least for farmers on lower slopes, the deposition of soil from higher fields is masking observable soil losses (deposition – losses) in their own fields. This may explain why farmers are aware of soil erosion but are not immediately concerned. Infiltration rates of soils at research sites vary and are high in some cases. Soil cover / mulch increases infiltration rates and is a key factor for controlling erosion.
		Report detailing erosion rates and change in soil fertility over time	Jun 13	Benchmarking of soil erosion using a method that hadn't been used before in Vietnam (pin method), was completed in 2009 in various locations in the two project provinces. The methods and results are reported in Appendix 10. A poster was produced for internal display at the UQ LCAFS booth. Full integration of erosion methods into on-farm research (farmer research managed trials) and FFS was not accomplished.The pin method appeared not suitable for farmer experimentation as the fields must not be disturbed, which is impossible in farmer managed situations.

Objective 2: Develop improved farm and value chain management practices to optimise sustainability and profitability in smallholder maize and fruit based farming systems.

2.1 Identification and prioritisation of market opportunities for improved smallholder profitability with associated market information requirements.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
2.1.1	Identification and validation of product range with market potential	Shortlist of products (up to 4)	May 10 and ongoing	The RVCA activities and subsequent initial market research identified the potential for improvements in the plum, peach and persimmon VC. However, the Mid-term review recommended limiting the project's activities in Lai Chau, so no VC activities were conducted there as of 2011. The need for investigation of the value chain of pumpkin and pulses emerged from the opportunities for a second crop created by improved soil management practices. The research team evaluated rice bean, soya bean and black bean and all these crops are suitable as a second crop in maize based system. The value chain analysis in Son La province had identified plum, pumpkin, soybean and dwarf bean as potential products for further value chain development (see Appendix 6a). It was decided to focus VC work on plum and pumpkin in 2011, and continue detailed VC work on plum in 2012 in Moc Chau district, Son La province, which is reported in Appendix 11. An in-depth analysis to validate the market potential of the short-listed products in terms of markets and smallholder production potential was not conducted due to lack of financial and human resources, which were fully allocated to the plum value chain development activities.
		Chain members identified and sites confirmed.		
		Production constraints identified	Jun 13	
		In-depth value chain study of secondary crops in maize based systems in Son La province		
2.1.2	Development of whole supply chain strategies to improve smallholder engagement	Broad strategies identified for each chain: - Plum VC in Moc Chau - Pumpkin, rice bean soya bean	Dec 12 Jun 13	Whole supply chain strategies to improve smallholder engagement were developed for the Tam Hoa plum value chain in 2010 and 2011. This resulted in high level engagement of Hanoi based wholesalers with collectors and farmers in Moc Chau. The initial engagement established in 2012 was continued in 2013 resulting in significant increase in volume of plums that farmers and local collectors committed to the high value plum VC in 2013. A detailed report on the plum VC development is provided in Appendix 11. Development of VC for pumpkin from Moc Chau was initiated in 2012 and is reported in Appendix 11. Links have been established with ASODIA, a French NGO working with a range of stakeholders on plum brandy in Moc Chau (see Appendix 2). In 2012, HUA carried out a study of the potential of the already grown crops pumpkin, soybean, mung bean and rice bean as complimentary crops. The plum value chain research consumed the resources (people and budget) of the value chain team, not leaving sufficient resources to study other complementary crops.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
2.1.3	Confirmation of products, participants and channels suited to development as competitive value chains	Product list Validation of the RVCA Detailed analysis of demonstration value chains	Aug 10 Sep 13	RVCA results were validated for plums. Detailed analysis of the plum demonstration chain was reported, while an overall final report of value chain work was finalised in September 2013 (Appendix 11). Many activities were carried out to study various aspects of the value chain and the project formed strong relationships with VC actors/ collectors.
2.1.4	Review of (agricultural) information sources and service providers.	Document detailing information sources and service providers in project target areas Methodology design for diagnostic study workshop	Jul 12	A literature review on extension approaches and services in Vietnam and particularly the North West was conducted by HUA partners in 2010. The results of this review are captured in the PhD thesis of HUA Lecturer and JAF recipient, Nguyen Huu Nhuan. The thesis was completed in July 2015 and can be accessed via the UQ Library (https://espace.library.uq.edu.au/view/UQ:398448). During the initial stages of the PhD research, the study findings informed the project team in their outreach strategy design. Identification of local agricultural information sources and services was contained in the site selection activities and community based diagnostic studies (Appendix 3).
			May 10	RUDEC presented an overview of the policy environment surrounding rural development in the North West at the 2010 annual meeting (available on request). A draft report of their policy study was submitted in October 2011 (Appendix 12). The report was not considered specific enough for the Northwest region by the other Vietnamese senior project team members. However, by that time relevant staff at RUDEC had already left the organisation and would not respond to further requests for involvement. Subsequent policy studies were not conducted by RUDEC and no longer deemed necessary.
2.1.5	Profiling of the current access to and needs for information and services by participating communities.	Document detailing mechanisms to improve access to information and service providers in target communities Document detailing access, needs and opportunities of target communities to information and service providers	May 10	Current status of the access, needs and opportunities to information and service providers of the eight participating target communities was documented in an internal community profile report (Appendix 3).

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
2.1.6	Identification of potential mechanisms to improve access to information and services	Report on communication pathways between project research partners and between project research partners and local government, DARD and farmers with strategies to improve these communication	Apr 11	A communication analysis was conducted by an AYAD hosted by the project in early 2011, which is reported in Appendix 16. The study highlighted the weak involvement of local extension officers at research sites as researchers dealt directly with farmers, a lack of information and data sharing among partner institutions, the need for a common framework for data collection and recommended the development of a project web space for project internal information sharing and data safe keeping, and the development of a simple monitoring framework. The results were used to improve the project's communication strategy for internal communication and informed the establishment of a project website, as well as the formulation of the outreach strategies in each province.
		Project website developed and maintained. Report on website use by various stakeholders	Jun 12 Dec 13	A project website was developed in 2011 with the intention to be used as a platform for internal project communication across participating research institutions and extension providers. The website included features to allow project partners to upload and share datasets, preliminary results, interim reports and final reports. However, the project partners were reluctant to share anything but final reports, indicating that open (albeit internal) platform provided is not compatible with the common Vietnamese practice of publicising only finalised and approved reports. In 2013, the website was restructured to serve the main purpose of providing information about the project to the general public. The project team was not able to provide sufficient content onto the website, and consequently the website has not gone public. The project appeared not to have sufficient resources to manage a specific project website adequately, and should probably not have attempted to establish one.

2.2 Evaluation of different management practices best suited to local conditions for increasing production and sustaining resource base.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
2.2.1	Participatory technology development trials testing land and crop management innovations through collaborative research mechanisms	Participatory Integrated Crop Management (ICM) trials installed and evaluated	Dec 2013	In 2010, 19 (4 on-station and 15 farmer researcher) trials dealing with various aspects of erosion and crop management in the maize cropping system were conducted. The trials conducted in the first half of the rainy season revealed that with good soil management practices there would be an opportunity of cultivating a second crop in several of the locations, which was trialled in the second half of the season. The trials also showed potential for incorporation of a range of intercrops or off-season crops. (Appendix 13a). A paper reporting on the preliminary findings of the erosion management and maize ICM trials conducted in 2010 was presented at the Second International Conservation Agriculture Workshop and Conference in Southeast Asia July 2011 in Phnom Penh and was published as a book chapter in 2012 (Nicetic et al., 2012, Appendix 21). In 2011, the number of field trials was reduced following the recommendations of the Mid-Term Review, Eight trials testing five erosion management strategies, and six crops with potential to be intercropped with maize were conducted. In two of those trials two consecutive crops within the rainy season were also tested. Summary of the trial results is presented in Appendix 13b. In 2012, two trials were conducted in Tam Duong district of Lai Chau province testing maize grown with Guatemala grass as hedgerows in Gieng Ma and two crops within one rainy season with the use of mulch on flat and sloping lands in Ban Bo.
				In Son La province, four experiments were conducted: two in Mai Son district testing two crops within rainy season (Chieng Chan) and soil erosion management practices (Na Ot); two in Moc Chau testing pumpkin-maize system (Pieng Sang) and soil erosion management practices (La Nga) (Appendix 13b). Field trials on erosion assessment under different soil management practices were completed in 2010-13 and a summary reports are provided in Appendix 13a (2010) and 13b (2011-13). The results were not conclusive in demonstrating reduced erosion rates as a function of soil management practices. Large impact of soil cover on infiltration indicated that soil cover is the most important factor controlling erosion. However, the amount of ground cover accumulated over the project period on the experimental is still too low to cause significant reduction of soil erosion. The methodology to measure erosion was modified for the 2013 trials to reduce the effect from soil deposition, however, weaknesses of the method for implementation under farm conditions have been identified and are described in Appendix 14. Five presentations relating to the project were delivered at the Third International Conference on Conservation Agriculture in Southeast Asia in December 2012 in Hanoi, and published in the proceedings (Appendix 22) Also, the Project formulated a Participatory M&E (PM&E) system (see 3.2.1), which improved the participation of farmers in planning, implementation and analysis of trial results.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
2.2.2	Identification of promising cropping systems related to market opportunities and smallholder biophysical key constraints	Report detailing the combined results of the diagnostic study	Jun 10	A detailed report of the diagnostic studies was finalised in June 2010 (Appendix 3).
2.2.3	Participatory pilot trials engaging farmers in integrated land, crop and value chain management	System trials installed and evaluated	Nov 3	Trials (2011-13) to improve existing plum orchards and establish new temperate fruit orchards were conducted from 2010 to 2013. All decisions made during these trials were influenced by the diagnostic study, PM&E and plum VC development. Farmer researchers were encouraged to test promising treatments on their own land and adapt to their own conditions. In Moc Chau the Project worked with 5 farmers to improve their existing Tam Hoa plum orchards. In Moc Chau and Lai Chau, the Project worked with 14 farmers to plant new temperate fruit orchards of DCS1 early flowering peaches, and smaller areas of Rubenal plum and Fuyu and Jiro persimmon varieties. Results are reported in Appendix 15.

Objective 3: Build competitive value chain models which engage smallholders with more profitable markets that support improved land and crop management.

3.1 Development of competitive value chains through implementation of intervention strategies that effectively engage smallholders in the fruit and maize based systems and overcome current value chain constraints.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
3.1.1	Value Chain Building training workshop	Team members competent in Value Chain Building processes Workbook for participatory value chain building (RVCA workbook) revised/updated	Ongoing Nov 13	As there had been several staff changes of the field researchers in the CASRAD team, two training events were organised first in November 2010 and second in March 2011, to build capacity in Value Chain Assessment and Improvements. Additional workshops were organised in November 2011 and March 2012 during which analysis of the completed activities and planning for the new activities were performed. A team capacity building was conducted in the form of an Innovation Workshop on Agricultural and Value Chain Systems Research: From Theory to Practice (September 2011) and Workshop on Agribusiness Research-for-Development Methods (September 2012). The RVCA workbook was revised and circulated in English (Appendix 5) and Vietnamese.
3.1.2	Value Chain Building work-shops with small-holders and supply chain members to link market oppor-tunity and current capacity	Workshop reports	Nov 12	A series of workshops with smallholders on plum and pumpkin VC were conducted in 2012 and the first half of 2013. The report on these workshops are included in the final report on plum and pumpkin VC (Appendix 11).
3.1.3	Whole value chain members in development of improved value chains incorporating evaluation and review cycle.	Evaluation and review cycle for each demonstration chain Improved commercial activity	May 11 May 12 May 13	The High Quality Plum Chain and Pumpkin Chain were selected for value chain development in 2011. This included the development of a High Quality Plum Chain. CASRAD organised a “Moc Chau Plum Degustation Conference” in May 2011 to have consumers and retailers evaluate Moc Chau plums. This conference was followed by a sensory evaluation session in May 2012. The sensory evaluation compared plums at three stages of ripeness: the early stage of ripening (9.5 to 10.9o Brix), medium ripening (11-12.4o Brix) and fully ripened (≥12.5o Brix). Results showed that colour is the main factor in consumer decision to buy plums and sugar content is the main factor in consumer organoleptic satisfaction. (Appendix 11). A large part of the benefit of the higher price of High Quality plums was captured by traders who sort plums into different quality grades.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
				The Plum VC work found that that improved marketing and potential branding must be on the basis of earliness to market (High prices are only achievable early in the season; pruning and fertilizing to promote larger plums delayed plum development and so misses the high-price period), plum colour and food safety standards, which became input for the design of the 2012 activities. The 2012 VC work also worked on involving a larger volume of plums, as one problem identified was too few, and more chain actors (collectors, wholesalers and retailers) but volume of plum that was marketed through wholesalers in Hanoi was very low. In 2013, collector and farmer groups from Moc Chau traded directly with retail shops in Hanoi. The plum and second crop VC reports are provided in Appendix 11. Despite initial potential identified, Pumpkin VC work in 2011 revealed that markets and prices for pumpkin fluctuated greatly and further research was required to develop a greater understanding of the pumpkin value chain. Consequently, activities in 2012 were redirected to a broader market potential study of complementary crops in the maize based system (processing pumpkins, rice bean, soybean and mung bean) conducted by HUA researchers. The report is provided in Appendix 17. Effective integration of cropping system research (production) and value chain (marketing ++) activities and outputs was not achieved. The different project components appeared to be implemented in isolation rather than in collaboration.

3.2 Identification of best-bet management practices and design of associated communication methods and materials in maize and temperate fruit based farming systems that engage the market

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
3.2.1	Identification and verification of promising innovations through adaptive trials Final analysis in late 2013	Report on evaluation of identified best bet management options to improve systems adaptability to manage risk Scientific paper	Dec 13	Recommendations for best management practices were formulated as result of trials reported under Objectives 2.2.1 and 2.2.3 and results from FFSs. Some key recommendations include (1) the cultivation of two (but different) crops per year possibly with a short-duration maize varieties; (2) legume crops; (3) mulching; and (4) minimum tillage (Appendix 13b).

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
				In Son La province, four experiments were conducted, two in Mai Son district (in Chieng Chan and Na Ot) and two in Moc Chau districts (Pieng Sang and La Nga). • Chieng Chan: two crops within one rainy season. The cropping pattern involved maize as the first crop and black bean as the second crop. Black bean performed better in mulched plots but maize suffered severe mice damage in mulched plots resulting in the discontinuation of the experiment in 2013 as requested by farmers. • Na Ot: soil erosion management practices. There were no significant differences in yield between control, minimum tillage and no-tillage treatments. Farmers are showing interest in minimum tillage because it requires less labour input. • Pieng Sang: pumpkin was tested as the first crop followed by maize as the second crop within one rainy season. Both crops were successful and farmers within the village started applying this cropping pattern in their own fields. An assessment of outreach was planned for later in 2013. • La Nga: soil erosion management practices. Minimum and no tillage treatments performed significantly better than the control. The Participatory Monitoring and Evaluation (PM&E) methodology (Appendix 18) guided the project activities towards planning and tracking the achievement of outputs and outcomes. It is worth noting that the project team designed the system and produced written guidelines through a series of rounds of revisions to be culturally suitable to the team of field researchers who had to implement the PM&E system. The activities involved with PM&E resulted in an increasing influence of farmer researchers in decision making on trial design, implementation and evaluation throughout the seasons.
3.2.2	Design and pretesting of dissemination methods and materials (FBS part of FB&FS)	Draft FBS modules for FF&BS manual Implementation of participatory processes using technical solutions Materials for dissemination of research outputs	Mar 13	Modules for a Farmer Field and Business School (FFBS) were developed and tested in a season-long on-the-job training of trainers in Lai Chao and Son La provinces in 2012-13. The training concluded in September 2013 and facilitators' guidelines were finalised and produced in Vietnamese and used by the Extension Centres and FFBS facilitators for subsequent training events they organised as part of their own outreach program. A technical manual on sustainable land and crop production on sloping land in the northwest of Vietnam, capturing the research findings, was produced (in Vietnamese, Appendix 24) and made available to extension officers in Son La and Lai Chau provinces.
3.2.3	Pilot roll-out of dissemination methods and materials (linked with improved value chain elements)	Pilot scheme documented	Dec 13	Four pilot Farmer Field & Business Schools (FFBS) were conducted in 2013, each involving nine sessions spread over two cropping seasons. Follow-up implementation plans were designed at provincial level and implemented by the local government services upon completion of the project. A report on the overall outreach strategy is provided in Appendix 19.

Objective 4: Evaluation of value chain interventions and improved land and crop management techniques to support scale out of successful technologies into government and nongovernment development strategies

4.1 Identification, design and piloting of effective mechanisms of value chain engagement that improve stakeholder profitability.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
4.1.1	Analysis of small-holder and chain member impact of intervention	Impact analysis and mapping of value chain potential	Annual cycle link-ing to Reflection & Planning Workshops	As part of the plum value chain development activities, annual workshops with stakeholders to analyse impacts of value chain interventions were conducted in 2011, 2012 and 2013 (Appendix 11). Farmers participating in planting of new early ripening peaches in Lai Chau reported high incomes from their first peach season. Also, farmers at project sites who were able to plant two crops per season instead of one crop achieved higher incomes.
4.1.2	Identification of outreach approach to improve access to information and services.	Document detailing mechanisms to improve access to information and service providers in target communities Report on communication pathways between project research partners and between project research partners and local government, DARD and farmers with strategies to improve communication.	Apr 10 Jun 12	This output was added in the variation of the project document but doubled up with the output of activity 2.1.6 and 3.2.3. A comprehensive outreach strategy was designed and piloted, involving field days and cross visits, training and communication materials (photo stories, videos, training manuals, printed information materials), demonstration plots, a Training of Facilitators for extension officers, and the design and piloting of a Farmer Field School (FFS) model on sustainable upland maize production systems. A report on the overall outreach strategy is provided in Appendix 19. A booklet produced from a selection of farmers' photo stories is contained in Appendix 20. The strategy and implementation results were presented at the 4th CANSEA Conference in Cambodia in December 2013 (Appendix 25). In addition, NOMAFSI published the results in a paper entitled "Promoting the adoption of sustainable land use practices in maize-based systems in northwest Vietnam" in the 'NOMAFSI's Achievements in Research and Technology Transfer, 2006 – 2015", printed in 2015 by the Agricultural Publishing House, Vietnam (original in Vietnamese, Appendix 26).

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
4.1.3	Design of outreach activities and production of toolkit (FFS part of the FF&BS)	Draft FFS modules of FF&BS manual Participatory video with featuring awareness raising training modules Laminated leaflets for farmers	Mar 13	Draft Farmer Field School (FFS) modules were designed and FFS facilitation guidelines were developed and tested in a season-long on-the-job training of trainers in Lai Chao and Son La provinces. Technical manuals were also drafted by researchers and revised by the team of trained extension officers. The footage for a series of videos involving farmers, extension officers and researchers involved in the project was collected and editing of two video modules to serve as training and discussion material in the FFS completed. An additional promotional video was produced and finalised in September 2013. Laminated leaflets with pictures of pests and diseases of selected crops were produced by PPRI and distributed to farmers in the project villages. The crops include plum, peach, maize, soybean, and groundnut.
4.1.4	Piloting of FF&BS in four locations	FF&BS curriculum delivery and training outputs documented	Dec 13	During pilot implementation, it was decided to call the training model designed for the purpose of sustainable upland maize systems just “Farmer Field School”, rather than FF&BS, as the focus of the training is on crop management. The curriculum, however, still contains topics on farm management and marketing, as well as a range of exercises to enhance farmers’ critical skills. Four FFSs were piloted engaging 83 farmers in two villages in Son La and two villages in Lai Chau. Each farmer participant was encouraged and supported to apply the preferred techniques presented in the training in a small selected plot of 500 m^2 in their own field, involving a total of around 4 hectares (Appendix 19).

4.2 Evaluation of effectiveness and impacts of collaborative mechanisms for improved farming systems and value chain development on smallholders' livelihood.

No.	Activity	Outputs/ milestones	Comple-tion date	Comments
4.2.1	KASP study of farmers participating in pilot outreach activities	KASP analysis documented Scientific paper	Dec 13	Due to delayed pilot FFS implementation, evaluation was only conducted at the field school level by the facilitators and local government officials, but no reports were submitted to the project team. Vietnamese researchers, however, observed that during subsequent (post-project) seasons two of the four villages that had conducted the pilot FFS in 2013 had over 50% of farming households practise minimum tillage and apply mulch on their lands (Appendix 25). It was also documented that local provincial and district governments in Son La, Lai Chai and Yen Bai continued training of trainers and large-scale farmer training from 2014 onwards, involving approximately 1,000 farmers in 2014, and over 3,000 in 2015 (Appendix 26). The strategy and implementation results were presented at the 4th CANSEA Conference in Cambodia in December 2013 (Appendix 25). In addition, NOMAFSI published the results in a paper entitled "Promoting the adoption of sustainable land use practices in maize-based systems in northwest Vietnam" in the 'NOMAFSI's Achievements in Research and Technology Transfer, 2006 – 2015", printed in 2015 by the Agricultural Publishing House, Vietnam (original in Vietnamese, Appendix 26).
				Vietnamese researchers had become convinced that the participatory nature of the research resulted in a land and crop management system that appeared acceptable and applicable for farmers in the north-western highlands, both from economic, environmental and social perspectives. This was expressed by several of the project partners in the promotional video (https://vimeo.com/135539202), (In Vietnamese, English subtitles)
4.2.2	Analysis of small-holder and chain member impact of intervention in plum value chain	Impact analysis and mapping of value chain potential	Dec 13	A plum value chain analysis is available, including capturing of benefits by various actors along the chain during 2011-13 (Appendix 11).

7 Key results and discussion

The project aimed to increase smallholder engagement in competitive value chains associated with maize- and temperate fruit-based farming systems while improving land and crop management practices for the development of sustainable and profitable farming systems. The project targeted smallholder farmers in the Northwest Highlands of Vietnam who recently acquired market access and were in transition from subsistence to commercial agriculture. The following is a summary of key results.

7.1 Participatory needs and opportunity assessment

7.1.1 The Community Based Diagnostic Study

The Community Based Diagnostic Study was conducted from August to December 2009 following the methodology described in section 5.2.1 and in the Guidelines for community based diagnostic studies (Appendix 4). The study was conducted in eight communes, with detailed investigation carried out in one village of each commune. Some of the farmers involved in study were later selected as “farmer researchers” and erosion management and integrated crop management trials were established in their fields.

The diagnostic study was conducted by researchers from Plant Protection Research Institute (PPRI), Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) and Centre for Agrarian Systems Research and Development (CASRAD) together with the provincial DARD/PPSD staff and district extension officers. The study was led by researchers from PPRI but all field work was done by mixed teams comprising staff members from all institutions who contributed their specific skills. Establishment of mixed teams was a very important step in the development of high level of inter-institutional cooperation achieved in the first year of the project. Even though the formation of the mixed teams was a novel concept, very different from the normal mode of operation of Vietnamese research institutions, after initial facilitation by the Australian team the mixed teams performed independently, harmoniously and effectively. Data collected showed a certain level of inconsistency as a result of many people being involved and different teams conducting the research in different communes but the increased capacity of Vietnamese researchers to conduct interdisciplinary, participatory diagnostic research more than compensates for the slight distortions of collected data. Further to building relationships between researchers, the diagnostic study achieved a high level of farmer involvement in the process and built understanding and trust between farmers, extension officers and researchers. The final result of this process is not just data but the setting of a research agenda that was negotiated between researchers and farmers. Through this process of negotiation, farmers took ownership over all experiments in their fields, which provide a solid foundation for further collaboration and the development of scaling up models later in the project.

The report (Appendix 4) is a compilation of village profiles. Each of the eight village profiles systematically describes a range of characteristics of the village and its population. The data underpinning these profiles were collected through several activities conducted over a 3-4-day period in each village, including (1) two community meetings, one at the beginning and one at the end of the activities in each village; (2) two focus group discussions, one on natural resource management and the other on market engagement; (3) a transect walk through the village, and (4) interviews with 12-15 individual farmers and the local leaders in each village.

All four villages in Son La province had been engaged with markets for more than 10 years at the time of the Diagnostic Study. Marketing mechanisms for maize and temperate fruits were well developed and included collectors and wholesalers. Both communes in Sin Ho district, Lai Chau province, however, were not engaged with markets and crop

production was primarily for subsistence purposes. Nevertheless, in Ta Ngao commune, a transition towards market-oriented production was in its initial stage. Giang Ma village in Tam Duong district, Lai Chau, had recently become connected with markets and farm families there were in an obvious transition from subsistence to market oriented production. Farmers in Giang Ma commune were very interested in the development of temperate fruit production. Hung Phong village in Ban Bo commune had substantial production of pigs and was able to meet the demands of the rapidly expanding Lai Chau town population. All maize produced was used to feed pigs and marketing of pigs was well developed with abattoirs established in nearby Tam Duong town.

The demographic representation of the villages included in the project differed significantly between villages in Son La and Lai Chau provinces. In Son La, three out of four villages were inhabited by Thai ethnic minority and one village was inhabited by Dao minority. In Lai Chau, three out of four villages are inhabited by Hmong minority and one village was inhabited by the Kinh ethnic group (who form a majority in the lowlands). Male farmers in all four villages in Son La had completed a level of education that indicates they would be sufficiently fluent in Vietnamese and have literacy levels that allowing them to read and understand basic extension materials. Female farmers in all villages in Son La had similar education levels to male farmers, except for Ta Chan where the level of education that female farmers had completed indicated that some of them may have problems with spoken Vietnamese language and are illiterate. In Lai Chau the education levels of male and female farmers in all three Hmong villages was very low and indicated that both male and female farmers would have difficulty reading basic extension materials and the majority of female farmers and some male farmers would have difficulty speaking Vietnamese. It can still be assumed that the majority of farmers understand Vietnamese language at the basic level. Children in all eight villages were educated to the level that supposedly they are fluent in Vietnamese and sufficiently literate to use written extension material. In villages where heads of family have difficulties with communication in Vietnamese and cannot read extension materials, the older children can be involved in project activities and act as assistant farmer researchers and translators. In all villages both male and female farmers were involved in agricultural production and decision making with generally just slight dominance of male farmers. Farmers reported to source information mainly from within their own closed circle. Family members and neighbours were the main source of information for most farmers, followed by the village leader. Extension officers were ranked very low in all villages as a source of information but it is likely that village leaders source their information from extension officers. Television is the main connection with the outside world with the influence of radio and newspapers being negligible. The development of relationships between researchers-extension officers-village leaders seemed crucial for future dissemination of research outputs. Projects should also explore possibilities of using local (provincial) TV stations to reach out to the communities.

In all villages farmers cultivated crops in small fields, the vast majority of which were on slopes. Average size of agricultural landholdings in villages in Son La province was 2.71 ha with the largest average landholding of 4.44 ha in Ta Chan village and the smallest of 1.40 ha in Pieng Sang village. In Lai Chau province, the average agricultural landholding was less than half of that in Son La province with an average of 1.17 ha. The largest village average for landholding of 1.46 ha was in Lung Su Phin village and the smallest of 0.66 ha was in Lang Mo village. Land is not owned by the farmers but farmers have long term land rights for using the land. Even though decisions about land management and agricultural production are generally made by individual farmers, there tends to be little variation between farmers' practices within a village, which indicates that major production decisions are made collectively with significant influence of the village government.

Hybrid maize production occupied most of the land in all villages in Son La province but rice occupied most of agricultural land in all 3 Hmong villages in Lai Chau province. In Son La rice was grown on only 2-10% of agricultural land mainly for farmers own consumption

while maize was grown as a cash crop. In Sin Ho district, Lai Chau, both rice and maize were grown for farmers' own consumption and maize was also used to feed farmers' animals. In Giang Ma village (Tam Duong district) some hybrid maize was grown for sale but most maize and rice were grown for farmers own consumption. Farmers grew peanuts, soya beans and temperate fruit on only 3% of agricultural land but most household income came from those crops. In Ban Bo maize was produced on 57% of agricultural land and was used as input in farmers' pig production. Tea was the main cash crop in Ban Bo and rice was mainly used for farmers own consumption. In Son La rice was mainly grown in small areas on flat land whereas in Lai Chau upland rice was grow mainly on the slopes. Maize was grown on slopes in both provinces.

In both provinces a long dry season and lack of water for irrigation was reported as the main constraint for more intensive agricultural production. Generally only one crop of maize (or rice) is grown in the rainy season from April-September and land is open for free grazing by farm animals for the rest of the production cycle (October-February). In all villages farmers identified the introduction of a successful second crop into production cycle as their highest priority. Erosion and related reduction of soil fertility was present in all sloping fields and farmers were aware of the problem but not to the extent that they put erosion prevention at the top of their priority list. From focus group discussions it can be concluded that fear of losses caused by rats and maize diseases exacerbated by use of mulch, overshadowed concerns about erosion. The perceived negative effect of mulch together with the perceived necessity to increase labour inputs for the establishment of mini-terraces at the time of soil preparation were the main reasons for the slow introduction or even resistance of these effective and proven erosion prevention methods .

Even though all villages included in the project were connected to major centres by good sealed roads, there were no proper roads between villages and fields. Lack of internal roads was mentioned as the main infrastructural constraint for intensification of production since the majority of fields are 3-10 km from the built-up areas on the steep slopes. Improved access to the fields is a top priority for farmers.

Lack of market information and capital to invest in new opportunities and in post-harvest facilities were reported as major constraints for more intensive market engagement. At the time of the study, farmers saw maize as the major opportunity for profitable production but they were aware of the need for diversification of their production. Introduction of legume crops (soybean, peanuts, cowpea, mung bean and rice bean) and short-season drought tolerant maize hybrids as a second crop was seen by farmers as their major opportunity for production intensification. Taking opportunity of the cool climate of Lai Chau, which is unique for Vietnam, for development of temperate fruit production, was seen as another opportunity but farmers acknowledge their lack of knowledge and experience in growing fruit crops. Farmers in Gieng Ma and Lung Su Phin, however, identified the introduction of early peach varieties, nectarines, and early and late plums as a priority. Other identified opportunities are coffee in Na Ot commune and pig production in Lai Chau province.

Diagnostic study results were discussed with community leaders and farmers at four district meetings organised in December 2009 and with researchers and representatives of provincial Department of Agriculture and Rural Development at Planning and reflection workshop in March 2010.

At these meetings the project partners agreed on the following course of action to address erosion prevention and farmers' need to intensify production:

Field crops: Introduce effective but practically feasible soil management practices, especially mini-terraces and minimum tillage with mulch. These management practices will not just prevent erosion but also increase moisture retention. Increased soil moisture will then allow farmers to grow a second crop, preferably a legume, which will prevent soil erosion and improve soil nutrition. The second crop will increase and diversify farmers' production and provide new marketing opportunities.

Temperate fruit: In Moc Chau district, improve existing plum production and introduce production of early peach. In Lai Chau province introduce varieties of peaches, nectarines and plums with high chill factor requirements that cannot be successfully grown elsewhere. Introduction of new varieties will be in relatively large number of small orchards with active involvement of farmer researchers and whole community. The process of the orchard establishment will be researched and will form bases for development of scaling up models.

7.1.2 Rapid Value Chain analysis and appraisal of potential complimentary crops for diversification of maize-based system

During the diagnostic study it was established that temperate fruit and in particular plums would have great potential to replace maize as a major contributor to household income. Other crops with potential to be included in maize based system to diversify production and increase smallholders' income included soya bean, mung bean, rice bean, pumpkin.

Plum production in Moc Chau district-Son La province

The Tam Hoa Plum is one of three hybrids of the Japanese Plum (*Prunus salicina*), originating from Southern China, that are grown between 700-1000m altitude mainly for the domestic market in Vietnam.

Mộc Châu is one of ten Districts in Sơn La Province and the total production of Tam Hoa Plums in the Mộc Châu District is 17 - 25,000 tonnes from 1,719 ha (Mộc Châu Extension Centre). Marketing of the crop is largely opportunistic depending on the interaction of the price for green plums for processing versus ripe plums for fresh consumption so many plums are not harvested. It is not known how many plum producers there are at any one time as production is opportunistic. Despite this, the contribution of plums to household income appears to be around 20%, independent of the socio-economic status of the family (Annual Report, 2009).

The Mộc Châu District is not geographically or climatically uniform and can be characterised into three areas based on production characteristics, environmental conditions and transportation issues.

Figure 3 characterises the geographic transect and Table 6 below it provides more detailed characteristics of each area. Primarily work was conducted in Area 1 in Ban On and Co Do Villages and in Area 3, the more isolated Pieng Sang Village of the Dao Minority.

Area 1 has the best quality plums but harvesting is later by 10 days and 15 days compared with Area 2 and 3. This creates a tension for the Hi-Q Plum Chain because of the price-quality balance. The plum season usually extends over 40-45 days with a mid-season of 20-25 days. Earliness is a key value attribute for consumers, and there is some willingness to trade-off ripeness to achieve earliness and premium prices. So to obtain premium prices, high quality plums must be marketed in the first 7-10 days of the season. In the latter stages of the season ripe plums are in abundance in the wet markets and so do not command a premium. Hence, farmers from Area 1 are keen to get to market as early as possible with fruit that, whilst it is higher quality than Areas 2 and 3, it may compromise the standards required by the Hi-Q Plum Chain marketing protocols.

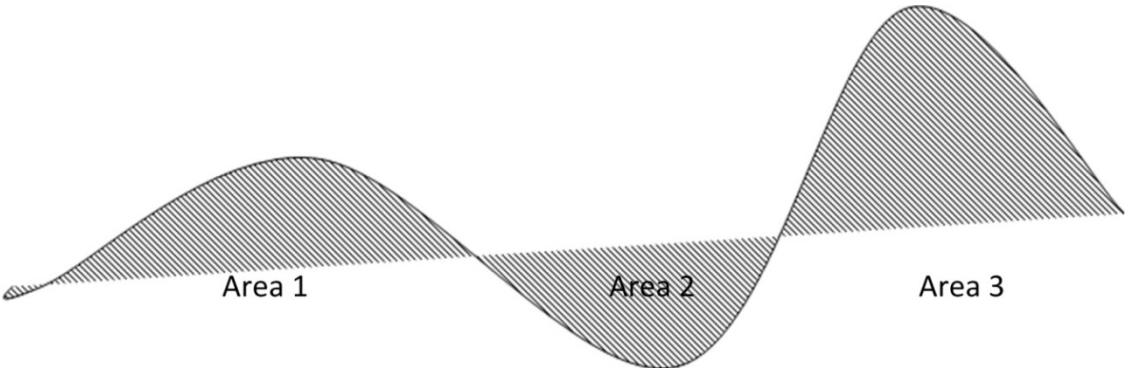

Figure 3: Landscape Transect of Mộc Châu Plum Producing Districts

Table 6: Characteristics of plum production districts in Mộc Châu

Characteristic	Area 1	Area 2	Area 3
Location	Areas 84, 85, Co Do, Ban On, Tan Lap, Bo Lau, Ba Khem	Long Luong, Bo Nhang, Ba Phach, Chieng Di 1, Chieng Di 2, Thong khuong, Bo Bun, TK Tien Tien, Vuon Dao	Kim Chung, Mộc Châu, Tà Xùa, Pieng Sang, To Mua, Chieng Ve
Age of trees	• < 10 years old: 10% • 10–15 years old: 60% • > 15 years old: 30%	• < 10 years old: 10% • 10–15 years old: 70% • > 15 years old: 20%	• < 10 years old: 15% • 10-15 years old: 75% • > 15 years old: 10%
Average production area/household	• < 1 ha: 20% • 1-2 ha: 50% • > 2 ha: 30%	• < 0.3: 10% • 0.3-0.5ha: 70% • 0.5-1ha: 20%	• < 0.5 ha: 30 % • 0.5–1 ha: 40% • > 1 ha: 20%
Proportion of plums in each area (2009)	60%	15%	25%
Proportion of plums sold green or ripe	Green: Co Do 80%; Ban On 40% Ripe: Co Do 20%; Ban On 60%	Green: 25.8% Ripe: 74.2%	Pieng Sang Green: 95% Ripe: 5%
Seasonal calendar	Beginning season: 15th May End of season: 20th June	Beginning season: 5th May End of season: 10th June	Beginning season: 1st May End of season: 5th June
Quality	Best in Mộc Châu Nicely reddish colour High sugar content Large size Soft when ripe Wax coating	Consistently big size but smaller than in Ban On Hard flesh Bad quality due to farmers' low technical skills Crunchy & not soft when ripe Wax coating	Hard Smaller size Nice colour Wax coating Bad quality, acrid after taste

Source: Diagnostic Study (2009)

Assessment of plum value chain in Moc Chau

Consumer value attributes of Tam Hoa Plums

The preliminary Rapid Plum Quality Evaluation conducted on 14th May 2010 as part of the RVCA, indicated that sweetness, firmness, colour and size were important to consumers. In 2011, a more in-depth sensory evaluation (after Meilgaard, Civille, & Carr, 2007) was undertaken employing an objective assessment of these characteristics (Annual Report 2011, Appendix 5c: Report on sensory evaluation of Tam Hoa plums). This indicated that the biophysical characteristics of these value attributes as well as consumer perceptions and consumers' ability to distinguish between these characteristics were more complicated than envisaged.

Sensory perceptions and the objective measurement of plum value attributes

The overall decision to buy plums is strongly related to consumers' perception of sweetness as indicated by their red colour (Tables 7 and 8). There was no clear preference for firmer or softer plums, however firm and soft plums were preferred in comparison to hard plums.

Table 7: Relative contribution of objective consumer value attributes to the preference and purchase decision (2011)

	Overall preference Adjusted R^2=0.272		Influence decision to buy in early season Adjusted R^2=0.216		Influence decision to buy in main season Adjusted R^2=0.238	
	Adjusted β	S	Adjusted β	S	Adjusted β	S
Sweetness (^{0}Brix)	0.041	P=0.452	0.101	P=0.279	-0.067	P=0.466
Hardness (kg/cm^2)	-0.239	P=0.010	-0.067	P=0.481	-0.205	P=0.029
Colour of skin (0 yellow-green, 1 purple-red)	0.334	P=0.002	0.374	P=0.001	0.392	P<0.001

Table 8: Relative contribution of perceptions of consumer value attributes to preference & purchase decision (2011)

	Overall preference Adjusted R^2=0.556		Influence in purchase decision in early season Adjusted R^2=0.269		Influence in purchase decision in main season Adjusted R^2=0.280	
	Adjusted β	S	Adjusted β	S	Adjusted β	S
Perceived Sweetness	0.686	P<0.001	0.383	P<0.001	0.389	P<0.001
Perceived Hardness	0.101	P=0.149	0.204	P=0.024	0.211	P=0.019

As the red colouration developed, sugar content increased towards 110 Brix and hardness dropped below a penetration force of 6 kg/cm2, consumers were more likely to purchase. A further increase in sugar content and softening of the plums did not significantly increase the purchasing decision. However, there were gender differences in perceptions. Females appeared to be more influenced by red colouration whilst men were more

influenced by sweetness. Multivariate regression analysis showed that colour was the strongest and most easily observed predictor of the positive purchasing decision.

The on-farm trials found that the training and pruning of the plum trees and application of relatively large quantities of fertiliser in experimental orchards resulted in a significant increase in the quantity of plums produced and in plum size. The treatments delayed the development of red colouration and sugars. This caused the plums in experimental orchards to be harvested late, resulting in lower profitability in comparison to the traditional production regime.

Thus, the results of sensory evaluation and the field drivers of those characteristics indicate that effort in experimental orchards should be refocused from yield and fruit size to colour and sugar content. Fertiliser input may need to be reduced and the balance among N:P:K changed. Pruning during the ripening stage to expose fruit to sunlight could be considered and progressive harvesting when fruit passes 110 Brix should be introduced.

The dynamics of selling green plums or ripe plums

Between 2008 and 2012, ripe plum consumption fell whilst green plum market demand has fluctuated (Table 9). Green plums are collected and packed into cardboard boxes

Table 9: Relative plum market volumes in the focal districts 2008-2012 (Tonnes)

	2008	2009	2010	2011	2012
All Areas Total					
Green	4,416	5,159	3,784	3,790	7,891
Ripe	18,584	19,841	18,217	16,210	9,109
All Areas Total	23,000	25,000	22,000	20,000	17,000
Area 1					
Green	1,339	2,111	1,145	1,311	2,870
Ripe	12,461	12,889	12,055	10,689	7,330
Area 1 Total	13,800	15,000	13,200	12,000	10,200
Area 2					
Green	887	1,018	769	628	1,145
Ripe	2,563	2,732	2,531	2,372	1,405
Area 2 Total	3,450	3,750	3,300	3,000	2,550
Area 3					
Green	2,191	2,030	1,869	1,852	3,876
Ripe	3,559	4,220	3,631	3,149	375
Area 3 Total	5,750	6,250	5,500	5,000	4,250

Source: General Statistics Office of Son La and Mộc Châu and Mai Son District statistics.

without grading by 10-12 wholesalers, who each send two or three 20-30 tonne trucks per day to Tan Thanh on the border where they are sold by consignment in the Pingxiang market and re-sorted into ripe plums for fresh produce consumption or green plums for processing.

The project's 2009 investigation of the market for green plums in Pingxiang and Nanning in southern China showed that the demand for Vietnamese Tam Hoa plums is dependent on the price and availability of the Chinese Man Com variety, which means it is highly unpredictable. The factors driving Chinese demand are:

Chinese large-scale domestic production which is difficult to forecast as it is strongly affected by climate and disease;

International market demand for processed plum (largely from Japan, Korea, Hong Kong, Singapore and Thailand) which is also unpredictable due to fluctuating internal and global economic conditions.

When Chinese demand is high, green plums are diverted from many Vietnamese production areas into that market, but if the demand is low and the Vietnamese season is good then prices are driven down in Vietnam by a glut. Consequently, some trees are not harvested in some years.

However, other factors also influence the price of ripe plums:

- Competition and substitution by other fruits occurs due the large variation in the timing and duration of the plum harvest period as well as the rate of ripening. This may mean that the premium price period for plums coincides with that of Longans, Lychees, Rambutans and other types of plums (Table 10). If those fruits are similarly priced or cheaper then substitution may occur which moderates the price of Tam Hoa plums.
- The profitability and workload of competing enterprises such as cattle production, tea harvesting and dairying;
- Ripe plum harvesting is much slower than for green plums (100-150kg versus 400-500kg per day), which means a higher cost of production for ripe plums;

Table 10: Seasonal competitors with Tam Hoa Plums

Product	April				May				June				July			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
2013 Tam Hoa Plums																
2012 Tam Hoa Plums																
2011 Tam Hoa Plums																
Lychees (1)																
Longans (2)																
Yellow plums (3)																
Red plums (3)																
Rambutans																

Note: Sources (1): (Nguyen, Truong, & Dao, 2005); (2): (Jiang, Zhang, Joyce, & Ketsa, 2002); (3): The scientific and varietal names of these fruit are not known and this data has been sourced from interviews with wet market traders. Little appears to be known about their seasonal variation in harvest date but it is likely to be as variable as Tam Hoa Plums. Note also that hatched areas simply help differentiate the months.

- Green plums have a much shorter harvesting season of 5-10 days whilst ripe plums have a season of 25-35 days. Therefore, if the farmer has more profitable enterprises then the longer, more complicated engagement with harvesting ripe plums is an opportunity cost for his livelihood.
- Marketing green plums avoids the cost and effort involved in fruit fly control. Originally, the production of green plums developed because there were no effective controls and the market demand grew. However, today there are cost-effective means of fruit fly control but the avoidance of having to undertake the tasks persists as an incentive to harvest green plums.
- There are increasing farm labour shortages for plum harvesting because the trees in many orchards have been planted too close and allowed to grow without pruning, which, in some instances, has resulted in the canopy becoming intertwined making picking difficult.

Green plums are usually harvested from the warmer hilly slopes, commonly starting nearly 10 days earlier than ripe plums. Some areas such as Pieng Sang (Area 3) and Co Do (Area 1) are early areas but produce poorer quality ripe plums and this is an important decision-making factor for farmers supplying green or ripe plum markets. As soon as the higher quality areas start harvesting, the prices for these poorer quality supplies drop significantly.

Therefore, farmers in areas producing poorer quality plums make early decisions to optimise their income by selling to the Chinese market if the prices are reasonable, thus minimising the risk that they will receive no income from plum production.

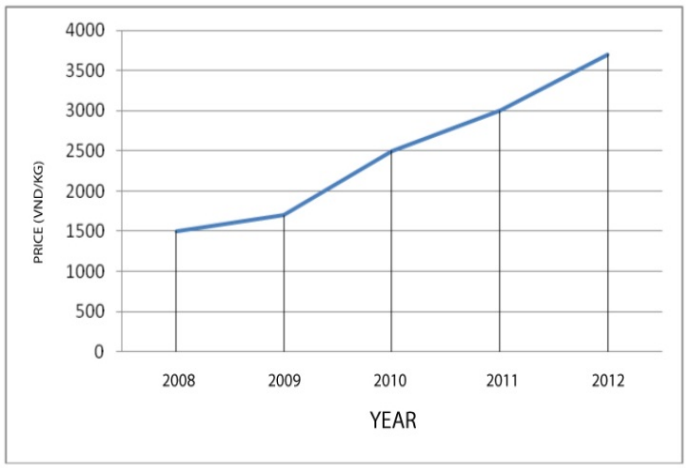

Figure 4: Price changes for green plums (2008-12)

Note: Prices not adjusted for inflation

Figure 4 demonstrates that the decision to supply the green plum markets has recently been easier because green plum prices have been steadily rising. In early season 2013, nearly 300 tonnes/day (approximately 7 trucks with loading capacity of nearly 40 tonnes/truck) were being sent to the Chinese market.

Tam Hoa Plums are consumed fresh in Vietnam and often used as a special 'treat' for visitors, a gift or a temple offering.

A detailed report on plum value chain development is presented in Section 7.4 and in Appendix 11.

Crops complimentary to upland maize production

The aim was to determine the market potential of crops complementary to upland maize in the North West Highlands of Vietnam. The research was conducted by a team from the Hanoi University of Agriculture (HUA) led by Prof Pham Van Hung, Pham Van Hung, Head of the Department of Accounting & Quantitative Analysis, Faculty of Economics & Rural Development.

The main crops of the Mộc Châu district are maize, rice, tea, canna, vegetables and fruit trees (peach, plum, etc.). Pumpkin, soybean, rice bean and mung bean are sub crops grown as the second crop in a year (Table 11). During the project period, rapeseed has also become a major crop in the district.

After assessing a range of small, legume crops, those chosen for investigation were processing pumpkins, rice bean, soya bean and mung bean.

Table 11: Current land use of survey households (square metres) (n=111)

Items	Mường Sang	Phiêng Luông	Nà Ớt	Chiềng Chăn
1. Land area per household (m^2)	23,681	29,817	23,283	28,329
2. Cultivated area per household (Unit: m^2)				
- Maize	23,608	22,964	11,760	26,596
- Soybean	N/A	N/A	700	400
- Pumpkin	6,317	5,450	100	167
- Rice bean	1,000	N/A	N/A	2,500
- Mung bean	1,000	N/A	100	1,900
- Rice	2,875	2,927	1,880	4,341
- Other crops	19,375	4,183	10,841	5,683

Pumpkin can be grown as the first crop, which is competitive with maize, or as the second crop, which is complementary crop to maize (Table 12). In contrast, the number of households growing rice bean and soybean is small (Table 13). Pumpkin, soybean and rice bean are all grown as second crops.

Among selected crops, only pumpkin and mung bean are considered as commercial crops while rice bean and soybean are mostly produced for family consumption. Of the target crops, the most commonly grown are pumpkins and Phiêng Luông is the main producer.

Table 12: Some major crop rotations in the local area (n=111)

Mường Sang	Phiêng Luông	Nà Ớt	Chiềng Chăn
Maize - Rape	Maize – Pumkin	Maize	Maize
Maize - Pumpkin	Pumpkin - Pumpkin	Terraced rice	Maize – Mung bean
Rice - Maize	Maize	Rice – Rice	Rice – Rice
Rice - Pumpkin	Pumpkin – Rice	Cassava	
Rice – Vegetables	Arrowroot		
Vegetables	Rice – Rice		
Cassava	Terraced rice – Tea		

Table 13: Number of households growing target crops (n=111)

Item	Mường Sang (n=29)	Phiêng Luông (n=27)	Nà Ớt (n=27)	Chiềng Chăn (n=28)	Total (n=111)
Soybean	0	0	1	2	3
Pumpkin	6	24	3	3	36
Rice bean	1	0	0	1	2
Mung bean	1	0	2	5	8

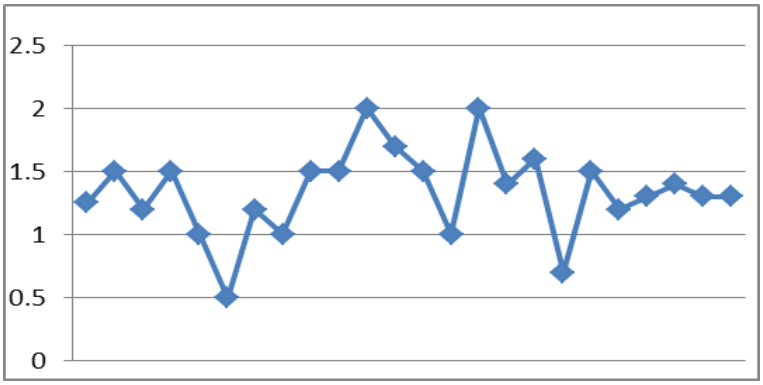

Figure 5: Pumpkin prices in Moc Chau in 2011 (VND '000/kg)

In 2011 and 2012, pumpkin prices fluctuated significantly (Figure 5). This, combined with the thin-shelled variety grown makes them difficult to store for any more than one month so pumpkins are declining in popularity as a potential crop and this led to a decrease in the area grown. In contrast, prices for mung bean are quite high and stable.

Farmers generally rely on their mobile phones for obtaining information and access their own social networks rather than formal sources of information or collectors. Information about inputs for production focuses mainly on input prices. Farmers often collect information related to input prices from input suppliers, neighbours and relatives.

Householders interviewed believe that water, capital and transportation are limiting their ability to produce crops (Table 14). Horizontal collaboration amongst farmers and vertical collaboration between farmers and other stakeholders in production and marketing of agricultural products have not been developed.

Table 14: Constraints on agricultural production (n=111)

Responses	Percentage of total respondents (%)
1. Dependent on natural water	34.83
2. Lack of capital	32.58
3. High input price	5.62
4. Difficulty in transportation	10.11
5. Lack of labour	4.49
6. Lack of technical support	4.49
7. Others	7.87

Interestingly, there was a wide variation between communes in their interest in applying new farming practices. Phiêng Luông was the most interested (90%), Mường Sang (59%), Chiềng Chăn (50%) moderately interested, and Nà Ớt quite disinterested (33%). Between 50 and 72% of people believed that they would have to use a bank loan of around VND 30 million over a period of 21-30 months if they were going to attempt to grow a new crop.

Infrastructure in the target communes is poor, especially for two communes in Mộc Châu district. Most of inter-village and inter-field roads are just “land lines”. Hence, it is very difficult to travel in wet season. As rice usually gets the priority in the use of water, this could be limiting in drier seasons.

Table 15: Farmer willingness to expand production of the target crops (n=111)

Commune (no. families interviewed)	**Mường Sang (n=29)**		**Phiêng Luông (n=27)**		**Nà Ớt (n=28)**		**Chiềng Chăn (n=28)**	
	No. H’holds	Area (m^2)	No. H’holds	Area (m^2)	No. H’holds	Area (m^2)	No. H’holds	Area (m^2)
Soybean	3	1,667	2	4,000	9	2,222	3	4,100
Pumpkin	**9**	8,289	**19**	8,326	3	1,833	1	2,000
Rice bean	2	7,000	1	10,000	2	5,000	1	2,500
Mung bean	2	1,650	1	2,000	1	50	**9**	2,611

Table 15 identifies the number of households in each commune who are willing to increase the area of specific crops and the area they want to grow. It demonstrates that, whilst most of the interest focuses on growing pumpkins, when compared to the total numbers of farmers in each commune, there is little willingness by smallholders to consider growing new or commercial versions of these crops. However, the proposed increases in areas grown are significantly larger than the average currently grown.

7.1.3 Scenario analysis for comparing research scientist assumptions of farmer perceptions of soil erosion as risk to future farmer livelihoods

This section outlines findings of a social inquiry undertaken in 2011 that was designed to compare research scientist knowledge and understanding of farmer perceptions toward soil erosion with actual farmer perceptions of soil erosion across four communes in the North - West Mountains of Vietnam. The full report of this inquiry is presented in Appendix 22.

Overall, the results of inquiry highlighted that farmers are aware of soil erosion and were able to hypothesis what they or other farmers would do if land was no longer viable. All of the communes could outline contingency plans if land was no longer viable – including selling land to others, buying land from other farmers, moving and/ or opening new areas. Interestingly, these are all local level responses and there was little mention of the external influences and policies that inform their contingencies. Overall, it is difficult in this small inquiry to ascertain the level of risk that the farmers feel.

What is clear is that farmers have greater short-term priorities. While some of the risks that soil erosion presents were identified, there were multiple reasons why action was not being taken to act on these perceptions. These included:

- lack of understanding about the amount of time left that farming could continue;

- concerns about costs of inputs and availability of labour and mulching materials to manage erosion;
- desire to be paid by government for implementing erosion management activities;
- perceived group pressure and social norms that encourage continuation of traditional farming practices; and
- a greater concern for soil nutrient levels than for soil erosion.

Based on the above findings, it cannot necessarily be drawn that the farmers did not care, but that there were other priorities and more short-term goals and constraints that imposed on the longer-term risks. Linked to this is the important finding that most of the communes identified the risk associated with soil erosion on livelihoods as an issue for the next generations. Therefore, what comes through and was identified by the research scientists as well is a preference for short-term action despite long-term vision.

An important consideration that was raised through this process was the importance of the household in the response to soil erosion prevention. The farmer researchers across the different trial areas identified that farming was not collective, and that decision-making was more likely within the household, rather than at the village level. Therefore, it would be advantageous to research this aspect of community relations further to explore if soil erosion prevention works better at the larger scale, which can only be achieved by wealthier farmers and hence further disadvantage poorer households.

Another interesting point was that the perception of farmer researchers about other farmers in the village at times reflected the perceptions of the scientists that the majority of farmers are lazy and do not care about erosion. This inquiry has shown that this is not the case, and conducting further research to compare perceptions of farmers from different socio economic background in the same villages would provide a more rounded picture of the social - relational aspects of soil erosion, as well as their experiences and perceptions of the barriers.

7.2 Erosion and ICM trials in maize based system

7.2.1 Erosion trials

The results from three years of erosion measurement trials were consistent in showing that minimum tillage with use of organic material in situ as mulch reduced erosion by 40-50%. Zero tillage achieved slightly higher erosion reduction (more details in Appendix 14).

Maize integrated crop management trials showed that minimum tillage and no-till can increase yield and reduce labour requirements, provided that only mulch in situ is used. Guided through participatory monitoring and evolution processes during three years of adjusting the amount of mulch applied to experimental plots and practices that initially used high external inputs, the project team developed an optimised crop management system that suits farmers' socio-economic realities and production practices with modest but significant reduction of erosion. However, the increased infestation of mice in areas covered with mulch still forms an obstacle for the wider use of mulch. Detailed results for erosion experiments conducted in 2012 and 2013 are shown below.

The method we used to assess erosion was able to demonstrate substantial soil movement. It was not able to demonstrate any significant impact on soil erosion reduction using the soil conservation methods we trialled. This means the method is not suitable or the erosion control methods we trialled are inadequate. Most likely, both factors have some impact on the final result. The pin method that was successfully used to measure erosion on undisturbed soils is not appropriate to measure erosion on disturbed-cultivated soils. However, field observations also confirm that even the reduced tillage treatment eroded substantially (even though in a lesser extent) which was unambiguously corroborated by the erosion barrier assessment.

The main questions that require further investigation are:

- What are the threshold slopes where maize cropping becomes unsustainable?
- How much ground cover is needed and what are the limitations of conservation agricultural practises on what soils and slopes?
- What are land management options on slopes that are too steep for maize production, and farmers' incentives to adopt them?

7.2.2 ICM trials in maize based system

Trials conducted in 2010

In 2010, the first season of the field trials, NOMAFSI in collaboration with Tay Bac University and local extension services conducted a total of 19 experiments: 6 in Lai Chau province, 9 in Son La province and 4 at NOMAFSI Tay Bac Research Station. The location of field trials and an overview of farmers and research and extension staff involved are shown in Table 3.

The main objectives of trials were to: a) evaluate effectiveness of mini terraces and mulch for erosion prevention and the influence they have on maize growth and yield and; b) evaluate suitability of a range of legume crops for intercropping with maize and assess their impact on maize growth and yield. In addition to these main objectives, new hybrid and non-hybrid varieties of maize were evaluated in a subset of these experiments and the influence of maize planting density on yield was assessed in one experiment conducted at Tay Bac research station.

All experiments except for the experiment in Ta Ngao and erosion trial in Gieng Ma were designed as randomised complete/ block with 3 replicates (=blocks). Data for percentage of germination and yield were statistically analysed using mixed model of analysis of variance (SPSS v. 17).

All on-farm field experiments were conducted following participatory principles with farmers being involved in planning, setting up and post-experiment evaluation. However, experiments cannot be considered as fully participatory because farmers did not influence agronomical decisions like time of sowing or fertiliser use and they were not adequately involved in assessments during the course of the experiment. Nevertheless, participatory evaluation conducted after the 2010 trials provided the opportunity for farmers to have a significant contribution in interpretation and analysis of the experimental results with the views of farmers shown in the "Conclusions and comments" sections of this report. Farmers were pivotal in all economic analyses presented in the report.

Main findings of these experiments were:

a) Use of mulch increased yield of maize whether mulch was used on mini-terraces or without them. Mulch alone and in combination with mini-terraces was compared with the farmer practice of burning all organic material on the fields before sowing ("burn") in 7 experiments. The yield of maize was increased in both mulch treatments in all 7 experiments. In 4 out of 7 experiments, this increase was statistically significant. Average increase of yield over these seven experiments was 0.7 t/ha when mulch was not used on mini-terraces and 0.9 t when mulch was used on mini-terraces. Mini-terraces without addition of mulch were directly compared to mini-terraces in combination with mulch in 3 experiments. Adding mulch increased yield in all 3 experiments but the increase was only statistically significant in one experiment. Average increase of yield that could be attributed to the use of mulch on mini-terraces was 0.3 t.
b) The impact of intercropping maize with legumes was evaluated in 6 experiments. In all these experiments maize was sown in strips of two rows with a narrow spacing of 0.4 m between rows within each strip. Spacing between the 2 strips of maize was 1 m. Legumes were sown in this 1m-space between two maize strips. This intercropping

arrangement did not reduce the number of maize plants sown in comparison with the number of maize plants planted in farmers' fields.
Black bean was trialled in 2 experiments, and rice bean, soya bean and peanuts in 3 experiments. Only the peanut crop was harvested at the end of the experiments, but yield was low (< 1t/ha). All other legume crops were destroyed by pests and diseases before harvest.
However, legume crops had a positive impact on maize growth and yield. The yield of maize was increased in all 6 experiments with statistically significant increases recorded in 5 out of 6 experiments. Average increase of yield over the 6 experiments was 0.8 t/ha.

c) It became apparent that the use of high doses of fertilisers alone within current farming practices is not economically viable. If higher use of fertiliser was adopted as part of a more comprehensive change in cultivation including use of hybrid varieties and high density planting, then yield increases of 4 to 5 times current levels may be possible, justifying higher investments and resulting in increased income for farmers. However, in the current socio-economic circumstances in most project locations, a high level of production intensification is not possible because farmers do not have financial means to increase inputs, labour availability to apply high doses of fertilizer or technical knowledge to implement intensive cultivation. In future experiments a lower fertiliser dose adapted to farmer socio-economic circumstances should be used.
d) In Gieng Ma, maize varieties Ha Giang Yellow and Ha Giang White were trialled in the farmer's field and they outperformed the local variety (unknown origin). Farmers will sow Ha Giang varieties in their field in 2011.
e) Seven maize hybrids (LVN 14, LVN 81, LVN 154, LCH 9, LVN 146, LVN 99 and LVN 61) with short to medium development length were evaluated and compared to variety LVN10, a variety widely used by farmers in Son La province. Two experiments were conducted: one in a farmer's field in Chieng Chan Commune, Mai Son District, Son La province and other at Tay Bac Research Station.
Results from these experiments were not entirely consistent. In both experiments, varieties LCH9 and LVN99 performed significantly better than the benchmark variety LVN10. Variety LVN146 was the best performing variety in the Tay Bac station experiment but it did not perform better than LVN10 in the Chieng Chan experiment. The other tested variety did not have a significant advantage over the benchmark treatment.
The main inconsistencies between experiments are results for the length of maize development from sowing to harvest. Varieties LCH9, LVN99 and LVN146 had development times of 94, 92 and 91 days respectively in Chien Chang experiment, which was significantly shorter than the benchmark variety LVN10 that had a development time of 106 days. However, in the experiment at Tay Bac station maize development was longer with 111, 110 and 112 days for LCH9, LVN99 and LVN146 respectively.
Results indicate that varieties LCH9, LVN99 and LVN146 may be suitable for use in a 2-crop per season system but further evaluation is necessary before final conclusions can be made.
f) There was a significant linear relationship between planting density and yield. Results indicate that a significant increase in yield can be achieved with increased planting density under high fertiliser use. Modes of incorporating higher planting density in farmer's practice have to be further investigated.

During participatory evaluation of the experiments in Ta Ngao, Ban Bo and Na Ot in August and September 2010, basic economic analyses were done. They compared existing farmer practices with experimental erosion management practices. Farmer researchers contributed to the estimation of workdays necessary for each production activity, cost of inputs and income from maize sale.

Main conclusions of these economic analyses were:

a) In Ta Ngao level of farmer's engagement with markets is very low. The use of mini-terraces and mulch together with high doses of fertiliser resulted in an increase of production of 150% but did not lead to higher profitability due to very high input costs. Analysis has also shown that shifting maize production (=opening new production areas by cutting forest followed by short term use of land and long fallow afterwards) with no inputs, as is practiced in Ta Ngao, currently remains an economically viable option for famers. However, the increase of population in the area and reduction in deforestation reduced availability of new areas of land and will soon make this type of farming unsustainable due to the short duration of fallow.
b) In Ban Bo, farmers are well connected with markets and used significant amounts of fertiliser but without substantial increases in yield, resulting in only moderate profitability of their production. In these circumstances improved crop management that included more frequent use of smaller quantities of nitrogen fertilisers, mulching and pest and disease management practiced in experimental fields significantly improved production and increased profit of farmers involved in the project.
c) In Na Ot farmers were well connected with the market and used a low dose of fertilisers in their fields resulting in moderate yields and profitability of their production. In these circumstances, application of very high amounts of fertiliser on experimental fields did not result in proportional increases of income and led to lower profitability of production in the experimental treatments compared to farmer fields. It can be concluded that increased investment in only one production component, in this case fertilisers, does not result in increased profitability if other factors in the cultivation system remain unchanged. It can also be concluded that the increase in maize production that can be attributed to the use of mulch and cultivation on mini-terraces was not proportional to the increase in labour input, so profit expressed per day of work in the experiment was lower than in the farmer's fields.

Based on the results from 2010 the project team developed the experimental program for 2011. The major changes include concentrating more effort on obtaining viable yield from the species used for intercropping, introducing minimum tillage or no-tillage as an economically viable method that may assist in the prevention of erosion and basing inputs used in the experiments on farmer current use with only minor adjustments where necessary. It was planned to put more effort into precise measurements of erosion by focusing resources on only two sites rather than four sites as in 2010. The research team woild also focus much more on farmer participation in planning, execution and evaluation of experiments. To assist with the latter, comprehensive guidelines on participatory monitoring and evaluation were developed and training for researchers and extension officers was conducted in September and November of 2010.

Trials conducted in 2011

In 2011 the research agenda was based on a thorough evaluation of the results from the 2010 maize experiments involving both researchers and farmers and following the recommendations of the project's mid-term review, the number of experimental sites was reduced from eight to six and number of experiments from 16 to eight.

Erosion measurements in 2011 showed that mini-terraces and minimum tillage reduced erosion by 50% and zero tillage by 65% in comparison to conventional burn and plough soil cultivation. Yields were relatively high in all treatments ranging between 4.8 and 6.2 t/ha in Na Ot and between 6.8 and 7.2 t/ha in La Nga. There were no statistically significant differences in yield between tested soil cultivation options; however, the minimum tillage gave the highest yields at both locations. Participatory evaluation sessions showed that farmers prefer minimum tillage, involving the opening of a small trench using a hoe or a cultivator pulled by a buffalo to apply seed and fertilisers, and the use of mulch. In Na Ot where enough organic material was left on the fields from the previous maize crop and weeds to form an effective mulch layer, this option required less labour than the conventional practice. However, in La Nga additional mulch had to be brought in from neighbouring fields making minimum tillage less attractive to the farmers.

In Giang Ma, hedgerows with Guatemala grass were used for erosion prevention and while no measurement of soil loss was undertaken, the build-up of soil behind the hedgerows was a clear indication of its effectiveness. The farmer who practised the hedgerow technique had 5 cows and he found the forage produced by Guatemala grass as useful as maize. He decided to extend the area planted with Guatemala grass in 2012, which is a clear indication that the use of tropical grasses as hedgerows is a viable option for erosion management for farmers who have a significant number of livestock.

Two successful consecutive crops were grown at all three locations assigned to these experiments (Ban Bo, Chien Chang and Pieng Sang). In Ban Bo, two maize crops were grown, with the second crop of maize yielding as high as the first maize crop, which resulted in a significantly increase in farmers' income of 73% in comparison to only one crop. The yield of the second maize crop was statistically higher in plots where mulch (from residues of the first maize crop) was used and where soya bean was sown as an intercrop, in comparison to plots that were not mulched. There were no significant differences in maize yield between plots sown with soya bean and where dead mulch was used. However growing soya beans as an intercrop provided additional economic benefit for farmers.

In Chien Chang, only legumes, including soya bean, mung bean and black bean, were grown as the second crop and they all resulted in a satisfactory yield and income (19 million VND/ha for mung beans, 22.7 million VND/ha for black beans and 8.1 million VND/ha for soya bean). The yield of the black bean crops was significantly higher in plots were mulch was used, while for soya bean and mung bean there were no statistically significant differences between mulched and non-mulched plots.

In Pieng Sang, pumpkin was grown as the first crop and maize with and without legume intercrop as the second crop. Pumpkin yield was overall very high, with pumpkin grown on fields with mulch yielding over 30T/ha and without mulch 25 T/ha. Pumpkin grown with mulch had statistically significantly higher yield than pumpkin grown without mulch. The pumpkin price, however, appeared to be low that season, so the additional investment in mulch offset the gain in yield.

Maize grown as second crop in Pieng Sang without and with mulch obtained high yields of 5.7 t/ha and 6.1 t/ha, respectively. As a high price of over 5,000 VND/kg of maize prevailed at harvest time, investment in mulch paid off. Peanut and soya bean sown as intercrop gave reasonable yields adding to the farmer income (peanut 18.0 million VND/ha and soya bean 7.3 million VND/ha), however, intercropping did not significantly influence the yield of maize. Both legumes when grown with mulch had a significantly higher yield than sown without mulch.

The results of the trials at the Tay Bac Station in Son La showed that synergistic advantages of legume crops intercropped with maize which reduce sowing density of maize cannot compensate for the loss of income due to reduction in maize yield. Hence re-spacing of maize with a distance between two maize rows within the strip of 0.4 m and distance between strips of 1 m is the preferred intercropping option because it does not reduce number of maize plants grown per hectare (Figure 6). In 2012 and 2013 re-spacing of maize rows was implemented in all experiments which had intercropping as an experimental treatment.

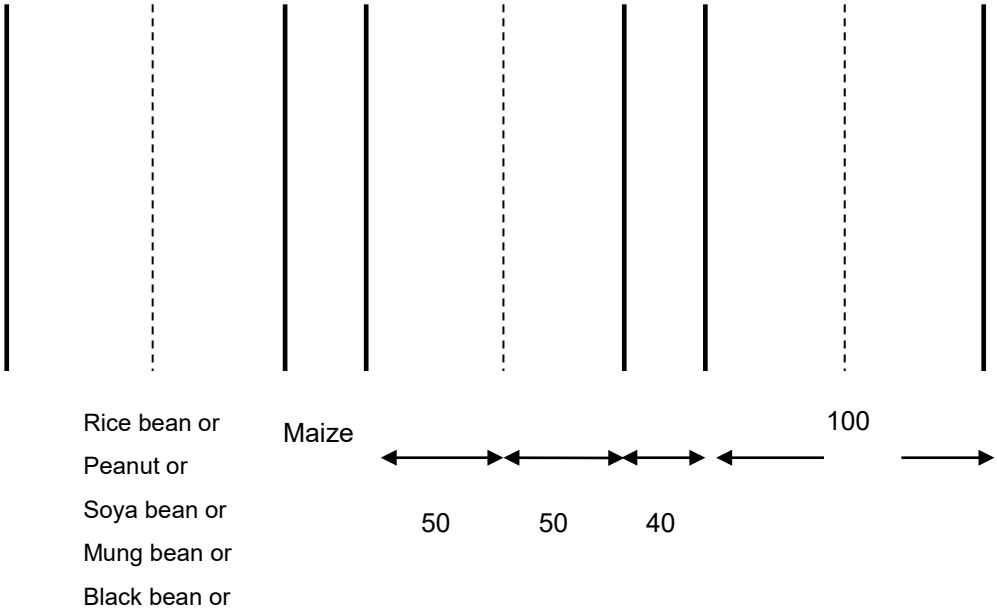

Figure 6: Respacing of maize for intercropping

Trials conducted in 2012 and 2013

During 2012 and 2013 a significantly smaller number of field trials were conducted than in 2010 and 2011 but majority of trials were conducted over two years. In an experiment conducted in Giang Ma commune, Tam Duong district of Lai Chau province, a cropping system that includes maize, rice bean and Guatemala grass was evaluated over two rainy seasons from March 2012 to December 2013. In Ban Bo commune of Tam Duong district in the same time period, cropping systems that include two crops within a rainy season were evaluated on flat ground, on gentle slope and steep slope. In the period from February to October 2012, several cropping systems were evaluated in Pieng Sang village, Moc Chau district of Son La province. All systems included two crops within a rainy season. Maize and pumpkin were evaluated for the first crop and maize, soya bean and peanut as the second crop. The detailed report on these experiments is presented in Appendix 13b.

Maize intercropped with rice bean and with Guatemala grass as hedgerows - Gieng Ma – Tam Duong-Lai Chao

This experiment was established in March 2012 and concluded in December 2013. The aim of the experiment was to assess maize, rice bean and Guatemala grass performance over a relatively long period. The experiment was designed as a participatory evaluation trial with Hmong ethnic minority farmers and did not have replication.

In areas where Guatemala grass was planted, maize occupied 0.7 ha and Guatemala grass 0.3 ha. Productivity of this area in 2012 was 2.66 t of maize and 1.4 t of Guatemala grass and in 2013 it was 3.29 t of maize and 2.74 t of Guatemala grass (Table 16).

Increase in yield of maize in 2013 can be contributed to better rainfall pattern. The Guatemala grass in 2013 was in its second year of development so it had a stronger root system and it was harvested continuously for 12 months while in 2012 Guatemala grass was transplanted in March from planting material produced at the NOMAFSI research station and the first harvest was in May 2012, so it was harvested for only seven months.

In both years, rice bean developed well with an estimated production of fresh biomass at about 10 t/ha but after maize was harvested rice bean was outperformed by weeds and did not produce seeds in harvestable quantities.

Table 16: Guatemala grass yield presented for each harvest in 2013

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Nov	Oct	Dec
Volume (kg/3000m^2)	90	200	300	360	410	400	360	210	180	150	80
Calculated volume (kg/ha)	300	667	1000	1200	1367	1333	1200	700	600	500	267

The farmer's evaluation of the cultivation system using Guatemala grass and maize was very positive but farmers did not consider growing rice beans as a viable option. The positive evaluation of the Guatemala grass and maize production system was confirmed by farmers attending farmer field schools. Further research is necessary to evaluate the possibility of using rice bean as livestock feed and to develop agronomic practices that would maintain growth of rice bean after maize harvest for an additional two to three months until pods develop and can be harvested. There is a strong opinion among farmers in Son La province that there is a good market for rice bean which does not seem to be present among Lai Chao farmers so their motivation to maintain rice bean after maize harvest is very low. Market research to establish profitability of rice bean production in Lai Chao is necessary

Two crops within a rainy season grown in flat field, on gentle slope and steep slope – Ban Bo – Tam Duong-Lai Chao

This experiment was established in March 2012 and concluded in December 2013. The aim of the experiment was to assess the viability of two crops within a rainy season on gentle and steep slopes. In 2010 and 2011 it was established that two crops can be grown in flat areas but there were still doubts whether this could be replicated on sloping lands. In 2012 and 2013 the experiment was established on a gentle slope (of approximately 10 degrees) and on a steep slope (approximately 30 degrees) but with established small terraces about two metres wide. During the experiment regular participatory monitoring was conducted and a participatory evaluation involving a group of five farmers was conducted at the end of the experiment. Experimental treatments and main cultivation information are presented in Table 4 (Section 5.2.3). The experiment was designed as randomised complete block with four replicates.

In 2012 for the first crop, the yield of maize in flat areas has reached 5.5 t/ha, on gentle slopes 4.3 t/ha, and on steep slopes 3.9 t/ha. For the second crop the yield of maize in flat areas was 6.3 t/ha, on gentle slopes 5.5 t/ha, and on steep slopes 4.7 t. There were significant differences in maize yield for the first crop and for the second crop at p=0.05 between flat, gentle, and steep slopes. There were no differences in yield between mulched and non-mulched treatments (Figures 7 and 8). Maize yield for the first crop was significantly higher when maize was grown on flat land then on gentle slopes or steep slopes and yield was also significantly higher when grown on gentle slopes in comparison to steep slopes. For the second crop, maize yield was significantly higher when maize was grown on flat land than on steep slopes but there were no significant differences in yield between maize grown on flat land and gentle slopes and between maize grown on gentle slopes and steep slopes.

For soya bean, which was only sown in the second crop, the yield reached 1.05 t/ha in flat land, 1.34 t/ha on gentle slopes, and 0.96 t/ha on steep slopes. There were no significant differences between treatments in yield of soya bean.

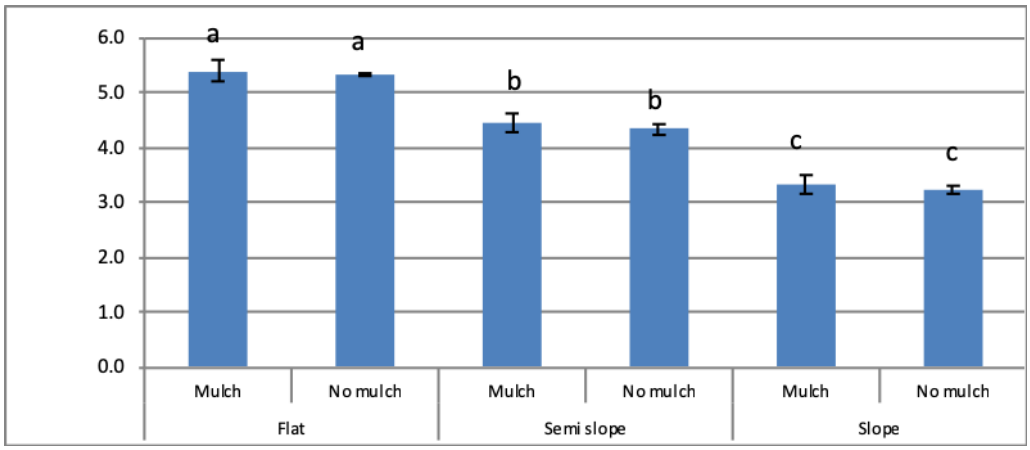

Figure 7: Maize yield (t/ha) first crop in Ban Bo 1/04 to 21/07 2012

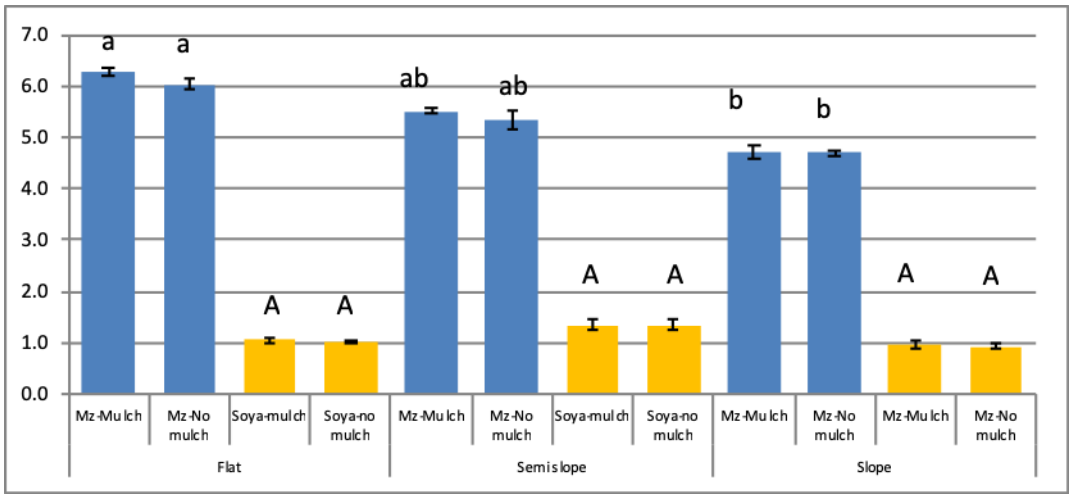

Figure 8: Maize and soya bean yield (t/ha) second crop in Ban Bo 4/08 to 28/11 2012

In 2013, maize yield for the first crop has reached 5.5 t/ha on flat land and gentle slopes, and 3.5 t /ha on steep slopes. For the second crop maize yield was lower than in 2012 reaching only 4.1 t/ha on flat land, 4.0 t/ha on gentle slopes and 3.1 t/ha on steep slopes, however soya bean yield was at the same level as in 2012 reaching 1.0 t/ha on flat land, 1.3 t/ha on gentle slopes and 0.9 t/ha on steep slopes. Similar to 2012, there were significant differences in maize yield for the first crop and for the second crop at p=0.05 between flat, gentle, and steep slopes. There were no differences in yield between mulched and non-mulched treatments (Figure 9 and 10).

Maize yield for the first and the second crop was significantly higher when maize was grown on flat land than on gentle slopes or steep slopes but there were no significant differences between yields recorded when maize was grown on gentle slopes and on steep slopes.

For soya bean, significantly higher yield was recorded when soya bean was grown on gentle slopes than when it was grown on flat land and steep slopes. There were no significant differences between yields recorded on flat land and steep slopes.

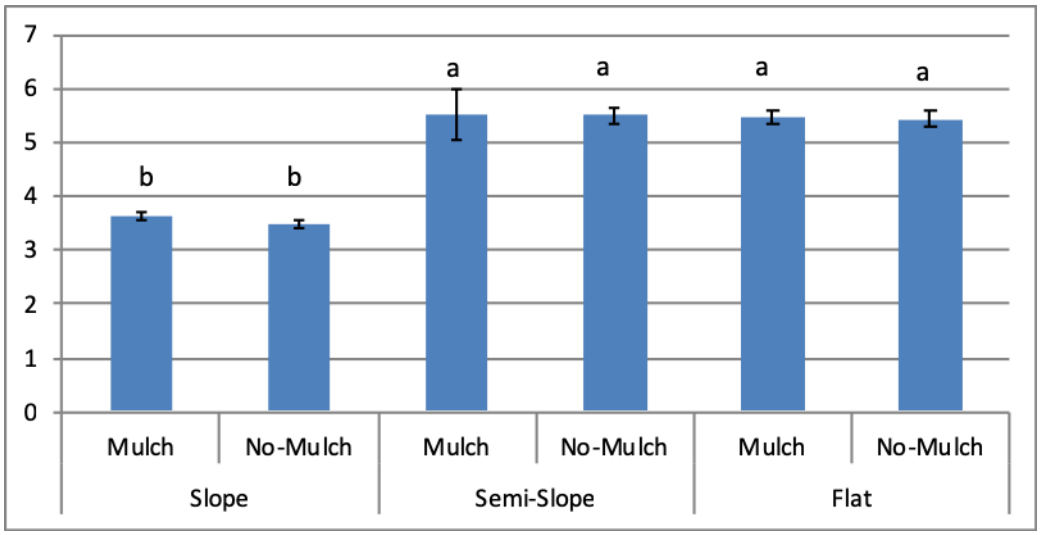

Figure 9: Maize yield (t/ha) first crop in Ban Bo 14/04 to 30/07 2013 (error bars represent standard error of means)

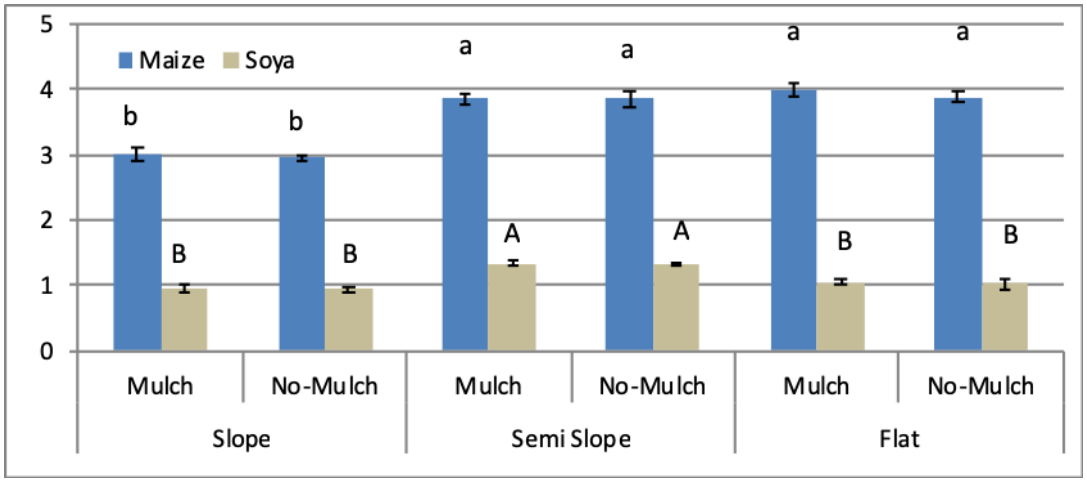

Figure 10: Maize and soya bean yield (t/ha) second crop in Ban Bo 9/08 to 26/11 2013 (error bars represent standard error of means)

The production of the first and second maize crop and the production of soya bean grown as the second crop was profitable when income and inputs other than labour are considered regardless of the steepness of the slope in 2012 and 2013. However, higher profitability was recorded when crops were grown in flat land than if they are grown on the slopes. Growing two crops per year increased return per land area.

When return is analysed based on the input of labour then returns per labour day in 2012 for the first crop of maize grown on steep slopes of 115,000 to 120,000 VND per labour-day was below the ongoing rate for hired labour at the time of 150,000 VND. For the second crop growing maize gave returns above the rate paid for hired labour regardless of the slope inclination, however soya beans gave returns below the rate paid for hired labour.

In 2013, when due to the late start of the rainy season, yield was lower than in 2012, only the first crop of maize grown on flat land and gentle slopes gave returns marginally higher than the rate for paid labour. These results indicate that growing maize is just marginally profitable if labour has to be paid. If the current trend of increased employment opportunities in NW Vietnam continue, there is possibility that farmers will reduce maize production and enter the labour market.

It can be concluded that over the four year of the project activities in Ban Bo, farmers experienced benefits of growing two crops within a single rainy season and by the end of the project two crops were grown on large scale in approximately 150 ha of flats and gentle slopes. Farmers' preference is to grow two crops of maize and only a few farmers grow soya bean as the second crop. Farmers concluded that there is not much benefit of mulching in the first crop but they use stubble of the first maize crop as mulching material for the second maize crop. Using maize stubble as mulching material does not require much labour and benefits of mulching are more visible when used for the second crop because rainfall is significantly reduced in the last few weeks of maize development.

Farmers also concluded that it is possible to grow two crops on gentle slopes when minimum tillage and mulching are used. On slopes where terraces are needed, the amount of labour invested may not be worthwhile.

Two crops within a rainy season grown in flat field – Pieng Sang – Moc Chau-Son La

The experiment was established in February 2012 and concluded in October 2012. The aim of the experiment was to evaluate a possibility to intensify production in flat areas by growing maize or pumpkin as the first crop and maize intercropped with soya bean and/or peanut as the second crop. The experiment was designed as randomised complete block with 4 replicates.

Development of the maize variety AG 59 was much longer (131 days) when it was grown as the spring-summer crop than when it was grown as the summer-autumn crop (99 days). This was caused by early sowing time in February, so temperature and rainfall were lower in the first two months of the development in comparison to the usual sowing time in April. Development of pumpkin was 117 days until first harvest and 131 days to the last harvest.

Maize yield was higher for the spring-summer crop ranging from 6.6 to 7 t/ha than for the summer-autumn crop which ranged from 4.6 to 6.7 t/ha. There were no significant differences ($p \leq 0.05$) in yield between maize grown with or without mulch for the first crop (Figure 11) but for the second crop, yield was significantly higher when maize was grown with mulch (Figure 12). Yield of pumpkin was significantly increased ($p \leq 0.05$) when mulch was used.

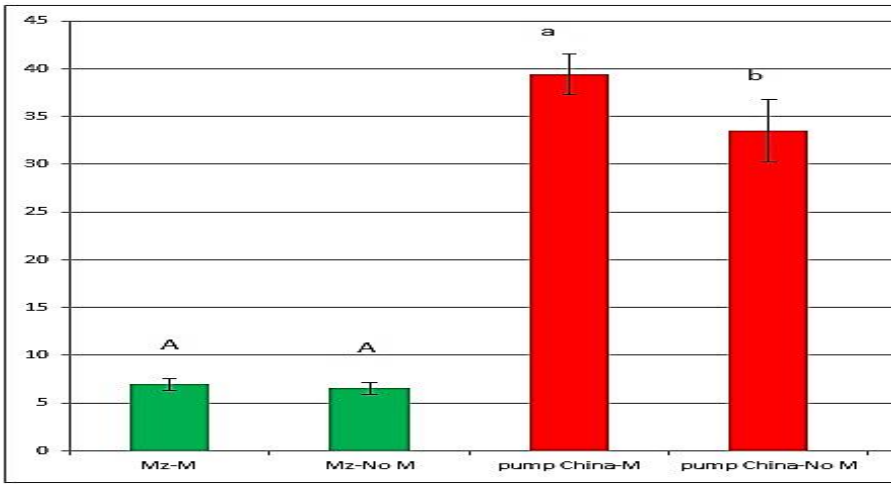

Figure 11: Maize and pumpkin yield ('00kg/ha) first crop in Pieng Sang 24/02 to 21/07 2012

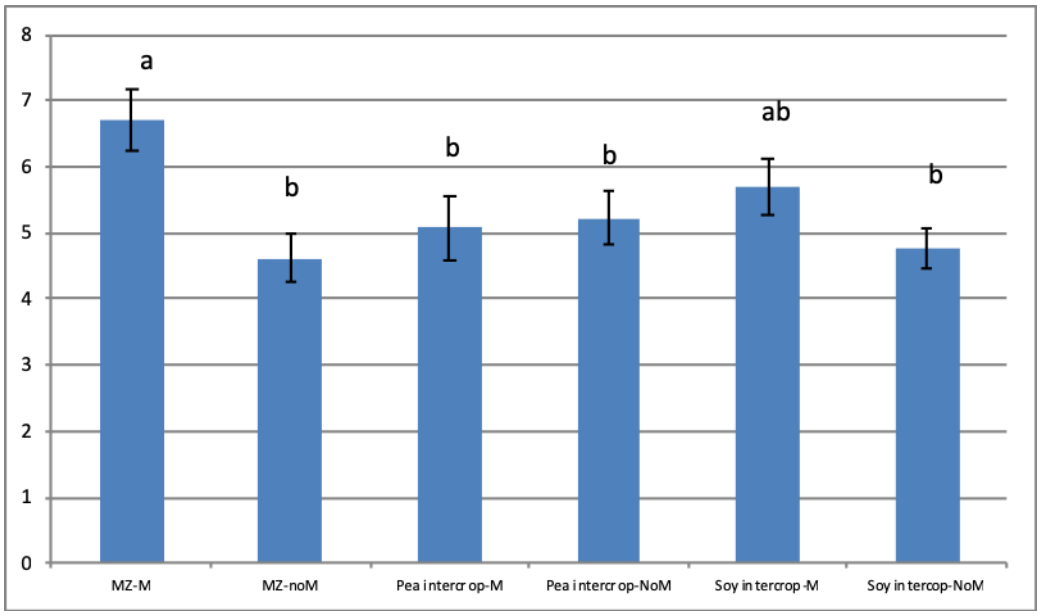

Figure 12: Maize yield (t/ha) second crop in Pieng Sang 06/07 to 8-13/10 2012

Both pumpkin (900,000 VND/ labour day) and maize (400,000 VND/labour day) were highly profitable in spring-summer sowings providing several time higher returns per labour-day than the ongoing rate of hired labour (150,000 VND/day)). Return for pumpkin was more than double in comparison with maize sown as spring-summer crop. Intercropping with soya bean (450,000 VND/day) and peanut (455,000 VND/day) nearly doubled profitability of the second crop when compared with growing just maize (280,000 VND/day). However, these results were achieved in flat fields in an area of Moc Chau with above average rainfall.

Farmers had seized the opportunity of growing pumpkin as the first early crop followed by the maize as the second crop and they planted pumpkin on relatively large scale in the year following the experiment (2013). Further market research is needed to establish size of the market for pumpkin in spring and early summer harvesting period to avoid overproduction if pumpkin is grown in a whole district.

Farmers evaluated the use of mulch as beneficial for increases in yield but further research is needed to find ways to source enough organic material to be used as mulch. The problem of increased rodent and insect pest population also has to be addressed before mulching will be used on a large scale.

7.3 Temperate fruit trials

There were two major activities implemented in the temperate fruit part of the project:

- Improvement to existing Tam Hoa plum orchards to gain higher yield and better quality implemented in Pieng Sang village, Phieng Luong commune, Moc Chau district, Son La province
- Establishment of newly planted temperate fruit orchards in Sin Ho and Tam Duong districts in Lai Chau and Moc Chau district in Son La.

Orchard improvements through pruning, fertilisation mulching and better pest control

Orchard, canopy and pest/disease management activities are presented in Table 17. Note that adjustments to the management strategies were made in 2013 (the last year of the project) to optimise the costs of inputs and labour and improve economic benefits of introduced management strategies.

Table 17: Orchard, canopy and pest/disease management activities in 2010 to 2013

Impacts	Completed (2010 – 2012)	Adjustments (2013)
Pruning	2 times/year (after harvest & end of winter)	1 time/ year (after harvest)
Applying fertilizer	- 3 times/year (after harvest, early Autumn, and end of winter)	-2 times/year (after harvest, end of winter) - Add secondary elements and micro element, micro element Ca, Bo when fruits are established
Mulching	Weeds, maize's stems, cana's stem... to mulch 30 cm away, around tree's trunk. The thickness of mulching layer 20cm.	As in 2012.
Pest and disease control activities	-Monitor some main pests' and diseases' occurrence - Control Fruit flies using methyl eugenol and protein baits when fruit flies' population reached 4 – 5 flies/bait.	- Monitor some main pests' and diseases' occurrence - Use methyl eugenol to monitor fruit's fly population and spray Protein bait from 1 – 1,5 month before harvesting.

Four experimental orchard management strategies (treatments) tested in period 2010 to 2013 are presented in Table 18. Treatments were implemented as a randomised complete block design with four replicates.

Table 18: Orchard management strategies implemented from 2010 to 2013

Treatment	Treatment 1 (CT1)	Treatment 2 (CT2)	Treatment 3 (CT3)	Treatment 4 (CT4/control)
Technical intervention	-Pruning -Applying fertilizer 1 -Mulching	-Pruning -Applying fertilizer 2 -Mulching	-Pruning -Mulching	-No intervention
Time frame	2010 – 2012	2012 - 2013	2010 - 2013	2010 - 2013

Applying fertiliser 1

#	Type	Total (g/tree/year)	After harvest (g/tree)	Early Autumn (g/tree)	End of winter (g/tree)
1	Urea (46 %)	**450**	100	100	250
2	Phosphorous (16 %)	**340**	100	100	140
3	Potassium (60%)	**540**	150	150	240

Applying fertiliser 2

#	Type	Total (g/tree/year)	After harvest (g/tree)	End of winter(g/tree)
1	Urea(46 %)	**350**	100	250
2	Phosphorous (16 %)	**250**	100	150
3	Potassium (60%)	**350**	150	200

Initial fertiliser input based on PPRI recommendation at the time (2010) was too high resulting in lower fruit quality: increased fruit cracking (Table 19) and lower sweetness (Table 20). During the 2013 plum season, inputs were optimised and successful control of fruit fly was achieved using baits mixed with insecticide. Spraying frequency was much lower than in 2011 and 2012 because plums were picked at an earlier stage of maturity. Finally after three years of experimentation and optimisation of pruning (less severe pruning), fertilising (lower nitrogen input) and harvesting of mature but not fully ripened plums (approximately 11° Brix), the trials showed a three times higher net income (excluding cost of labour) than farmer practice (Table 21). In previous years (2010-2012)

farmers had higher net income than project orchard because of higher cost in the experimental orchards and too late entry into the market due to putting the maturity requirements too high (>12° Brix). Results of this experiment resulted in major changes in recommendation for fertiliser use and level of pruning.

Table 19: The percentage of cracked fruits at harvest time in 2011

Monitoring date	The rate of cracked fruit(%)		
	Pruning+ fertilization	Pruning	Control
6/6	13.16	0.91	0.00
17/6	4.79	2.03	0.51
22/6	6.54	0.46	0.00

Table 20: Yield and fruit size in various treatment 2010-2013

Year	Yield (kg/tree)			
	CT 1	CT 2	CT 3	CT 4 (Control)
2010	11,9a	-	8,1a	2,1b
2011	16,5a	-	9,1b	5,6c
2012	12,3a	11,9a	10,9a	9,3b
2013		58.5	35.7	16.8

Treatment	Sugar content (Sweetness) %				Hardness (kg/cm^2)			
	2010	2011	2012	2013	2010	2011	2012	2013
CT1	11,24b	12.0 b	9.71b	-	7,64b	5.3 a	-	-
CT2	-	-	10.08ab	10.9	-	-	-	7.3
CT3	11,13b	11.7 b	**10.45a**	11.0	7,6b	5.8 a	-	9.5
Control	**12,09a**	**12.6 a**	10.35a	11.1	9,48a	6.2 a	-	9.0

Monitoring year	Plum's diameter (cm)			
	CT1	*CT2*	*CT3*	*CT4 (control)*
2010	3,98a	-	3,76b	3,62b
2011	4,04a	-	3,87ab	3,64b
2012	2,96a	2,96a	2,9a	2,63b
2103		3.31	3.12	3.20

Table 21: Economic analysis of treatments implemented in 2013

#	Items	Unit	Price('000 VND)	Treatment			Value (.000VND)		
				CT1	*CT2*	*ĐC*	*CT1*	*CT2*	*ĐC*
I	**Over 200 trees**								
1	***Cost of labour***			***45***	***34***	***8***			
	Dressing fertilization	Day		6	-	-			
	Pruning	Day		15	15	-			
	Clearing weeds + mulching	Day		8	8	-			
	Spraying pesticide	Day		5	5	-			
	Spraying foliage fertilizer	Day		5					
	Spraying protein baits	Day		1	1	1			
	Harvesting	Day		5	5	7			
2	***Input cost***						***2196***	***225***	***190***
-	Fertilizer								
	+ Phu My Urea	Kg	*10.8*	70	-	-	756	-	-
	+ Lam Thao phosphorous	Kg	*4.2*	50	-	-	210	-	-
	+ Belarus potassium	Kg	*13.5*	70	-	-	945	-	-
	+ lime	Kg	*0.6*	100	-	-	60	-	-
	Cabo	Bag	*5*	40	-	-			
-	Pesticide								
	+ Sherpa 25EC	Bottle	*35*	1	1	-	35	35	-
	Fruit fly	Trap	*9*	10	10	10	90	90	90
-	Protein baits	Bottle	*100*	1	1	1	100	100	100
II.	**Gross income over 200 trees**						**36270**	**22134**	**10416**
	Estimated yield	Ton	*3100*	11.7	7.14	3.36	36270	22134	10416
III.	**Net benefit**						***34074***	***21909***	***10226***

Establishment of new orchards

The project established peach orchards with variety DCS1 in Giang Ma commune, and supported farmers to develop production (Table 22 and 23). In 2013 the first batch of fruits becoming available in small but still commercial quantity (Table 23). These were sold for a high price: VND 30,000/kg. Based on these results, the Lai Chau provincial government initiated the expansion of 300 ha of temperate fruit orchards. The first phase of this expansion has already started with an expected establishment of 20 ha of peach orchard by the end of 2013. The local government with support of NOMAFSI was also developing peach production.

Table 22: Establishment of peach orchard in Gieng Ma, Lai Chao province

Plan	Completed activities (2011 – 2012)	Adjustment (2013)
Digging holes	Hole standard: 80x80x80cm	-
Planting trees	Prepare seedlings, fertilizer to plant Take care of the new orchards	-
Pruning, training	-Train branches to make open- vase canopy -2 times/year (June& December)	-maintain the open-vase shape -1 time/year
Applying fertilizer	3 times/ year(following procedure)	As in2011 – 2012
Mulching	Dead mulching materials: dead weeds, hay..... to preserve the soil's moisture	As in 2011 – 2012
Intercropping	With peanut and soybean	As in 2011 – 2012
Plant protection activities	Monitor main pests and diseases to address suitable solution	As in 2011 – 2012

#	Type of fertilizer	After Harvest (g/tree)	Early Autumn (g/tree)	End of winter (g/tree)
1	Urea (46 %)	75	75	150
2	Phosphorous (16 %)	35	35	70
3	Potassium (60%)	60	60	120

Table 23: Yield and income in 2013

Farmers	Yield (kg/tree)	Kg of sold peach	Price (.000đ)	Income from peach(.000đ)
Giang Pao Giang	6.1	125	28 – 30	3.500
Tan A Tai	31.3	280	22 – 26	6.000
Giang A Giao	22.9	320	25 – 30	8.000
Giang A Vang	11.3	140	25 – 30	4000
Ma Khoa Giang	10.2	230	25 – 28	5.800

7.4 Value chain development

Due to delays caused by the changeover of both Vietnamese and Australian project personnel, value chain interventions to develop a high quality plum chain did not commence until 2011.

Based on VC analysis, the Project Team and the collaborating farmer interest groups in Ban On and Co Do that included the local collectors decided to develop chains directly to modern retailers specifically safe fruit shops.

Plum farmers

Production and marketing protocols were agreed upon and stipulated:

- Eligibility of plum orchards are that they must be from 8-14 years old, and located 700-1000m altitude above sea level with suitable sun light and humidity;
- These orchards have to implement the recommended management techniques;
- A harvesting protocol ensures equity and fairness between member farmers in fulfilling orders;
- Farmers are able to appoint representatives to negotiate and contract on their behalf;
- The interest group's focus is wider than just plums extending to other food crops.

In addition to the formal production and marketing protocols, farmers have shown a willingness to collaborate in trials to improve value chain practices. In 2011, collaborating farmers were asked to trial harvesting techniques that incorporated visual grading for ripeness whilst plums were being picked. This reduced grading by collectors but did not eliminate it as tree vegetation and blemished, misshapen or green plums were still present in sufficient quantities to require grading. However, it also reduced the efficiency of pickers to about 40% of the normal productivity, significantly increasing the cost of production. This strategy was therefore abandoned in subsequent seasons.

Plum farmers-collectors

One farmer interest group was established in Ban On, the commune producing the best quality fruit. Whilst the Co Do farmers decided not to form an interest group, one of the larger collectors in that commune opted to collaborate with the project. The quality, quantity and timeliness of information flows for the collaborators were improved by:

- Collaborative planning, monitoring and evaluation meetings prior to, and at the end of the season. This included self-monitoring by the farmer interest group, in part using photographs;

- Training in aspects of plum in harvesting, handling and value chain management principles, which was then implemented by the group in their marketing practices.

Collectors

There appears to be no standards within the plum industry for grading and packaging. The Ban On and Co Do Project collectors were:

- Trained in the grading of plums for colour, size, blemishes and waste. These procedures were adopted and improved the quality of plums for the Hi-Q chain and raised retailer satisfaction with the consistency of plum quality;
- As a result of an identified consumer preference for unpackaged plums (Annual Report 2010, Appendix 5: Consumer Report on Tam Hoa Plum in Ha Noi), a retailer preference for 3-10 kg boxes and a wholesaler preference for 30 – 40 kg boxes, the project trialled and introduced improved, branded packaging of various sizes (40 kg, 10 kg, 3 kg) to reduce damage in transit and build geographic identification. These reduced waste occurring in transit to wholesalers.

Transporters

- Alternative forms of transport were trialled (e.g. buses, dedicated plum freight trucks, mixed produce freight trucks). As volumes from the chain increased, full loads of plums in dedicated freight trucks became the norm;
- The stacking of plum boxes and their placement in mixed loads was modified to reduce losses due to handling damage and the collapse of stacked boxes. This, as well as the use of the stronger boxes contributed to a reduction in waste due to crushing damage;
- Timing of arrivals at Long Bien were monitored and improved, ensuring that the Hi-Q plum chain produce did not miss the next day's market at Long Bien or wholesaling in Ha Noi.

Retailers

The RVCA found that Mộc Châu Plums were often poorly presented and placed in-store. This was due to the lack of merchandising skills of the retail storeowners and lack of knowledge about the provenance of the plums. Whilst the training of storeowners in merchandising was beyond the scope of the project, the introduction of branded boxes and consumer information in the form of coloured posters did improve consumer awareness of Mộc Châu Plums.

Collector-wholesaler and wholesaler-farmer information flows

Collaborative planning, monitoring and evaluation meetings were conducted prior to and at the end of each season with farmers, collectors, wholesalers and retailers invited. Only two wholesalers attended in 2012. This was because these small business owners had difficulty in leaving their shops for a two-day trip to Mộc Châu. Tam Hoa plums were such a small part of their business due to their short season and low profitability compared to staple food lines that the cost-benefit balance did not provide any incentive for them to invest the time in the 12 hour round trip and time on-site visiting the Mộc Châu suppliers.

Retailer-farmer information flow

There was no interest amongst retailers in meeting with farmers for the same reason as explained in the previous section.

Consumer-farmer information flow

The project's consumer research showed that consumers had no interest in the provenance of Tam Hoa plums beyond understanding that they were safe from contaminants. Only ten per cent of respondents knew that Tam Hoa plums came from Mộc Châu and were more likely to suggest Lạng Sơn in Lạng Sơn Province or Bắc Hà in Lao Cai Province.

Collector-wholesaler relationship for chain coordination

A moderate strength relationship already existed but was variable from quite strong and trusting with a long-term commitment of up to 20 years to short-term transactional relationships. Evidence was found that some collector-wholesaler relationships had intuitively adopted many of what could be called 'value chain management principles'. That is, principles of relational reciprocity, co-investment of resources, co-innovation to solve problems, value-sharing and tolerating periods of loss to ensure the longevity of the relationship.

The Project Team conducted training and provided advice on chain development to facilitate the development of longer-term relationships and cooperation to deliver value. The collaborating collectors adopted much of the recommended behaviour. The economic analysis, in a subsequent section, demonstrates that they achieved a net benefit from the Hi-Q chain, which was several times as much as the normal chain; however, the impact of that on their total business was small due to the small volume of high quality plums.

Wholesaler-farmer relationship for chain coordination

The lack of incentive for wholesalers and retailers to visit Mộc Châu for discussions with farmers is understandable given that the small volumes sold represent a very small income for stores (Table 24). For this reason, the intervention to improve this component of coordination was not successful. However, when two wholesalers did so in 2012, they were able to form direct supply relationships with two farmers in addition to meeting with the interest group itself and negotiating process changes to improve the quality and consistency of supply.

The Hi-Q plum chain performance 2011-13

As mentioned previously, the commencement of chain coordination did not occur until 2011. In the following three years, the Hi-Quality Chain achieved the following throughput:

- 2011 – 940 kg through TWO retailers (one dropping out)
- 2012 – 1,400 kg through THREE retailers
- 2013 – 3,066 kg through FOUR retailers

As the volume marketed in 2011 was too small for analysis, the following analyses are largely confined to 2012-13.

The collaborating stores were small independent retailers with a localised clientele and a 'convenience' store format similar but even smaller than the IGA X-press stores in Australia. Despite a strong focus by the project team in 2011/12 and 2012/13 on increasing the throughput of the chain by recruiting much larger numbers of such stores, this failed (Annual Report, 2012).

Table 24 shows the low volume throughput and gross income derived from Tam Hoa plums. Whilst there was no available data on the contribution of plums to the store turnover, it was apparent from in-store observations that it was very small, possibly lower than 1%. Given that the 42 day plum season in 2013 was slightly longer than average for Tam Hoa plums, their contribution to annual store turnover would have been extremely small.

Table 24: The importance of Tam Hoa plums to each individual retailer (2013)

Company	Total Weight (kg)	Average kg/day	Av. Gross Income/day VND (A$)
Ha An	961	25.29	556,368 (27.82)
Vinagap	1,160	30.53	671,579 (33.58)
Donavi	585	15.39	338,684 (16.93)
Fivimart	360	9.47	208,421 (10.42)

Note: Big Green did not participate in 2013.

Figure 13 indicates the retail price fluctuation for Hi-Q and non-project stores in the 2012 season. The project stores, Big Green, Ha An and Vina Gap had negotiated a stable price to growers of VND 22,000 and also held their retail price stable during the season. It shows that non-project stores suffered an opportunity cost by being involved and so appear to have been disadvantaged in 2013.

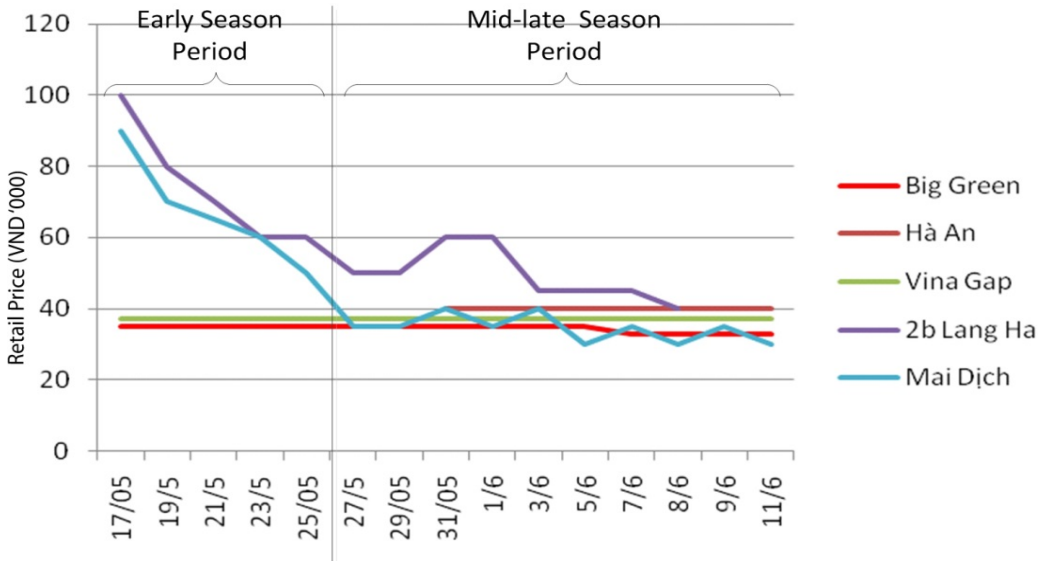

Figure 13: The fluctuation of retail prices in Hi-Q chain stores and non-project stores (2012)

Table 25 provides an overview of the cost-benefits of being involved in each of the three plum channels and provides further insight into chain behaviour. It indicates that there is an advantage to all the stages of the chain in coordinating the marketing of a line of high quality plums into specialty grocers. However, combining the retail data from Tables 24 and 25 indicates that the net benefit to the four retailers of Hi-Q plums ranged from VND 65,000 – 175,000 per day and VND 2,489,500– 6,648,000 for the 2012 season.

Table 25: Comparison of profit and net benefit to chain stages from different plum marketing channels (2012)

Chain Stage	Green (Co Do)				Ripe plums (Normal market)				Hi-Quality (Ban On Farmer Interest Group)					
	Purchase Cost	Input Costs	Sale Price	Net Profit	Purchase Cost	Input Costs	Sale Price	Net Profit	Purchase Cost	Input Costs	Sale Price	Net Profit	Net Benefit vs Ripe	Net Benefit vs Green
Farmer		795	3,200	2,405		3,968	8,200	4,232		3,968	15,056	11,088	6,856	8,683
Collector	3,200	150	4,000	650	8,200	160	12,500	4,140	15,056	1,650	23,000	6,294	2,154	5,644
Wholesaler	4,000	150	NK	NK	12,500	1,200	14,000	300					N/A	NK
Retailer					14,000	2,100	22,000	5,900	23,000	5,200	37,000	8,800	2,900	N/A

Assumptions:

- 400 trees per hectare.
- All prices and costs are from 2012 and based on interviews conducted by the project team with the Ban On Group and Co Do farmers.
- In 2012, all plums in Ban On were sold as ripe or to the Hi-Q Project. Co Do sold 80% of its plums green to China.
- Labour costs include the cost of family labour at VND150,000/day, the normal rate in 2012.
- Green plums:
  - Generally are not fertilised, pruned or protected from pests so the costs listed are just for labour.
  - Labour costs are lower for green plums. Ban On farmers estimated harvesting green plums costs 23% of the harvesting ripe plums (1.5 days/tonne versus 6.5 days/tonne).
  - Collectors buy green plums at the farmer's house and so incur a cost of transport. The bags/boxes used are second hand.
  - The price paid by wholesalers to collectors is an estimate as the latest project data is 2009 when the price was very low.
- Ripe plums:
  - Farmer's costs were averages of the Ban On Group. Other costs were averaged from those provided in interviews with downstream chain actors.
  - Few farmers regularly apply fertilisers, fruit fly chemicals or prune their trees.
- Hi-Q Plums:
  - Costs are those provided by the Ban On Group, its collectors and collaborating retailers.
  - Hi-Q plums are a direct supply to retailers in Ha Noi and do not go through the Long Bien markets as do ripe plums (refer hatched cells).

Because the Co Do farmer group decided not to participate in the project, the volumes above were effectively achieved through one farmer group of ten farmers. Whilst the net profit in Hi-Q plums for farmers is 260% higher than for ripe plums and 460% higher than green plums and 380% higher for collectors, the overall volume throughput was regarded as too low. Mr Phong, the collector from the Ban On Group, said:

If the high quality chain can consume farmers' plums at this higher price, then local farmers are very happy. However, we have to increase the consuming volume more to motivate other farmers to join.

Mr Chu Quang Tao, the largest farmer in the Ban On Group, who has 1,500 trees, harvests 10 tonnes per day at season's peak and trialled the project's 'grading at picking' technique said:

> *'The price is good but high quality plums are too much trouble. I need to have at least 30% of my crop going through this chain if I am going to do this.'*

Figure 14 shows the significant production and quality differences between the two areas involved in the Hi-Q plum chain despite them being geographically only several kilometres apart. Co Do starts the season 10-15 days earlier than Ban On and finishes earlier. However, when Ban On starts producing it matches Co Do in price and then exceeds it because of the higher quality. However, Figure 14 also demonstrates the significant price differential achieved by the Hi-Q plum chain; albeit a standard price for the season.

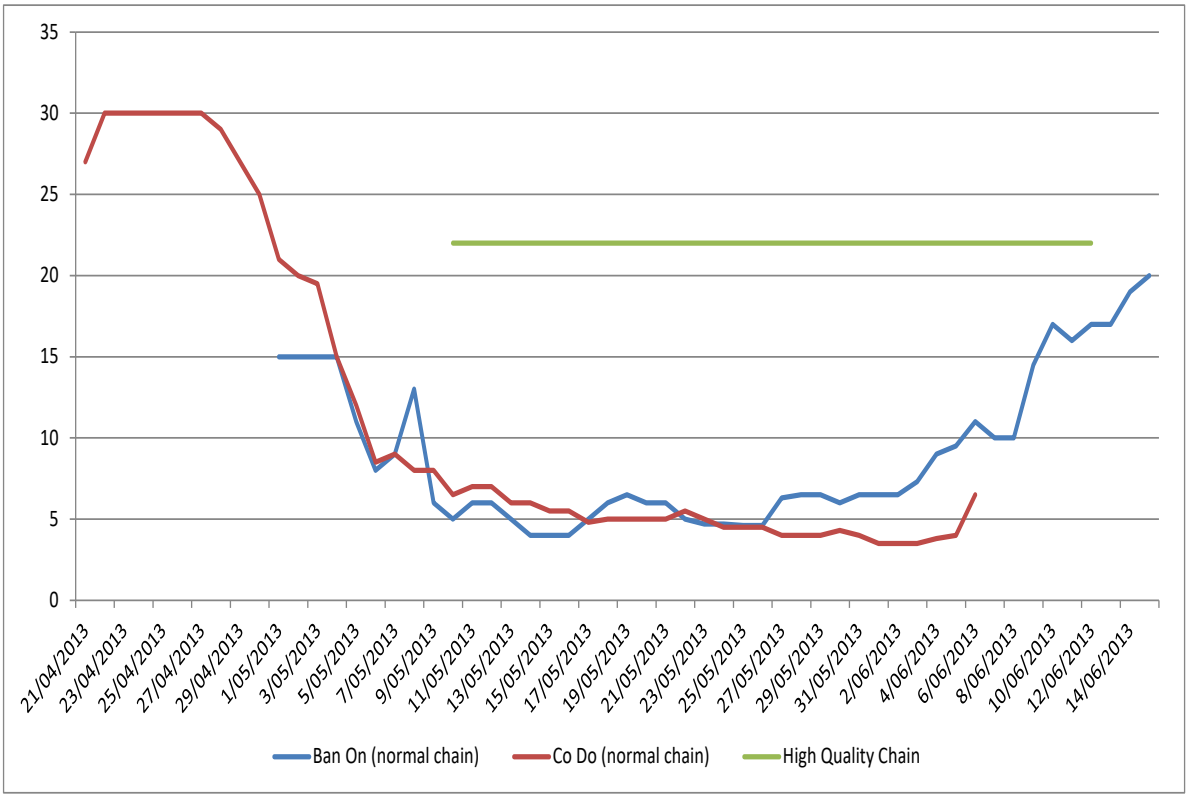

Figure 14: Comparative 2013 prices received by Ban On and Co Do ripe plums with the Hi-Q plum chain

7.5 Outreach strategy development

The outreach strategy aimed at developing a model for engaging small-scale farming households in the Northwest region to learn about, trial and adopt the sustainable crop management system, in general, and practices to control soil erosion, in particular, as developed by the applied and adaptive research activities. The strategy focused on: (1) demonstration and dissemination of practices suitable for wide application in the target sites; (2) enhancing farmers' awareness of the need for these practices and their knowledge and skills to apply them; and (3) building capacity and linkages for the facilitation of the strategy by the local agricultural extension system allowing large-scale implementation.

The outreach strategy development process was closely linked to all phases of the project through:

- Participatory planning of annual action plans
- Participatory planning of detailed plans of each trial
- Adaptive participatory trials of different technical options for soil erosion control and for sustainable cropping systems management
- PM&E of each trail
- Participatory annual evaluation

The actual pilot scale outreach, however, started in 2011 after trial results had yielded recommendations for best technical options suitable for farmers in the different sites. A long and intensive consultation process was undertaken with the local DARDs and Extension Service resulting in an agreed outreach strategy that involved the following specific activities during the pilot phase (2012-13):

- Field days and cross visits at the project sites
- Production and dissemination of photo stories by farmer researchers
- Demonstration of best-bet practice plots by the DARD extension officers with active involvement of project researchers and farmers.
- Training of Trainers for extension staff, involving two events each of four days, in September and December 2012, for 17 extension officers from Son La and Lai Chau provinces
- A pilot Farmer Field School (FFS) program with a strong business component comprising, involving 83 farmers in two villages in Tam Duong, Lai Chau, one village in Moc Chau, Son La, and one village in Mai Son, Son La.
- Production and dissemination of training and communication materials:
    - Technical manual on sustainable upland management (Appendix 24)
    - FFS Facilitator's guidelines (only in Vietnamese)
    - A promotional video for awareness raising (https://vimeo.com/135539202 and on DVD)
    - Two video modules for farmer training, one on 'Managing diverse farming systems on sloping lands' and the other on 'Soil erosion management' (on DVD and available at https://vimeo.com/256700835 and https://vimeo.com/256700894).
    - Laminated leaflets with pests and diseases of of selected crops (plum, peach, maize, soybean, groundnut)

- Posters on proper use of pesticides, soil erosion problems and some soil erosion control methods

The intensive inter-stakeholder collaboration, involving researchers, extension officers, farmers and local decision makers, throughout all phases of the research was considered highly effective and valuable. It led to improved linkages and significant results in ensuring that research results were being implemented at the field level.

7.6 Capacity building

Significant improvements were observed in the ability of (especially young) NOMAFSI, PPRI, CASRAD and TBU staff to engage in and facilitate participatory research, develop and implement research protocols, and collect, manage and analyse data.

A large number of capacity building events were organised over the project period for research and extension staff. In addition to continuous field based training on soil and crop production research methodologies during visits by UQ staff, a specific set of training events were conducted to enhance knowledge and skills on new concepts and develop methodologies together (Table 26).

Table 26: Training events conducted during the project period 2009 - 2013

Dates	Activity/Training topics	Participants
16 May 2009	Value chain principles and practices workshop: value chain analysis principles, methodologies and case studies	Key staff from CASRAD, HUA, PPRI and UQ/CIAT
1-4 Jul 2009	Training on erosion assessment methodology	Key field staff from NOMAFSI
3-5 Aug 2009	Diagnostic studies methodology development workshop (II): participatory needs and opportunity assessment methods and skills	Key staff from NOMAFSI, PPRI, CASRAD, HUA and UQ
8-11 Aug 2009	Training workshop for Rapid Value Chain Appraisal (RVCA)	Key staff from CASRAD, HUA, PPRI and UQ/CIAT
10 Jan - 12 Feb 2010	English language and data analysis training at UQ, Brisbane	Mr Le Huu Huan
11 Mar 2010	Reflection and planning workshop: one-day training in specific groups on ethics in research, participatory research methods (technology development, farmer researcher roles, M&E), and value chain development	Relevant representatives from all project stakeholder groups
22-26 Mar 2010	Assessment of the laboratory facilities and laboratory staff at NOMAFSI Headquarters for soil and plant analysis by Mr Graham Kerven from UQ	NOMAFSI lab staff
15-16 Sep 10	PM&E capacity building and field practice for maize ICM field teams	Key staff from NOMAFSI, TBU, HUA, Extension Service Son La Province

Dates	Activity/Training topics	Participants
02-05 Nov 10	Training in soil erosion measurement, sampling of soil for variety of soil physical and chemical analyses, selected soil physical analyses and designing experiment for valid statistical analysis	All NOMAFSI and TBU staff involved in the project implementation
18-22 Nov 10	Exploring concepts and tools for value chain research and development with practical implementation exercises at Ha Noi wholesale market	All CASRAD staff, TBU staff involved in VC research and selected PPRI staff
24 Nov 10	Innovation workshop (IV) for team leaders - participatory monitoring and evaluation	Team leaders from all partner organisations
26-27 Nov 10	PM&E capacity building and field practice for Temperate Fruit and Value Chain field teams	Key staff from PPRI, CASRAD, TBU, HUA, Extension Service Lai Chau Province
07-09 Mar 11	Value Chain strategy development workshop and training	Key staff from CASRAD, TBU and PPRI
21-22 Mar 11	Integrated pest management of maize, selected legume crops and temperate fruit	Conducted by PPRI for NOMAFSI, TBU and extension officers from Son La and Lai Chau
18-20 Apr 11	Training in establishment end cultivation of temperate fruit orchards - field visit to temperate fruit orchards in Bac Ha, Lao Cai .	Organised by PPRI for farmers, community leaders and extension officer involved in temperate fruit cultivation.
24-25 May 11	Designing and conducting sensory evaluation with focus on plums	Key staff from CASRAD and PPRI
12-13 Sep 11	Third Innovation Workshop on 'Agricultural and Value Chain Systems Research: From Theory to Practice'	Forty-three participants including project team members from CASRAD, NOMAFSI, PPRI, HUA, TBU and the provincial/district Extension Services in Son La and Lai Chau, as well as representatives from ACIAR projects in Vietnam and other research and development agencies including VAAS, FCRI, CIRAD, World Bank, SNV, VECO, GRET, Oxfam, M4Pand Helvetas.
12-13 Mar 12 Follow up on 24 Apr 12	Experimental design and statistical analysis (ANOVA and regression analysis)	NOMAFSI, PPRI and TBU staff
24-28 Mar 12	Value Chain research methodology workshop	CASRAD, HUA and TBU project team members
05 Jun 12	Conservation agriculture and erosion management-workshop organised at NOMAFSI Son La in cooperation with CIRAD	Team members from NOMAFSI, TBU, Extension and DARD of Son La and Yen Bai provinces.
9-19 Jun 12	Study tour to Laos to visit Conservation Agriculture demonstration sites managed by CIRAD	NOMAFSI staff

Dates	Activity/Training topics	Participants
10-11 Sep 12	Improving Market and Value Chain Research - Workshop on Agribusiness Research for Development Methods, Ba Vi (organised in collaboration with MALICA project and ACIAR AGB	Fifty participants, including market and value chains researchers from ACIAR-related Vietnam projects and some invited market and value chain research specialists
17-21 Sep 12	Training of Trainers "Sustainable Management of Integrated Upland Maize Systems"	Seventeen extension officers from Son La and Lai Chau provinces Researchers from NOMAFSI, PPRI and CASRAD served as resource person on their specific subjects (land and crop management, crop protection and agribusiness, respectively), but enhanced their own knowledge and skills on facilitation farmer learning and critical skill development.
10-24 Nov 11	Study tour to Australia on temperate fruit pest and disease management hosted by UQ	Dr Pham Thi Vuong, PPRI Mr Nguyen Nam Hai, PPRI
10-23 Feb 13	Study tour to Australia on value chain analysis hosted by UTAS	Mr Le Quoc Anh, CASRAD Mr Hoang Thanh Tung, CASRAD

Self-evaluation was conducted at various intervals during the project and complemented by a final evaluation during the last Innovation Workshop in November 2013. A comparative analysis of the project partners' perceptions at the start and end of the project is presented in detail in Section 8.2 and Appendix 27, but a few quotes are presented here to illustrate the progress made in terms of capacity to engage meaningfully in a participatory, transdisciplinary project.

The field-based researchers expressed that they enhanced their understanding of and skills in conducting in participatory and interdisciplinary research, making them collaborators that are more effective in international projects, as well as in their own institutions. They felt that their research has become more relevant to the needs and conditions of the farmers they are targeting. This is illustrated by the following quote from a researcher from TBU that was captured in the promotional video:

> *"We can see that this project has a lot of positive changes in terms of approach. For example, many projects have been implemented by applying a top-down approach without much participation by farmers. However, the farmers in this project have actively taken part in all project phases, from planning to implementation and evaluation. We listened to farmers' voices. And all our implemented activities here were designed to answer farmers' needs and demands. This is a highly valuable approach that many other projects do not have. In the future, we would like to adopt this approach when participating in other projects."*

It also became evident that Agricultural Extension Officers involved in participatory research activities and/or facilitator training during the pilot outreach activities, had become better communicators. As such, they felt they had a more meaningful relation with farmers and, as such, were more successful in supporting farmers to enhancing their knowledge and skills. This is illustrated by a quote from one Extension Officer in Vietnam in the promotional video:

> *"… we have learnt a lot how to work well with farmers from different ethnic groups. For instance, when working with Thai or Dao or H'mong people, we have to learn their customs and habits to adapt our working method and act more suitably according to their ways. The success of the project was to enhance the capacity of*

> *our extension service. Also, to improve the skills of farmers involved in the project's trials. I have learnt how to share and disseminate knowledge and skills for farmers in my localities. During the implementing process, we tried to put ourselves in farmers' shoes. Then we tried to consider how best to approach them."*

In addition to capacity building of project collaborators, the project also hosted a range of other studies and positions:

- Fifteen Master and Bachelor students from Tay Bac University conducted their thesis research within the context of the project trials in Moc Chau. They received bursaries to cover transportation and printing cost from an anonymous donor, which was matched by the C*f*CSC.
- An Australian Youth Ambassador in Development from February-December 2011 on a "Project Information Systems and Communication Officer" position. The candidate, Ms Amanda Lugg, was a graduate of the UQ Master of Communication for Social Change.
- A UQ soil science honours thesis project by Emma Tscheppera entitled "Socio economic and biophysical constraints to the adoption of soil erosion control methods in North West Vietnam".
- PhD project (2011-15) by HUA Lecturer and JAF recipient Mr Nguyen Huu Nhuan: "Assessing impacts of participatory communication strategies underpinning agricultural research for development in culturally diverse environments of the North-West Highlands of Vietnam" ((https://espace.library.uq.edu.au/view/UQ:398448).
- UQ Master of Communication research thesis (Semester 2 2013), by Ms Nguyen Thi Thanh An: "The suitability of participatory communication for agricultural research projects in Vietnam: a case study" (Appendix 23).

8 Impacts

8.1 Scientific impacts

There are three areas of scientific impact that the project contributed to:

1. The introduction of a transdisciplinary and collaborative research framework in the Vietnamese research for development arena.
2. Advancement of the Conservation Agriculture in Southeast Asia (CANSEA) network.
3. The establishment of the usefulness of a new erosion measurement technique under Vietnamese highland soil conditions.

Each of these will be discussed separately in the sections below.

A transdisciplinary and collaborative research framework

The project applied for Vietnam and ACIAR, a novel research approach that was transdisciplinary, collaborative and participatory. Transdisciplinarity was expressed through the involvement of researchers from a diverse set of academic disciplines, including agronomy, plant protection, agribusiness, soil science, social science and communication. In addition to the standard academic disciplines, roughly divided into the 'hard' and the social sciences, 'development' was considered a relevant discipline, as the development paradigm and objectives of the research project, emphasising community engagement in giving direction to the research, determined the project's epistemological approach. This allowed for other stakeholder groups such as farmers, local governance bodies, service providers and the private industry, to take active part in the collaboration.

The alignment of all these disciplines in the overall project methodology and the collaboration was actioned through a systems-based situation analysis at the start of the project, annual Reflection & Planning Workshops, and annual Innovation Workshops. The participatory nature of the project was expressed through the active involvement of selected farmers as Farmer Researchers in each project site. These farmers were engaged in trial design and planning, implementation and analysis.

The activities were supported by the use of two methodologies that helped everyone to understand each other better: (1) a mental models study that compared farmers' and researchers' perception about erosion and hence provided a platform to debate these different perceptions (Appendix 22), and (2) the Participatory Monitoring and Evaluation system (Appendix 18). The concept of Participatory Monitoring and Evaluation (PM&E) became accepted and was incorporated as a common research practice by the Vietnamese research partners. Guidelines for PM&E were modified to better meet their conditions and needs. PM&E of adaptive field experiments is perceived as a way to formulate new and adjust existing research activities in order to make them more relevant to the realities of targeted smallholder farmers. Subsequently, the PM&E in the Northwest project has served as an important first step towards outreach activities initiated in 2013.

While it was a steep learning curve for everyone involved to reckon with each other's disciplines and ways of working, over time the dynamics of the team changed and allowed for adapted methodologies and a stronger voice of farmers in the determining the direction of the research. This eventually led to a farmer-training curriculum that matched the needs of the Northwest highland communities and the capacities of the Extension system to spread it beyond the research project sites (Appendices 19 and 25).

The research approach and supporting methodologies were presented at various academic events and published in proceedings (Appendices 8 and 22). Verbal statements were made by Vietnamese partners about the importance of this approach in the

promotional (albeit non-scripted) video produced at the end of the project (https://vimeo.com/135539202).

Conservation Agriculture in Southeast Asia (CANSEA) network

The project team, in particular NOMAFSI and UQ, became active members of Conservation Agriculture in Southeast Asia (CANSEA) network. This collaboration resulted in many members of the project team taking an active role in the Organising and Scientific Committee of the 3rd International Conference on Conservation Agriculture in Southeast Asia that was held in Hanoi in November 2012.

Erosion measurement technique

The project developed and tested a method for soil erosion measurement, the so-called 'pin method', which is a modified profile meter method that monitors the drop in soil surface level below fixed reference points (steel pegs, or pins, driven into the soil). The advantage of this method is that it has minimum impact on farm operations. However, the method appeared unsuitable for use on disturbed (ploughed) soil because of too high variations between individual measurements.

8.2 Capacity impacts

See also Section 7.6 above.

Project partners capacity

The Vietnamese partners within the project had a high level of capacity to achieve relevant scientific outcomes, as was demonstrated through their involvement and success in both ACIAR, national and international projects. However, despite institutional linkages within the Ministry of Agricultural and Rural Development (MARD), organisations typically worked on projects in isolation. A significant gap existed between scientific impact and community impact, a result of the limited capacity of organisations to convert scientific impact into economic, social or environmental impacts.

As such, a significant focus of the capacity building within this project related to drawing together different Vietnamese organisations and fostering collaborative work to enhance effectiveness of current and future research work. This Transdisciplinary Research for Development (TR4D) approach also supported the development of organisational and individual capacity to move scientific impacts to community based impacts.

All project activities provided learning opportunities, which exposed research partners to new approaches for development and on-the-job training, such as soil science principles, market and value chain assessment and evaluation methodology. The project involved several visits of Vietnamese project partners to Australia, including a visit for two NOMAFSI staff in Year 1 to learn soil/plant analysis in the UQ LACFS labs, and training or conference travel for two groups of representatives from the three major partner organisations in Year 3 and 4.

The capacity development aspects of the project extended beyond those agencies involved in the project and into the smallholder sector. This was due to the substantial number of farmers involved in project activities. Smallholders directly involved in the field research and pilot activities (Farmer Researchers) improved their capacity to implement new farm management strategies, being able to holistically consider the market and available land resources.

Using linkages to activities, such as those being carried out by ADDA where innovative and capable smallholders were identified and trained as future village based trainers, this project identified key smallholders who influenced the practice change of others, and potentially other smallholders in different regions of the North West Highlands.

Additionally, the project developed dissemination models through which partner organisations and affiliated programs (e.g. DANIDA, ADDA, World Vision) could implement farmer capacity building on a much larger scale. While no specific efforts could be made to train facilitators from affiliated programs, the materials produced were easily accessible to them

Enhanced capacity of the project's field researchers from partner organisations became evident through the more independent management and reporting of field trials, supported by a revised Participatory Monitoring and Evaluation system. An evaluation of partner researcher and extension officer capacity to facilitate farmer participatory research and learning was conducted towards the end of the project as a thesis project by a UQ Master student in Communication for Social Change (Ms Nguyen Thi Thanh An, who is also part of the staff of the ACIAR Vietnam country office).

Farmer capacity

The capacity of farmers in the target areas (beyond the farmer researchers) to manage their crops on sloping lands more productively and sustainably and engage in more profitable temperate fruit value chains was achieved through specifically targeted training, as reported in Section 8.4 below. While evaluation of farmer capacity after training could not be conducted within the timeframe of the project, Vietnamese partner researchers observed, and reported informally, that during subsequent (post-project) seasons two of the four villages that had trained farmers in the pilot Farmer Field Schools in 2013 had over 50% of farming households practise minimum tillage and apply mulch on their lands (Appendix 25). It was also documented that local provincial and district governments in Son La, Lai Chai and Yen Bai continued training of trainers and large-scale farmer training from 2014 onwards, involving approximately 1,000 farmers in 2014, and over 3,000 in 2015 (Appendix 26).

8.3 Community impacts

8.3.1 Economic impacts

The major outcome of participatory evaluation of the 2010 maize ICM trials was the realisation that erosion management strategies trialled had negative economic impacts as they resulted in lower income per day of work for farmers. In 2011, adjustments to erosion management strategies were made resulting in minimum tillage (MT) and zero tillage (ZT) showing higher earnings per day of work (358,000 VND and 290,000 VND for MT and ZT, respectively) than farmer practice of burning and ploughing (281,000 VND). These erosion management strategies require significant changes in farmers' current cultivation practices and the availability of suitable mulching material. Successful harvest of two crops within a rainy season has already shown a positive economic impact in Ban Bo, where 50 ha were sown with a second maize crop after the first was harvested. Where mulch was not used, profit (excluding labour cost) for the first crop of maize was 22,000,000 VND/ha and for second crop 16,000,000 VND/ha, which represents a 73% increase of income. Where mulch was used, profit in the first crop was 25,000,000 VND/ha and in the second crop 21,700,000 VND/ha (a 112% increase). In 2012, 70 ha were sown with maize or soya beans as a second crop, what represents increase of 40 % in comparison to 2011. It is encouraging that even though still most of the farmers planted maize as a second crop significant number of farmers planted soya beans. Performance of the second maize crop was as good as the first crop doubling farmers net income from 27,000,000 VND/ha to 54,000,000 VND/ha.

In Chien Chang in 2011, profitable legume crops were grown as a second crop with mung bean returning profit (excluding labour cost) of 19,000,000 VND/ha, black beans of 22,700,000 VND/ha and soya bean 8,100,000 VND/ha.

In Pieng Sang in 2011, pumpkin was grown as the first crop. The yield of pumpkins was very high but due to the low price, profit was negligible. However, intercropping of maize and peanut grown as a second crop brought profit of 16,000,000 VND/ha for maize and 18,000,000 VND/ha for peanut. The most profitable cropping system was achieved in Pieng Sang in 2012 with the maize as a first crop and maize intercropped with soya bean or peanuts in the second crop. Maize was re-spaced so the number of maize plants per hectare did not decrease. Combined net-income (excluding labour cost) for both crops was over 60,000,000 VND/ha reaching 500,000 VND per labour-day for some treatments.

Farmers in La Nga grew rapeseed on a large scale as a second crop.

It seems that success of two crop growing cycles per rainy season tested on project sites with active engagement of communities and local government in planning and evaluating of outcomes resulted in significant initial acceptance by farmers in communities and districts where the project had activities. All successful second crops were grown without any irrigation on gentle slopes of 5-10 degrees and even though in the Northwest of Vietnam the majority of maize is grown on steeper slopes, the economic benefits of growing a second crop on limited areas of gentle slopes are very high.

Strategies applied to improve plum production that included pruning, mulching and use of fertilisers showed 3 times higher land productivity than farmers' practice of no input (34,074,000 VND/200 trees vs. 10,226,000 VND/200 trees). Labour productivity in experimental treatment was 757,000 VND/labour day, what is higher than labour productivity for maize production. The labour productivity for farmers' practice would be still much higher since farmers only used their labour for harvest. Overall after three years of participatory research developed strategies for production of Tam Hoa plum provide good balance between return and investment in inputs and labour maximising return with low inputs.

8.3.2 Social impacts

An increasingly active participation of community representatives at most of the project sites was observed during the last two years of the project. This could be attributed to the following fact:

- Some research results had become more evident to farmers;
- Trust had been sufficiently built up between field researchers and farmer researchers, and
- The field researchers' capacity to facilitate participatory monitoring and evaluation activities had visibly increased and they were more confident, as were the farmer researchers' in sharing their opinions.

Farmers' opinions in planning and evaluating sessions have become increasingly determinant in shaping up field trial protocols and conclusions. This resulted in better adapted and more applicable technologies for each of the research sites. Farmer researchers in Ban Bo, Pieng Sang, La Nga and Na Ot also actively shared their research experiences in the community through community feedback meetings in the trial fields and, in some places, through photo stories that were put up in public places. As such, the farmer researchers assumed important leadership roles in the community.

8.3.3 Environmental impacts

Erosion management and maize ICM field trials confirmed that minimum tillage, involving opening a narrow trench to apply seed and fertiliser either by hoe or cultivation implement pulled by buffalo, coupled with use of *in situ* organic material for mulch, can reduce erosion between 40 to 50%. This very undemanding soil cultivation practice has the added advantage of reducing labour input for soil preparation and hence gained acceptance by farmers while resulting in positive impacts on the environment.

8.4 Communication and dissemination activities

Internal organisation communication through a PM&E system

To achieve a shared understanding among all stakeholders, formulate aligned research questions, and develop a shared methodological framework, a well-designed communication platform was required allowing exchange of perspectives on problems, potential solutions, methods and results among researchers, development practitioners and farmers. Communication in this sense was not about sending messages from one to the other, but about facilitating dialogue and sharing power in decision making between researchers, farmers, local leaders and extension officers. Communication methods to facilitate the operations and collaborations of the transdisciplinary functions of the project were effectively embedded in a participatory monitoring and evaluation (PM&E) system that was tailor-made to the project

The PM&E system consisted of the following components:

1. A participatory field trials planning meeting with the objective to reach an agreement among researchers, farmers, extension officers, commune and village leaders on objectives of the trials, trial design and implementation details. Farmer researchers were chosen at community meetings at the start of the project. Criteria for selection included their interest to participate in trials, having fields on slopes appropriate for trials and their agreement to engage with other farmers in the community to discuss progress and outcomes of field trials. There were five farmer researchers in each of the seven project sites and their role was to design and implement trials together with researchers and extension officers.
2. Regular review meetings with farmer researchers and extension officers to monitor progress of trial implementation. Monitoring was performed every 2-3 weeks depending on the development stage of the crop. The main researcher responsible for a particular trial, the extension officer (one extension officer per trial) and the farmer researchers (five people per site) monitored all trial plots together, recorded progress of the crop and observed and discussed results of trial treatments and the economic implications for their farms.
3. A community feedback meeting around harvest time with the objective to capture the opinions of the community on trialled farming practices and how they may be included in existing farming systems. Community interactions consisted of field visits and discussions with farmer researchers, extension officers and researchers. Field visits were followed by discussions in the community hall of the village where researchers and farmers presented together.
4. Participatory assessments of yield in experimental plots with the objective to estimate yield together with farmers, extension officers and the village leader. In larger experimental plots researchers were leading the estimation of yields based on 2 m2 area with farmer participation. Once yields were calculated farmers discussed results and if they disagreed with them the process was repeated. If agreement was reached, then that result was recorded. In smaller experimental plots the whole crop was harvested and measured by farmers with the researchers' assistance. This activity was introduced in the second year of the project after disagreement between farmers and researchers about the estimated yields of experimental treatments. Farmers were claiming that the yield of new practices was overestimated by researchers.
5. Participatory evaluation of a field trial with the objective to evaluate economic and environmental performance of experimental treatments and to compare experimental treatments with farmers' own fields. Participatory evaluation was done with farmers, village and commune leaders and extension officers. Data from experimental fields were analysed by researchers and then presented to farmers. Farmers then commented on data compared them with the production on their own fields and most importantly they compared the performance of experimental treatments in relation to

their ability to provide material inputs (farmer financial situation) and labour. Outputs of the evaluation session were recommendations for next season's experiments and identification of barriers for adoption of trialled new practices. By the end of the project, as some of the experimental practices and more sustainable farming systems were adopted on a large scale, the outputs of evaluation became recommendations for provincial DARD and extension centres to support scaling up.

After the first year of PM&E system implementation it was concluded that PM&E was a successful mechanism that enabled researchers to conduct field experiments with farmers, not merely on farmers' fields. Some researchers, particularly younger ones, became good facilitators of dialogues with farmers and were able to couple scientific information with farmers' practical knowledge, which enabled development of innovations that were feasible in the agro-ecological and socio-economic context of specific communities. This is succinctly expressed by a young lecturer from Tay Bac University who stated: *'We listened to farmers' voices and all activities were designed to answer farmers' needs and wishes. This is a highly valuable approach that we would like to adopt in the future.*'

As the project progressed, it became clear that PM&E also provided opportunities for researchers to better experience the farming systems they worked in. Researchers became aware that farmers manage a system, not fragments in separation, hence forcing them to look beyond their discipline to be able to deal with the questions and issues raised by farmers and community leaders during PM&E activities. Evaluation of experiments went beyond measuring just yield and soil loss due to erosion, to include socio-economic and agro-ecological aspects of farming systems. The soil management practice that was previously considered the best because it resulted in the highest yield and lowest level of soil loss, was rejected due to the labour requirements that were beyond farmers' means without incentives such as government subsidies. Evaluation interviews with representatives from all stakeholder groups revealed that the PM&E system had been valued as it had provided the opportunity to learn from sharing ideas and plan, implement and reflect on the collaborative work. This is illustrated by the following comment made by Mr Song, a Dao farmer from Moc Chau: "*It started with project officers coming to the village's hall to discuss with farmers to help farmers understand more [...] Officers apply 3-together rules: firstly, they made a plan with farmers and we carried out the activities together we exchanges discussions and ideas and finally, we drew lessons learnt to implement the project's plans better The officers were very open to ask us questions and we were happy to carry out the activities. Then we learnt the lessons together [...] This project is important because it meets with the farmers' demand; if farmers only grow maize, their income will not be enough for living expenses, we learned to intercrop maize under the plum's branches or intercrop maize with soya bean or pumpkin to get more profit*."

An important moment in the development of the PM&E system was, when after the first year of implementation, a senior NOMAFSI researcher took leadership over the process. Initial PM&E guidelines developed by the Australian team followed the logic based on western conceptualisation of farmer participation that gives 'farmer researchers' equal status to researchers and extension officers. The PM&E process, after modification by the Vietnamese partners, still enabled farmers to be heard and their realities acknowledged and acted upon, but with researchers and extension officers leading the process and suggesting the final decisions that were then agreed upon by farmers. This 'power arrangement' between farmers and experts was productive, more comfortable for all parties involved and was the main contributor to development of intensified sustainable farming systems that were implemented over a relatively large area within the life of the project. The Vietnamese-modified PM&E system has been internalised by NOMASFI and is now being used in other projects.

Other communication mechanisms applied in the project involved the following:

- Internal project communication was materialised through annual reflection and planning workshop (focus on review of progress and planning of new activities), annual Innovation workshops (Focus on methodology development, and the production and sharing of activity reports). Biannual coordination meetings for all sub-team leaders were organised by the national coordinator, Dr Doanh during the first three years of the project.
- A project website was designed and made available to the wider public after it became evident that the project partners did not feel comfortable to use it mainly as an internal platform to share data and preliminary reports.

External communication, serving the function of disseminating research results to the wider community, involved the following activities:

- Community feedback sessions were organised in six villages at the end of the second season of 2012 and the first season of 2013. The main purpose was to share the tentative results of the adaptive field experiments and receive feedback from the community on the applicability of the technologies tested. About 5-10 farmers participated at each community feedback session.
- Photo stories were produced by farmer researchers as a way of allowing them to express their opinions about project activities and outcomes and share these visualisations with the researchers as well as with fellow community members. A selection of photo stories was collated in a booklet and printed in both Vietnamese and English (Appendix 20).
- A four-day Training of Facilitators for 17 extension officers from Son La and Lai Chau provinces was conducted in September 2012, in which the foundation was laid for them to become facilitators of the Farmer Field School (FFS) on sustainable maize-based system management.
- Four FFS units were implemented covering two cropping seasons in 2012/13. The trained facilitators further learned on-the-job while also engaged in improving the various training modules. The four FFS engaged 83 farmers and were conducted in Ten Pa and Na Van villages of Tam Dong district, Lai Chau province and, Suoi Khem village, Moc Chau district and Noong Luong village Mai Son district of Son La province.
- Three videos were produced and made available to all Vietnamese project partners and on the internet:
    - Promotional film to introduce the issues and opportunities to local policy makers ((DVD format and available at https://vimeo.com/135539202).
    - Technical module “Managing diversified farming systems on sloping lands” (DVD format and available at https://vimeo.com/256700835) .
    - Technical module “Managing soil erosion on sloping lands” (DVD format and available at https://vimeo.com/256700894).
- Laminated leaflets with pictures of pests and diseases of selected crops were produced by PPRI and distributed to farmers in the project villages. The crops include plum, peach, maize, soybean, and groundnut.
- A technical manual was produced (in Vietnamese) with the support of the Master Trainers and given to the provincial Extension Centre for use in training farmers.

9 Conclusions and recommendations

9.1 Conclusions

From the project's research outcomes and experiences, the following conclusions can be drawn:

1. Considerable soil erosion was measured, although the use of mineral fertilisers and the deposition of soil on fields on the lower slopes from higher fields were masking observable effects on yields. Farmers were found to be aware of, but not very concerned about, soil erosion as they were still able to obtain good yields and good prices for their produce. Consequently, there was generally low motivation to implement soil erosion management practices if it did not result in immediate higher return of investment or reduction in labour input.
2. The application of good soil erosion management practices was shown to make crop cultivation on sloping land more profitable and sustainable. These practices were only acceptable to farmers if implementation did not require additional labour or inputs that would not demonstrably be recovered. Minimum tillage in combination with mulching appeared to be an acceptable practice to farmers and after receiving training to better understand the long-term implications of soil erosion and gain the skills to implement the practices. It was assessed that in the year after completion of the project over 50% of farming households in the project sites practised minimum tillage and applied mulch on their lands.
3. The introduction of two crop-growing cycles per rainy season on project sites with active engagement of communities and local government in planning and evaluating of outcomes resulted in significant initial acceptance by farmers. All successful second crops were grown without any irrigation on gentle slopes of 5-10 degrees and even though in the Northwest of Vietnam the majority of maize is grown on steeper slopes the economic benefits of growing a second crop on limited areas of gentle slopes are very high.
4. Current temperate fruit industry is based on only one variety of plum (Tam Hoa) and, from a market perspective, any further increase in production is unsustainable.
5. Plum orchard and canopy management are not adjusted to targeted markets. Geographic areas with unfavourable natural conditions can be planned for production of processing quality plums, which under current market conditions still brings higher income to smallholders than most broad-acre crops, including maize. Orchard management for processing plum should include higher density planting, minimum pruning but moderate to high fertilizer input to encourage high fruit load. Moderate pruning is recommended for areas producing plum for the fresh traditional market, while open canopy that maximize sunlight exposure and consequently has light to moderate crop load with larger size and better colour of the fruit should be only used if access to supermarkets and high-end speciality safe food shops are guaranteed.
6. Collaborative development of the value chain of Tam Hoa plum provided a good balance between return and investment in inputs and labour maximising return with low inputs.
7. The project focused on development of value chain to modern retailers, in particular to safe fruit/vegetable shops. This market segment is extremely small with the throughput of plums representing less than 0.1% of Moc Chau harvest. This low capacity to absorb any significant volume casts doubt on justification of project interventions. However, other potential outcomes should be considered based on the fact that these retailers offer much higher prices to the farmers and actively promote the product and

Moc Chau origin on varies online platforms including social media. This can lead in more enabling environment for technical and marketing innovations and upgrading of fruit quality.

8. The careful and participatory design and piloting of an outreach strategy, in the form of a Farmer Field School on sustainable upland maize production systems with supporting materials (trainer manuals, leaflets, videos), and the development of facilitator capacity through a Training of Trainers, appeared vital in the scaling up of the project's research outcomes upon completion of the project. Over 4,000 farmers in the two project provinces (Son La and Lai Chai) plus one neighbouring province (Yen Bai) were trained in FFSs by local government staff who had participated in the Training of Trainers in the two years following the project completion (2014-15), which was all funded from local government funds.
9. The active involvement of all relevant stakeholders, especially farmers and local extension officer, is crucial in adaptive research for development that addresses complex issues, such as soil erosion and value chains. To engage in transdisciplinary collaboration, however, requires collective understanding of the direction and approach of the project, and the development of skills to engage in dialogue and negotiate research design and conclusions. It took about two years into the project, involving a diagnostic phase allowing everyone to analyse the situation from their own perspective, before the collaboration became more balanced. Farmers and extension officers began to function as co-researchers, and the disciplinary boundaries among the researchers from different institutes were acknowledged and a well-coordinated interdisciplinary mode of operation evolved.
10. Institutional cultures and existing inter-institutional relationships need to be recognised and understood before deciding the level of disciplinary integration to commence at. In our case we tried to operate within a transdisciplinary framework, which was not feasible given the existing institutional arrangements and mindset of Vietnamese and Australian researchers involved.
11. A participatory monitoring and evaluation system can serve as an effective communication mechanism for researchers, farmers and extension officers to negotiate the direction of research activities, conduct the analysis of research results considering both scientific and practical parameters, and formulate innovations systems that can be implemented in the local farming context.

9.2 Recommendations

Relating to maize-based farming systems on sloping lands:

1. Biophysical research into sustainable soil and nutrient management options is needed to enable the transition from tillage-based maize production to minimum soil disturbance. This research should increase understanding of the impact of rotation, intercrop and relay crops on soil fertility. The projects did not establish the impacts of minimum soil disturbance on maize cultivation and maize-legume farming systems on soil fertility, and consequently optimisation of nutrient budgeting and fertilisation was not addressed.
2. Comprehensive follow-up evaluation research of maize-based farming systems that includes livestock management should be conducted. It is recommended that such research incorporates socioeconomic, farming system and market analyses of crops that have the potential to replace maize, or at least be accompanied by maize, as inter- or rotational crops.

Relating to temperate fruit-based farming systems in the North West of Vietnam:

3. Temperate fruits are a viable alternative to broadacre crops, especially on steep slopes where legume cultivation is difficult. However, due to the long-term nature of

fruit tree cultivation, there should be (1) coordination of government programs and private sector initiatives, and (2) comprehensive planning based on market research and multi-stakeholder consultation, both facilitated through province-based industry associations. The associations should lead activities that introduce new varieties based on market demand and establish modern nurseries across high elevation (temperate climate) regions of North West Vietnam.

4. Before attempting any further value chain analysis, comprehensive market research should be conducted that examines (1) the retail segment in major demand centres, and (2) the demand, seasonality, supply (including fruit import from China) and price trends of major temperate fruit species.
5. Future value chain projects based in smallholder production systems should pay particular attention to the 'collectors' and 'aggregators' in the system; that is, those who gather the produce from the numerous small producers. These actors can play a major role in coordination of production by providing information about market demand and retailers' requirements to farmers. They have the capacity to gain access to retailers with high quality and food safety standards.

Relating to the planning and implementation of Research for Development:

6. Research for Development projects that attempt to address complex agricultural systems and livelihood issues require an approach to planning, implementation and evaluation that is transdisciplinary and participatory. As such, project design and funding should allow for adequate time and resources to (1) establish and facilitate a research team that is committed to and capable of conducting this type of research, and (2) incorporate proper diagnostic and PM&E phases that not only help direct the research agenda towards farmers' needs and conditions but also strengthen stakeholder capacity to collaborate effectively.
7. Effective outreach of research outcomes enabling community-based impacts requires adaptive research activity to design and pilot a suitable and scalable outreach strategy and develop outreach materials and mechanisms. This should be factored in project design and resourcing but operationalised flexibly, based on emerging needs and opportunities throughout the phases of diagnostic, applied and adaptive research.

10 References

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10.2 List of publications produced by project

See also Appendices, next section

Kirchhof, G., Nguyen, H.P., Trinh, D.N., Nicetic, O. (2012). Farmer-friendly erosion control measures in maize-based system of the northern mountainous region of Vietnam. Proceedings of the 3rd International Conference on Conservation Agriculture in Southeast Asia, Hanoi, 10-15 December 2012.

Nicetic, O., Le, H.H., Trinh, D.N., Nguyen, H.P., Kirchhof, G., Pham, T.S., van de Fliert, E., Le, Q.D. (2012). Impact of erosion prevention methods on yield and economic benefits of maize production in northwest Vietnam. In: Mulvaney, M.J., Reyes, M.R., Chan-Halbrendt, C., Boulakia, S., Jumpa, K., Sukvibool, C. and Sombatpanit, S. (eds). Conservation Agriculture in Southeast Asia and Beyond, Special Publication No.7, World Association of Soil and Water Conservation (WASWAC), Beijing, China. ISBN 978-0-615-73926-7, 124 pp.

Nguyen, H.N., Nicetic, O., Hinthorne, L., van de Fliert, E. (2012) Assessing the contribution of participatory approaches to sustainable impacts of agricultural research for development in the northwest highlands of Vietnam. Proceedings of the 3rd International Conference on Conservation Agriculture in Southeast Asia, Hanoi, 10-15 December 2012.

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Pham, T.S., Le, H.H., Do, S.A., Dang, V.C., Trinh, V.N., Nicetic, O., van de Fliert, E., Le, Q.D. (2012). Adaptive participatory research to develop innovations for sustainable intensification of maize-based farming systems in the northern uplands of Vietnam. Proceedings of the 3rd International Conference on Conservation agriculture in Southeast Asia, Hanoi, 10-15 December 2012.

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Van de Fliert, Elske, Pham Thi Vuong, Do Thi Minh Hien, Pradip Thomas (2010). *Narrowing gaps and building bridges: the role of participatory communication in transdisciplinary research for sustainable development*. Paper presented at the IAMCR 2010 Conference, 18-22 July 2010, Braga, Portugal.

11 Appendices

These are available at
https://drive.google.com/open?id=15A53haHg8-CJMi8gpZzMtjfvfaIKe5oC.

- App 1 - Value chain development paper
- App 2 - Overview R&D projects in NW VN
- App 3 - Diagnostic study report
- App 4 - Guidelines community based diagnostic studies
- App 5 - RVCA workbook
- App 6a - RVCA Son La 2009
- App 6b - RVCA Lai Chau 2010
- App 6c - Plum VCA Report 2010
- App 7a - Soil erosion lit review GK 091217
- App 7b - NRM in VN literature review - Ha Dinh Tuan_Final
- App 8 - IFSA WS1.3_van de Fliert et al paper subm
- App 9 - Guidelines for erosion measurement
- App 10 - Soil erosion benchmarking
- App 11 - Value Chain report
- App 12 - RUDEC Policy report 1309
- App 13a - Report maize production system trials 2010
- App 13b - ICM Experiments 2012-2013 1712
- App 14 - Soil erosion trials 2011-13 - final updated
- App 15 - Temperate fruit report 2012
- App 16 - Communication analysis report 1208
- App 17 - HUA Complementary crops 2012
- App 18 - PM&E Guidelines NW Vietnam 1307
- App 19 - Outreach strategy report 1309
- App 20 - Photo stories EN - final 1211
- App 21 - CANSEA2 - Paper Nicetic et al 2012
- App 22 - CANSEA 3 Proceedings 1212
- App 23 - Master thesis Nguyen Thi Thanh An
- App 24 - FFS manual-VN
- App 25 - CANSEA 4 presentation 1312
- App 26 - Promoting adoption SLM practices
- App 27 - Collaborator evaluation report-analysis 1405