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1 Acknowledgments

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2 Executive summary

The aim of this SRA bridging project was to develop background information and a proposal for a multi-program Agribusiness (AGB) and Soil Management Crop Nutrition (SMCN) project that will enhance the profitability and sustainability of vegetable-based farming systems in NW Vietnam.

2.1 Objectives

1. To undertake a preliminary market assessment of indigenous and conventional vegetables in Hanoi
2. To characterise the key geographic, agronomic, socio-economic and market situation, issues, constraints and opportunities for vegetable-based farming systems in NW Vietnam
3. To evaluate soil management and crop nutrition challenges and opportunities and develop a research strategy for increasing the productivity and sustainability of these farming systems
4. To develop a complementary research program that addresses key NSW research priorities for leafy vegetables and provides research expertise and support to the Vietnamese component
5. To develop a proposal aimed at enhancing the profitability and sustainability of vegetable-based farming systems in NW Vietnam

2.2 Activities undertaken

2.2.1 Consultation with Vietnamese project partners

- A concept note was prepared, translated and distributed
- Consultations were undertaken with each of the potential project partner institutes (new and existing) to discuss the project concept and the potential role of their institute. Following this Vietnamese partners were finalised.

2.2.2 Soil management and crop nutrition scoping study

- Scoping team: Dr Paul Milham (Soil Chemist, NSW DPI), Dr Sophie Parks (Plant Physiologist, NSW DPI), Oleg Nicetic (Farming Systems, UQ), Dr Tran Minh Tien (Soil Scientist, SFRI), Dr Nguyen Duy Phuong (Soil Scientist, SFRI), Dr Phan Thuy Hien (Plant pathologist and project coordinator, NIMM), Nguyen Thi Binh (Agronomist, NIMM), Cao Dang Kien (PPsD, Lao Cai), Hoang Quoc Thanh (PPsD Lao Cai), Dr Suzie Newman (Project leader, NSW DPI) and Dr Rodd Dyer (ACIAR)
- Field visit to Lao Cai (January 7-12, 2013) to examine soil and crop nutrition issues and constraints to the different farming systems under study (eg. rice-vegetables, temperate fruit-vegetables etc.). During the 4 day field visit the team visited 10 potential field sites and undertook a series of semi-structured interviews with farmers to determine current cropping practices and constraints to production. A series of soil samples was also taken.

Table 1. Farming system constraints

Farming System	Soil/water/nutrition	Production (incl. IPM)
Vegetable-only	• Nutrient inputs and management – both under and over fertilisation • Low soil organic matter • Low soil pH • Cultivation effects on soil structure • Management of soil borne diseases	• Seed quality and availability (trueness to type for IV) • High level of manual inputs eg. hand cultivation of soil • Effective crop rotations for management of soil borne diseases • Increased pest and disease pressure
Rice-Vegetable	• Low soil pH and organic matter • Compaction • Nutrient management – mining the soil with 3 crops • Availability and cost of organic inputs	• Seed/seedling quality and availability • Managing water availability • Lower crop management skills than vegetable-only system
Maize-Vegetable	• Low soil pH and organic matter • Sloping land • Erosion management • Soil conservation • Nutrient management • Competition for nutrients between maize and vegetables	• Seed/seedling quality and availability • Lower crop management skills than vegetable-only system
Temperate Fruit - Vegetable	• Low soil pH and organic matter • Nutrient management • Competition for nutrients between temperate fruit and vegetables	• Seed/seedling quality and availability • Competition for light and water between TF and vegetables • Optimising management of system • Pesticide drift from fruit to vegetable

2.2.3 Market Analysis Scoping Study

- The scoping team included: Assoc Prof. Wendy Umberger (Market and Consumer Research, UoA), Tiago Wandschneider (Value Chains Specialist), researchers from IPSARD, FAVRI, HUA and VWU, Dr Suzie Newman (Project Leader, AGB/2012/059) and Oleg Nicetic (Project Leader, AGB/2012/060).
- The objective of the scoping study was to undertake some preliminary market research that will then enable the consumer research component of the full proposal to be more effectively designed. The initial emphasis will be on understanding the size and value of local, regional and urban (Hanoi) market for both indigenous and conventional vegetables, gaining some insight into the different market segments, approaches to estimating future demand and the quality attributes that consumers look for.
- Activities included a review of the informational needs of supply and demand side data for conventional and indigenous vegetables, the design and pre-testing of a semi-structured questionnaire for wholesalers and retailers.
- This component draws together a multi-institutional, cross-project team (shared with AGB/2012/060) thereby not only providing the complex skill set that this component demands, but also facilitating the development of a strong marketing team that can tackle other Agribusiness projects.

3 Introduction

3.1 Background

The vegetable sector in north-western Vietnam faces a number of challenges – rapidly transforming markets, competiveness with peri-urban producers, poor infrastructure and logistics and environmental sustainability. This region encompasses some of the poorest provinces in Vietnam with Lao Cai having 40% of the population below the poverty line (GSO, 2010). Ethnic minorities particularly H'mong, Tay, Nung and Thai dominate the highlands region and engaging with these communities to improve their livelihoods is a key focus area of the Government and more particularly the Vietnam Women's Union (VWU Strategic Plan 2012)). These communities not only face poverty but also chronic malnutrition with 1 in 3 children under five suffering from stunting (NIN, 2009). Improving nutritional security through increased vegetable consumption is a vital aspect of improving the livelihoods of these NW farming families. Nationwide vegetable production is currently 8.3 million tonnes utilising 729,300 ha (FAO, 2010), whilst the NW of Vietnam produces 211,852 tonnes on 18,093 ha (GSO, 2010). Enhancing the role that vegetables play in these farming systems provides an opportunity for these smallholders to improve their profitability by engaging with high-value regional and urban markets.

This SRA was initiated following the recommendations of the final review of *AGB/2006/112 Increasing the safe production, promotion and utilisation of indigenous vegetables by women in Vietnam and Australia* which provided a strong case for a new phase of research. AGB/2006/112 looked to develop and test models that improved the profitability of women farmers supplying indigenous vegetables into transforming markets. Specifically the project has:

- Evaluated the market for indigenous vegetables
- Utilised a Collaborative Problem Solving Methodology (CPSM, Chambers and Spriggs, 2011) to identify and test appropriate marketing interventions
- Identified and tested on-farm 'best bet' management practices to produce high quality indigenous vegetables
- Developed and tested a Farmer Business School (FBS) for indigenous vegetable producers

Despite the success of AGB/2006/112 a number of research questions remain unanswered including:

- What are the key drivers for consumer demand for vegetables (both indigenous and conventional) both now and in the future? Do consumers perceive these vegetables as safe? What 'attributes' enhance consumers perception of food safety? Do NW vegetable producers have a regional comparative advantage?
- What marketing models will enable smallholders (including ethnic minorities) to successfully engage with local, regional and urban markets? Is cluster farming an effective model? Can alliances with speciality retail stores foster greater access to these markets? Likewise can linkages with regional wholesalers provide opportunities for reducing losses through improved postharvest management through the chain?
- What contribution to livelihoods do vegetables play in the different farming systems in the NW of Vietnam? What are the economic, social and environmental benefits of each of these systems?
- What are the opportunities for up-scaling the FBS? What is a sustainable model for its ongoing development?

This SRA was an opportunity to review ACIAR's current involvement in the NW highlands and to develop the next phase of vegetable work.

This SRA sought to design a project that built on ACIAR's current and past research initiatives in this area. Through consultation and pilot research activities the SRA developed important background information underpinning the design of four proposed project areas:

1. Market analysis

What is the size and value of the current domestic and Chinese vegetable market? What are the different market segments? What is the future demand for conventional, off-season and indigenous vegetables likely to be? What quality attributes do consumers look for when purchasing indigenous or conventional vegetables? Are these vegetables perceived as safe? What are they WTP for these attributes? How can smallholders capitalise on this knowledge?

2. Market development

This component will look to develop and test models that improve the profitability of farmers supplying into local, regional and urban markets. Potential models include: traditional, clusters/FMG, retailer-linked etc. Ongoing access to these markets will only be realised through the consistent delivery of a high quality safe product. Commercial alliances with regional wholesalers or urban retailers will be utilised to pilot improved postharvest management practices. The project will seek to engage the private sector in this component.

3. Vegetable-based farming systems

A number of farming systems exist in the NW highlands including: vegetable-rice, vegetable-temperate fruit, vegetable-maize and vegetable only based systems. This component will look to: 1) Analyse the economic performance of each of these farming systems. 2) Analyse the contribution that vegetables make to household nutrition particularly the health benefits increased consumption would bring to children in these communities 3) Identify and test 'best bet' management practices for key vegetable crops or systems and 4) Examine the environmental sustainability of these farming systems and provide recommendations on best practice soil, water and nutrient management for each of the systems.

4. Capacity building

This component will look at options for building on the FBS framework developed in AGB/2006/112. Particular consideration will be given to out-scaling. This component will also look to build the team's research capacity through targeted short term training initiatives, mentoring schemes, study tours and cross-linking with other project initiatives. The potential of a MALICA-ACIAR alliance in delivering this training will also be investigated.

3.2 Approach

The primary objective of this SRA was to develop the proposal for a new ACIAR project *AGB/2012/059 Towards more profitable and sustainable vegetable farming systems in north western Vietnam*. To that end a number of activities were undertaken in this SRA:

3.2.1 Development of a cross-project market research team and preliminary evaluation of Hanoi market

ACIAR projects in the Agribusiness program are tackling similar researchable issues and draw from the same pool of Vietnamese agribusiness research partners (IPSARD/CAP, VNUA, FAVRI and CASRAD). In 2014, two new agribusiness projects will commence – AGB/2012/059 *Towards more profitable and sustainable vegetable farming systems in* *north western Vietnam* and AGB/2012/060 *Increasing competitiveness and market access of smallholders in NW Vietnam to regional temperate fruit markets*. It is the intent of this SRA to look to build a cross-project market research team with AGB/2012/060 that draws researchers from CAP/IPSARD, VNUA, FAVRI and CASRAD to facilitate greater sharing of research approaches, stimulate new thinking and build a core base of agribusiness researchers who have the skills necessary to undertake a suite of Agribusiness projects. To begin this initiative a joint methodology workshop was held in Hanoi from the 14th -18th January 2013. Section 5 (Market Analysis) summarises this activity.

3.2.2 Farming systems scoping study

At present, most farmers grow vegetables in small gardens for household consumption (particularly in the case of ethnic minorities), however increasingly farmers are either integrating vegetables into rice, maize or temperate fruit crops, or replacing these crops altogether with specialised vegetable production for cash income. Enhancing the role that vegetables play in these farming systems provides an opportunity for smallholders to improve net household income by engaging with high-value local, regional, urban and export markets. This is particularly the case with indigenous vegetables where there are opportunities for remote communities to develop a marketing edge due to heightened consumer interest in indigenous or speciality products. Likewise for off-season production, where geographic advantage enables highland producers to capitalise on this market. Urban consumers perceive indigenous and highland vegetables as safe, nutritious and tasty and this enables producers to capitalise on this perceived market advantage. But with farming methods changing rapidly in these highland regions there is also the need to protect this reputation through the implementation of safe and sustainable farming practices (eg. appropriate pesticide use, implementation of IPM programs, safe management of organic nutrient inputs).

In January 2013, a project design team, comprising researchers from SFRI, NIMM, PPsD Lao Cai, NSW DPI and UQ undertook a scoping study to evaluate soil management and crop nutrition challenges and opportunities and develop a research strategy for increasing the productivity and sustainability of these farming systems. Section 6 (Farming Systems) summarises their findings.

3.2.3 Nutrition-sensitive agriculture – looking through the nutrition lens

Nutrition sensitive agriculture aims to maximise the impact of nutrition outcomes for the poor, while minimising the unintended negative nutritional consequences of agricultural interventions and policies on the poor, especially women and young children (World Bank, 2013). Within an ACIAR project context projects are increasingly looking to measure household consumption, nutritional and health impacts of agricultural value chain interventions. Additionally, there is strong evidence to suggest that empowering women through targeted agricultural interventions is one of the most effective pathways for impacting nutritional outcomes. Evaluating the impact of gender and ethnicity is also critical. In December 2014, a small discussion-centred workshop was held to bring together researchers and development specialists working in this space to share current research findings, methods (indicators) and approaches, and develop collaborative linkages. Section 7 (Nutrition-sensitive agriculture) reports on the outcomes of this workshop.

3.2.4 Consultation with Vietnamese project partners

The new project will build on the strong project partnerships (VWU, VAAS, FCRI, NIMM, CASRAD, PPsD (Phu Tho and Lao Cai)) established during AGB/2006/112. The Vietnam Women's Union will continue to lead the project. It is recognised that additional research skills in market analysis, economics, soils and postharvest research will need to be added to the Vietnamese team. The SRA will involve consultations with potential project partners, to enable identification and finalisation of suitable project partners. The results of these discussions are summarised in Section 8 (Project consultation).

3.2.5 Australian research program

A cross-project initiative designed to improve the food safety of leafy vegetables through the development of rapid low-cost field tests and improved management of on-farm microbiological risks. The development of this program is discussed in Section 9 (Australian research program).

4 Objectives

The aim of this SRA is as a bridging project for the development of a multi-program Agribusiness (AGB) and Soil Management Crop Nutrition (SMCN) project looking at enhancing the profitability and sustainability of vegetable-based farming systems in NW Vietnam. The specific objectives of the study were to:

- To undertake a preliminary market assessment of indigenous and conventional vegetables in Hanoi
- To characterise the key geographic, agronomic, socio-economic and market situation, issues, constraints and opportunities for vegetable-based farming systems in NW Vietnam
- To evaluate soil management and crop nutrition challenges and opportunities and develop a research strategy for increasing the productivity and sustainability of these farming systems
- To develop a complementary research program that addresses key NSW research priorities for leafy vegetables and provides research expertise and support to the Vietnamese component
- To develop a proposal aimed at enhancing the profitability and sustainability of vegetable-based farming systems in NW Vietnam

5 Lao Cai – ethnic diversity, poverty and nutrition

Prepared by Phan Thuy Hien (National Institute of Medicinal Materials)

5.1 Introduction

North Western of Vietnam is considered to be the poorest and most disadvantaged region in the country. This region has the highest household poverty rate with 19 districts listed as poorest districts out of total 62 poorest districts in Vietnam (Resolution 30a/2008/NQ-CP). There are more than 20 ethnic groups living in this region some of which still follow the shifting farming practice.

Insufficient household food security results in high malnutrition rate in this region, especially in children under 5 years of age (NIN and UNICEF, 2011). However, with a very cold winter, farmers in most of high mountainous areas can only produce one crop of rice per year and leave the paddy soil fallow for almost 6 months. The production of vegetables therefore would offer opportunities for creating other source of incomes for farmers.

Vegetables also contribute substantially to household food and livelihood security, especially for poor farmers. Many vegetables are rich in functional properties such as lycopene, beta-carotene and antioxidants and provide good sources of provitamin A (Weinberger and Lumpkin, 2007). The micronutrients and antioxidant compounds have important health impacts. Traditional vegetables contribute between 30 to 50% of iron and vitamin A consumed, respectively, in poor households (Weinberger and Lumpkin, 2007).

5.2 Household poverty distribution and level

Lao Cai has a population of 615,620 people (Vietnam Population Survey, 2009) with 64% of the population belonging to ethnic minority groups including Mong (22%), Tay (16%), Dao (14%), Giay (4.7%) and Nung (4.4%).

Located in the North West region, Lao Cai is one of the poorest provinces in Vietnam having 43.9% of the household population below the poverty line, ie. having each household member earning an income of less than 400,000 VND/month or 4.8 mil VND/year (Decision 09/2011/QĐ-TTg dated 30/01/2011, Vietnam Access to Resources Household Survey, 2012). The poorest groups are Mong, Nung and Dao with 83%, 75% and 72% of the population below poverty line, respectively (Lao Cai Department of Labour, War Invalids and Social Affairs, 2012).

Sa Pa is the high mountainous district of Lao Cai with the population of 53,580 people. There are 6 ethnic groups including Mong (53%), Dao (25%), Kinh (15%), Tay, Giay and Xa Pho (Lao Cai Statistic Office, 2009). Kinh group distribute mainly in Sa Pa town whereas other groups live in 17 other rural communes (Figure 1)

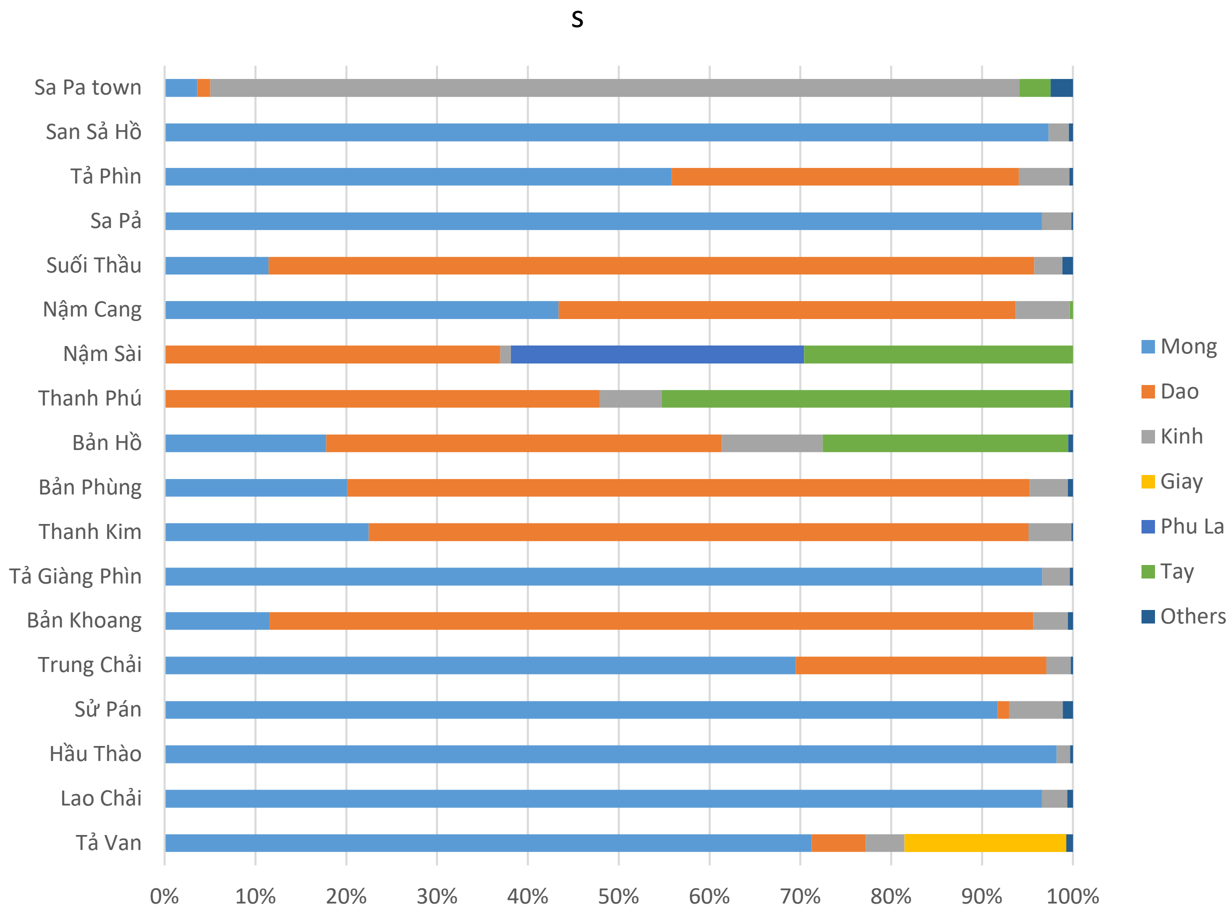

Figure 1. Ethnic composition in Sa Pa (by commune)

(Source: Lao Cai Statistic Office, 2009)

Together with Sa Pa, Bac Ha is one of a few high mountainous districts of Lao Cai with 53,676 people belonging to 14 ethnic groups and living in 1 town and 20 communes. The ethnic minority groups account for 82% of the total Bac Ha population with 47% being Mong group (Lao Cai Statistic Office, 2009). At the national level, Bac Ha is one of the 62 poorest district in Vietnam (Resolution 30a/2008/NQ-CP) having the poverty rate of over 50%.

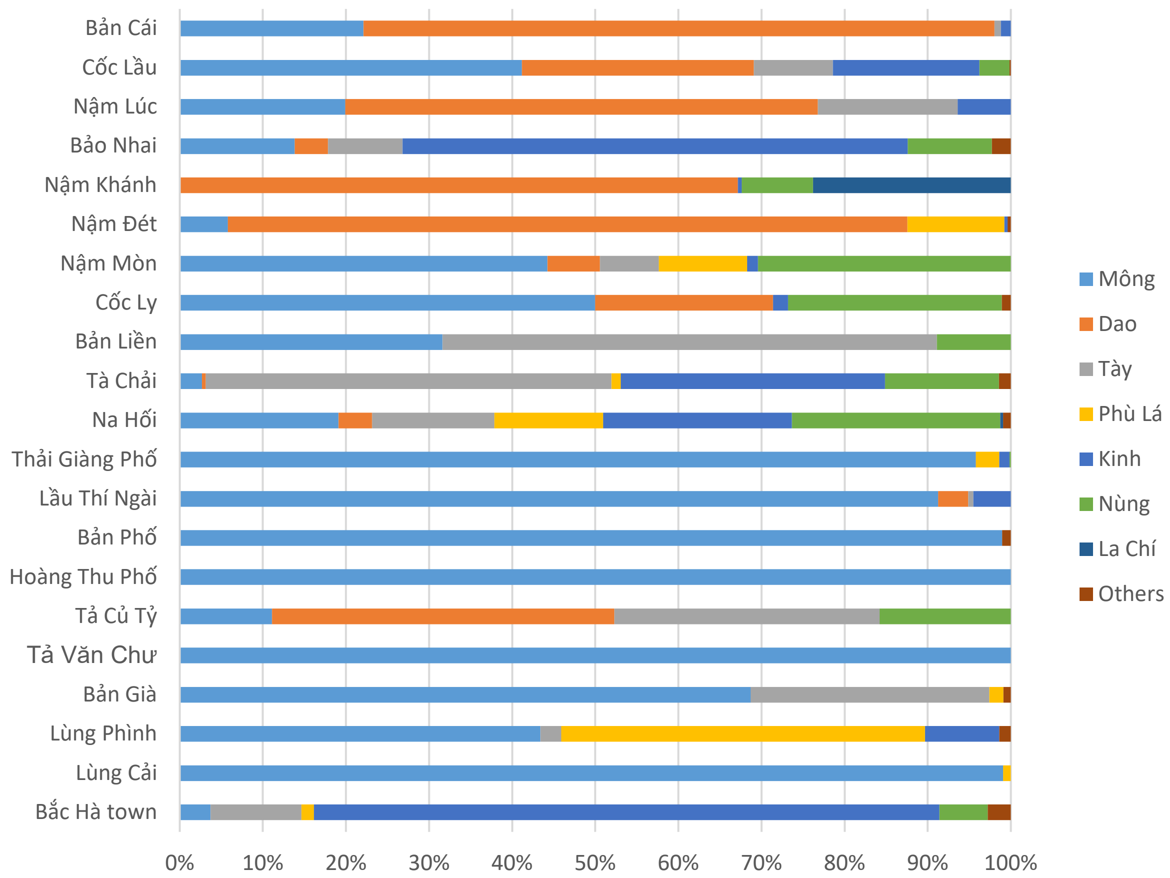

Figure 2. Ethnic composition in Bac Ha district

(Source: Lao Cai Statistic Office, 2009)

There are 16 communes in Sa Pa and 18 communes in Bac Ha listed as especially disadvantaged communes in Vietnam (Table 2). These communes are supported by Vietnamese Government Program 135 - Program on Socio-economic Development in Especially Disadvantaged Communes in Mountainous, Isolated and Remote Areas.

The overall objective of Program 135 is to accelerate radically the production and promote the agro-economic structural shift in the direction of market-driven production; to sustain the improvement of spiritual and material living conditions of the ethnic minority people in extremely disadvantaged communes and narrow the development gap between ethnic groups and other regions.

The main focus of Program 135 is on providing essential basic infrastructure to poor communes in mountainous and isolated areas. The program provides funding for roads, small-scale irrigation works for paddy fields, schools, electric power in residential areas, health clinics and clean water. Other aspects of the program include improving skills and training people of ethnic minorities on new production practice, training the leadership at the commune and village levels on professional and administrative management to manage better the economic and social development of their localities

Table 2. List of especially disadvantaged communes supported by Program 135 in Sa Pa and Bac Ha

Sa Pa district	Bac Ha district
Bản Hồ	Bản Cái
Bản Khoang	Bản Già
Bản Phùng	Bản Liền
Hầu Thào	Bản Phố
Lao Chải	Cốc Lầu
Nậm Sài	Cốc Ly
Sa Pả	Hoàng Thu Phố
San Xả Hồ	Lầu Thí Ngài
Sử Pán	Lùng Cải
Suối Thầu	Lùng Phình
Tả Giàng Phìn	Na Hối
Tả Phìn	Nậm Đét
Tả Van	Nậm Khánh
Thanh Kim	Nậm Lúc
Thanh Phú	Nậm Mòn
Trung Chải	Tả Củ Tỷ
	Thải Giàng Phố
	Tả Van Chư

(Source: Decision No. 2405/QĐ-TTg dated 10 December 2013)

5.3 Nutrition and child health

Lao Cai is one of the provinces with the highest rate of under 5 children suffered from under-nutrition issue in Vietnam. The average rate of underweight children is 26%, compared to that of 22.1% in northern mountainous regions and 17.5% nationwide. The stunting rate is especially high, 40.7%, which is the second highest stunting-rate-of-children province, just after Kon Tum. This rate is much higher than the average rate of the Northern mountainous, 33.7%, and the nationwide 29.3% (NIN and UNICEF, 2011) (Figure 3)

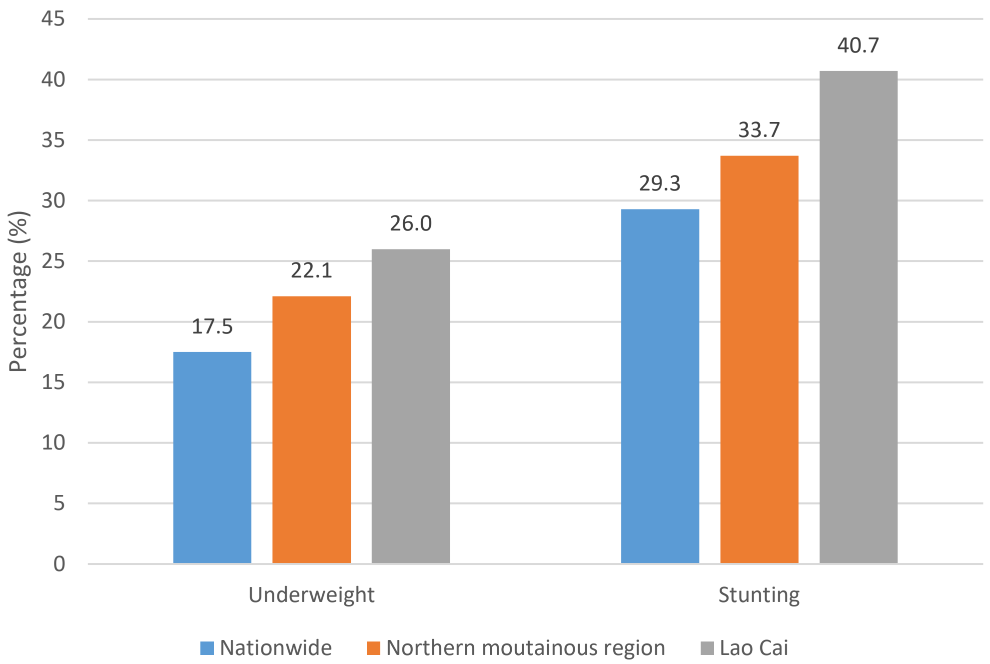

Figure 3. Prevalence of undernutrition among children under 5 years of age (Source: NIN and UNICEF Review of the nutrition situation in Vietnam, 2011)

Communities in Bac Ha and Sa Pa not only face poverty but also chronic malnutrition. The rate of underweight children is 32% in Bac Ha (Bac Ha Department of Health annual report, 2011) and 27.1% Sa Pa (Sa Pa Department of Health annual report, 2011). Important causes of the malnutrition among children under 5 are insufficient household food security and inadequate maternal and child care (NIN and UNICEF, 2011).

Government programs have been implemented in Lao Cai with efforts to overcome nutrition issues, which mainly aim at iron, vitamin A and Iodine deficiency.

National Program on children malnutrition control:

The program is managed by the district Department of Health and has been implemented at all the communes in Sa Pa and Bac Ha. The focus of the program is promoting the importance of appropriate or balanced nutrition depending on the living standard of each household, promoting breast feeding and training mothers in taking care babies and young children, especially when they are ill. The program also supports training of collaborating nutrition workers so they can promote the program to all people at commune level. However, the effect of the program is still limited. Most of households, especially those with children under 5, are not aware about the importance of having suitable nutrition following development stages. Many mothers still ignore examining their child weight monthly to follow their development progress.

National program on goiter control

This program is to examine and supervise the quality of salts used in local communities and to promote the importance of iodine uses. All households in Bac Ha and Sa Pa are using iodized salts.

Ministerial program on eye-disease control

The vitamin A supplements have been supplied to mothers after their babies are 1 month and to children from 6 – 36 months.

5.3.1 Benefits of vegetables in farming system

At a local level, increasing household vegetable production, incomes and consumption may also address the nutritional food security issues that many of these local communities face. In Bac Ha, Lao Cai - vegetable consumption is 80g/capita/day (Bac Ha District Annual Report, 2011) compared with the recommended intake of 200 g/capita/day (WHO). Indigenous vegetables typically produced in these regions tend to have high nutritional value. Khoi tu (*Lycium chinense*) has extremely high level of iron (≈ 25 mg/100g edible portion) and high level of calcium (>100mg/100g) while cai bap xoe (*Brassica oleracea*) and cai meo (*Brassica juncea*) have levels of vitamin C (> 25 and > 37 mg/100g) (NIMM AGB/2006/112 analyses, 2011).

5.3.2 Opportunities

With the advantages of high mountainous climate and high diversity of indigenous vegetables, many vegetables produced in this region are potentially in high demand in high-value regional and urban markets. Therefore, enhancing the role that vegetables play in these farming systems provides an opportunity for these smallholders to improve net household income by engaging with those markets.

Increasing household vegetable production and consumption may also address the nutritional food security issues that many of these local communities face.

At the farm level, identification of integrated soil, water and nutrient management practices best suited to local conditions is fundamental to productive and sustainable integrated vegetable farming systems.

6 Market Analysis

6.1 Methodology workshop

A methodology workshop was held 14th -18th January 2013 at the Vietnam Women's Union (VWU) to facilitate the design of the market analysis components of two new ACIAR Agribusiness projects: *AGB/2012/059 Towards more profitable and sustainable vegetable farming systems in north-western Vietnam* and *AGB/2012/060 Increasing competitiveness and market access of smallholders in NW Vietnam to regional temperate fruit markets*. These projects were designed in tandem – with the goal to build a cross-project marketing team.

6.1.1 Participants

The workshop drew together participants from 3 Hanoi based agribusiness research institutions:

- The Institute of Policy and Strategy for Agricultural Rural Development (IPSARD) – Centre for Agricultural Policy (CAP) - including Nguyen Trung Hieu, Nguyen The Long, Nguyen My Y, Bui Thi Viet An, Pham Thi Thuy;
- The Vietnam National University of Agriculture (VNUA) – including Nguyen Thi Thu Huyen, Nguyen Anh Duc;
- The Fruit and Vegetable Research and Development Institute (FAVRI) – including Nguyen Thi Tan Loc, Le Nhu Thinh.

together with the two project coordinators for *AGB/2012/059* Phan Thuy Hien (NIMM) and Nguyen Thi Thu Hien (VWU).

The workshop was facilitated by Wendy Umberger (University of Adelaide) and Tiago Wandschneider the international team leaders for the market analysis components of *AGB/2012/059* and *AGB/2012/060* respectively. The two project leaders – Suzie Newman (*AGB/2012/059*) and Oleg Nicetic (*AGB/2012/060*) also participated.

6.1.2 Data requirements to undertake a market analysis for vegetables in north-western Vietnam

Tables 3 and 4 detail the data required on both the supply and demand side to undertake a market analysis for conventional vegetables in north-western Vietnam and our knowledge of the availability of that data (as at January 2013). A similar activity was also undertaken for indigenous vegetables but given the limited data availability for these crops it is not presented. These tables are by no means exhaustive but are intended as a guide for the Market Analysis team as they collect secondary data to undertake the project proper. It also provides a framework for the data to be either found or collected to undertake such an analysis.

Table 3. Market Analysis for NW Vietnam (Son La, Lao Cai, Lai Chau, Dien Bien, Hoa Binh and Yen Bai) for Vegetables – Supply Side

Supply Side: Information needed for all vegetables produced in NW Vietnam	**Does Information Exist? Is it available?** *Yes / No / Do Not Know*	**What is the source and what vegetables?** *Government statistics or agency, previous research reports…*
What is produced (both conventional and indigenous and unique varieties or unique characteristics) **FAVRI**	Yes	GSO – till 2009 – tomato, kohlrabi, cucumber, beans, su su (Son La) (FAVRI) Northern Mountains– all vegetables 2007-2010 (GSO) (FAVRI) Annual reports from DARD – province and district (HUA) Tay Bach University – students graduate thesis (HUA) Household Living Standards Survey and agricultural census (5 years – 2008 latest, will be done in 2013) IPSARD
Where vegetables are produced (key production regions for each vegetable) **FAVRI**	Yes	As above
Current volumes of production **FAVRI**	Yes	As above
When they are produced (seasonality) – where they are produced (province) **FAVRI**	?	MALICA – old information – eg. sourcing of tomatoes (2003) Counter-seasonal project – tomato, cabbage, lettuce and sweet pepper
Changes in production over time (time series data) **FAVRI**	Yes	Annual reports
Who is producing them (e.g. farm size, diversification- crop rotations)	?	Agricultural census – provincial? (IPSARD) – website information not so detailed – need to contact
Cost of production information **HUA**	?	su su (Moc Chau – FAVRI – World Bank), pumpkin (Moc Chau – NW project), student thesis (HUA) NOMASFI
Spatial product flows both imports and exports (including cross border / international border trade to China and Taiwan)	?	Value chain (CASRAD)
International Trade- Official imports and exports data **IPSARD**	Yes	Vegetables in total (per border post (customs))
Trade policies **IPSARD**	?	Policies and enforcement – cross border Law document library – tariffs, non-tariff barriers, allow or ban imports General plan for agriculture Ministry of Trade Need to understand Chinese side as well 2012 Malica – trading with Chinese Need to identify ASEAN, WTO Changes in Food Safety Law
Other (Describe): **HUA**		Vegetable distribution chain (value chains)

Table 4. Market Analysis for NW Vietnam (Son La, Lao Cai, Lai Chau, Dien Bien, Hoa Binh and Yen Bai) for Vegetables – Demand Side

Demand Side: Information needed for all vegetables produced in NW Vietnam	**Does Information Exist? Is it available?** *Yes / No / Do Not Know*	**What is the source and what vegetables?** *Government statistics or agency, previous research reports…*
What are *current* key consumption markets for vegetables from NW Vietnam	No	GSO (2 years) – National level – depends on vegetable Value chain research (CASRAD - 2012 – Son La vegetables) Malica research (2005) ADB/Reta (2006) - reports
What are current key wholesale markets for vegetables from NW Vietnam	No	As above
What are key retail segments in the markets	?	Vietnam Agricultural Market Information Project (VAMIP) – 2009 Supermarkets - 2006 Malica - 2009 Planet Retail
Current annual quantity (volume) demanded in key markets	No	Follow up with health department VHLS survey
Annual seasonal variations in demand and drivers of those seasonal variations (supply side driven or consumer)	No	
Changes in quantity demanded over time (time series data)	?	VHLS survey - National
What consumer segments exist in the market? (*Note, this is complex information allowing us to characterize consumer market segments, including consumer socio-demographics purchasing behavior, preferences, willingness-to-pay and attitudinal information.)*	No	Japanese nutrition funded study related to health FAO Consumer preferences – tomato - FAVRI
Intrinsic quality attributes demanded at retail and wholesale level (e.g. firmness, variety, color, blemishes)	?	Superchain Malica FAO Moc Chau Consumer Report (2012) – counter-seasonal report
Extrinsic quality attributes demanded at retail and wholesale level (e.g. grading, safety certification, quality certification, packaging)	?	As above
Who demands these quality attributes (e.g. consumer, retailer)	?	
What are potential future key consumption markets for Vegetables from NW Vietnam? E.g. off season demand; specific varieties; markets with growing demand)	No	Consumer studies in China
Annual price ranges for vegetables from NW Vietnam		Value chain analysis MARD – 20 provinces – price data (IPSARD)
Annual price seasonality		
Trends in prices over time (time series data)		
Determinants of price at the farm level (econometric analysis)		
Determinants of price at the retail level (econometric analysis)		
Price premium for quality or product attributes		

6.1.3 Survey design and pretesting

A short questionnaire was developed for pre-testing at wet markets (both wholesale and retail), specialist fruit and vegetable stores and supermarkets (Appendix 1). Four teams undertook pre-testing across these selling points with a total of 23 interviews being undertaken. Each group then presented their main findings and suggested revisions to the questionnaire. This led into an overarching discussion of the proposed approach to be taken for both studies (Copies of the power-points and interview transcripts are available upon request).

Key findings – seasonality, priority crops, issues and opportunities.

Table 5 describes seasonality of different vegetables in the Hanoi wholesale markets. For temperate vegetables the main period of undersupply is the summer months, where these vegetables can only be produced in the highlands. For the north-west the following vegetables were identified as being priority crops - cải mèo (H'mong mustard), su hào (kohlrabi), dậu côve (French beans), ca chua (tomato), măng tây (asparagus), ngồng cải, khoai môn (taro), khoai tây (potato), xa lach (lettuce), sup lo (broccoli), sweet pepper and zucchini.

Wholesalers and retailers were asked about the main issues/problems that they faced with particular vegetables. One of the main issues raised was the availability of high quality, off-season product. For produce that was available during that period – often there were specific quality issues including texture, appearance and freshness. It seemed that a lot of product did not meet wholesaler or retailer specification – despite the lower quality standard for product at this time. Vegetable origin was also a concern – with retailers particularly concerned about Chinese product being sold as local product. Other concerns related to price instability, high product losses, quality deterioration and high transport costs.

When asked to consider opportunities for NW vegetables – retailers particularly speciality stores believed there were excellent opportunities for vegetables sourced from the north-west. They believed that consumers were more trusting of produce sourced from these provinces, particularly organic or indigenous vegetables.

6.1.4 Implications for design of the market analysis component of the project

The workshop provided a good forum to identify data requirements, to undertake some preliminary pretesting and to start to build and develop the market analysis teams. In terms of survey design key points to be considered:

- The analysis needs to cover both conventional and indigenous vegetable, but it is highly likely that different approaches need to be utilized to successfully do this. Whilst identifying a potential list of indigenous vegetables to include can be achieved readily – narrowing down the list of conventional vegetables to include is likely to be more challenging.
- Considerable time needs to be invested not only in the design of check-lists for the semi-structured interviews but also for reconnaissance trips to be able to estimate the population of actors in each catergory to enable an effective sampling strategy to be devised.
- Care needs be given to the timing to undertake the study/survey – should it be repeated in summer and winter to capture the different availability of vegetables at this time.

Table 5. Vegetable seasonality in Hanoi wholesale markets

Vegetable	1	2	3	4	5	6	7	8	9	10	11	12
Cải Bắp (cabbage)	X	x	x					x	x	x	x	x
Cải chip												
Cải xanh (mustard leaves)					x	x						
Rau muống (morning glory)					x	x		x	x	x	x	x
Rau cần (water dropwort)											x	x
Cà chua (tomato)	X	x								x	x	x
Dưa chuột (cucumber)											x	x
Su su (chayote)							x	x	x	x	x	x
Cà rốt (carrot)	X	x	x							x	x	x
Bí xanh (green melon)							x	x				
Mồng tơi				x	x	x	x	x	x			
Súp lơ (broccoli)												
Cải mèo (H'mong mustard)	X										x	x
Su hào (kohlrabi)	X									x	x	x
Cải cúc	X							x	x	x	x	x
Đậu côve french bean)											x	x
rau ngót				x	x	x	x	x	x			
Rau bí (pumpkin buds)										x	x	x
Măng tây (asparagus)												
Ngồng cải	X	x								x	x	x
Khoai môn (taro)												
Cải ngọt (sweet mustard)	X	x	x	x				x	x			
Cà pháo (eggplant)												
Hành tây (onion)	X	x	x									
Khoai tây (potato)	X	x	x								x	x

- How will the price and quality data be collected? Daily data is needed from the main wholesale markets in Hanoi – who will collect this, how often and when?
- What opportunities are there for collaboration between the market analysis teams for AGB/2012/059 and AGB/2012/060 to enable more efficient and effective data analysis?

6.1.5 Market analysis component – proposal design

Objectives and activities

To identify market opportunities and consumer preferences for indigenous and conventional vegetables in local, provincial, urban and export markets

1.1 Undertake a comprehensive market analysis (in local, provincial, urban and export markets) for 5 conventional and 10 indigenous vegetables.

- Focus: 5 local and provincial markets in NW highlands; 1 urban market (Hanoi) and 1 export market (in bordering Chinese provinces).
- The analysis will include: current and future potential market size and value; current production volumes; seasonality (supply and demand); spatial product flows and market channels; current and potential market segments; intrinsic and extrinsic quality attributes demanded and the value of these attributes and time series data (where available) on volume, price, quality and origin.

1.2 Conduct a consumer survey with a representative sample of households in key markets (e.g. Hanoi, NW Vietnam and China) to understand vegetable consumption patterns, purchase locations, preferences for vegetable attributes (e.g. varieties, origin, quality attributes) and perceptions.

1.3 Identify competitive pro-poor market opportunities, identifying likely sources of comparative advantage, competition and substitution and develop a market strategy.

Methodology

Geographical focus: north western Vietnam – Lao Cai, Lai Chau, Yen Bai, Dien Bien, Son La, Hanoi and neighbouring Chinese cities

This component will look to understand the market dynamics and identify opportunities for north-western vegetable producers in local, provincial, urban and export markets. It will include an analysis of key retail, wholesale, collector (intermediate) markets, in and around Hanoi and in north western Vietnam and neighbouring Chinese cities.

For the market research phase, research methods include literature reviews, analysis of secondary data (including VHLS and VAMIP[1]), focus groups, semi-structured interviews, structured surveys, spatial market analysis and modelling. It is recognised that the approaches needed to evaluate the indigenous vegetables market may be quite different from the conventional vegetable market. At selected wholesale and retail market outlets, information on varieties, prices, quality and origin (including production location if possible) of selected vegetables will be collected over time. This will provide an analysis of price trends over time and provide real time data to smallholders and farmer marketing groups. This will require the utilization/development of an iPad application to enable market agents to readily supply this data. Opportunities to collaborate and coordinate collection of market data with Fresh Studio will be explored and if appropriate implemented.

Following the market research phase, a consumer survey will be undertaken in key markets to understand: 1) the composition of food demand including consumption of specific vegetables, quantity, variety, and prices paid for each product, location typically purchased, and changes in consumption over a 3 and 5 year time period; 2) respondents' knowledge, attitudes, and practices regarding food quality and nutrition attributes in vegetable purchases, and 3) respondents' preferences regarding different types of retail food outlets for purchasing vegetables and other food products.

The survey instrument will be based on the instrument used for a similar consumer survey conducted in ADP/2005/006 *Markets for high-value commodities in Indonesia*. Obviously that instrument will be adapted for Vietnam and designed after conducting focus groups in each survey location. Enumerator training will then be conducted and the enumerators will pre-test the instrument to address any concerns/issues. The team of trained enumerators, which will be from partner institutions, will collect the data. This will be followed by data cleaning and data analysis. The results will be used to project changes in preferences and purchasing patterns with changes in income and urbanization that are expected over the next 10-20 years. We will also be able to conduct market segment analyses and understand drivers of demand for different vegetables, vegetable varieties and quality attributes by market segment.

Where appropriate, vegetable market and consumer data collection and research will be integrated with, or undertaken jointly with data collection for temperate fruits being undertaken by AGB-2012-060, the NW Vietnam temperate fruit project.

[1]VHLS – Vietnam Household Living Standards Survey, VAMIP – Vietnam Agricultural Market Information Project

7 Farming Systems

Prepared by Paul Milham (Consultant to UA), Tran Minh Tien; Bui Tan Yen; Nguyen Duy Phuong; Le My Hao, Bui Hai An and Tran Minh Thu (Soil and Fertilizer Research Institute)

7.1 Background

Vietnam has a land area of ~31 million ha, in which acid upland soils constitute 21-25 million ha (Phien et al.,1994, Nahn et al.,1994). These soils are widely distributed over the country. Their characteristics and fertility are well documented. For example, such soils are inherently low in fertility, and their fertility declines under cropping due to the loss of the shallow topsoil, decreasing organic matter, and the leaching of nutrients (Pushparajah and Batchik,1987; von Uexküll and Bosshart,1989; Moody,1994). The loss of soil organic matter degrades soil physical properties and decreases microbial diversity (Kennedy and Smith,1995). The subsoils may be deep but tend to be acidic and low in nutrient content.

Problems accompanying greater cultivation of acidic soils in the humid tropics of Asia have been well recognised (Craswell and Pushparajah,1989). In the central highlands of Vietnam, slash and burn practices and poor knowledge of techniques in soil conservation have led to nutrient deficiencies and toxicities in crops. However, the use of soil amendments to correct excessive acidity, increase nutrient value, water holding capacity and cation exchange capacity have improved yields (Moody, 2007). An FAO report states that most Vietnamese soils have low contents of C, N, P, K, Ca and Mg (Ha et al.,2006).

Sa Pa and Bac Ha districts lie in the highlands of Lao Cai Province (Fig. 1) and may consequently experience production and sustainability constraints which include: soil erosion, and loss of organic matter and structure; acidity related toxicities of aluminium (Al) or manganese (Mn); and deficiencies of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), molybdenum (Mo) or boron (B). This review attempts to identify the likely constraints and opportunities to mitigate them.

7.2 Topography

7.2.1 Sa Pa district

Sa Pa is a mountainous district of Lao Cai province located on the east side of the Hoang Lien Son range, an extremity of the Himalayas. This range includes the highest mountain in Vietnam, Fan Si Pan (3,143 m), which is administratively part of Sa Pa district. The topography is lowered from the West – Southwest to the Northeast. The lowest site in the district is Bo spring (400 m). The average height of the district is 1,200–1,800 m. The geographic boundaries of Sa Pa district are 22^{O}07’04” North to 22^{O}28’46” North and 103^{O}43’28” E to 104^{O}04’15” E, with a total area of 68,329 ha. The neighbouring districts are Bat Xat in the North, Van Ban in the South, Bao Thang in the East and Than Uyen (Lai Chau province) in the West.

Sa Pa topography is divided into 3 parts (sub-areas):

- Top high mountainous sub-area: includes the communes of Ta Giang Phin, Ban Khoang, Ta Phin, San Sa Ho with total area of 16,574 ha, i.e. 24.4% of the district area. This region has average height of 1,400–1,700 m and the topography is strongly fractured with steep slopes and narrow valleys.
- Sa Pa – Sa Pa sub-area: includes the communes of Sa Pa, Trung Chai, Lao Chai, Hau Thao, Ta Van, Su Pan and town of Sa Pa with total area of 20,170 ha, occupy 29.7% of the district area. The average height of this region is about 1,500 m. The topography is dominated by bowl shaped hills.

- Strongly fractured mountain sub-area: includes the 7 southern communes of Ban Phung, Nam Sai, Thanh Kim, Suoi Thau, Thanh Phu, Nam Cang and Ban Ho with total area of 31,120 ha, occupy 45.9% of the district area. The typical characteristics of this region is high and pointed mountain top, dipping slopes and deep and narrow valleys.

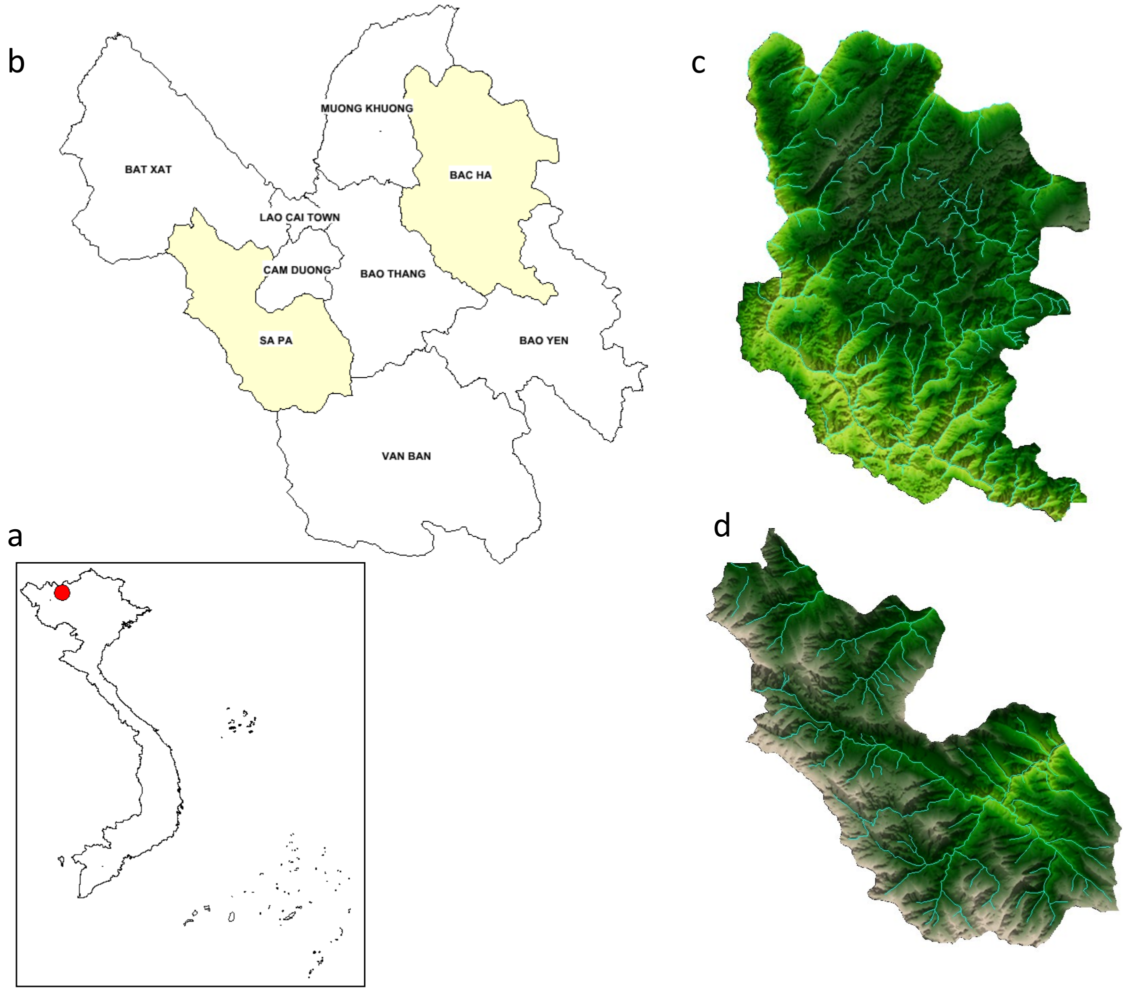

Figure 4. Location of Lao Cai province (b) on map of Vietnam (a) and topographic map of Bac Ha (c) and Sa Pa (d) districts.

7.2.2 Bac Ha district

Bac Ha district is located in North Western Lao Cai province, 66 km from Lao Cai city and 560 km from Kunming city (Yunnan province, PR of China). The district lies from 22^{O}19’ to 22^{O}24’ N and 104^{O}09’ to 104^{O}28’E. It is close to the districts of Sim Ma Cai and Muong Khuong in the North, Sin Man (Ha Giang province) in the East, Bao Thang in the West and Bao Yen in the South.

Bac Ha has 20 communes and 1 town with total area of 680 km^2. The district topography is divided into 3 parts (sub-areas).

- The upper sub-area: includes the communes of Ta Cu Ty, Ban Gia, Lung Phinh, Lung Cai, Ta Van Chu, and Lau Thi Ngai. The average elevation is over 1,500 m.
- The middle sub-area: includes the communes of Ban Pho, Ta Chai, Na Hoi, Nam Khanh, Ban Lien, Hoang Thu Pho, Thai Giang Pho and Bac Ha town with average height of 900–1,200 m.

- The lower sub-area: includes communes of Ban Cai, Coc Lau, Nam Luc, Bao Nhai, Nam Mon, Nam Det and Coc Ly, andh the height is lower than 600 m.

7.3 Climate

In Sa Pa, and the upper sub-area of Bac Ha, the weather is cold and dry in winter (November to April) and cool in summer (May to October). The annual average temperature here is around 18–20^{O}C. For the rest of Bac Ha, the average temperature is around 25–28^{O}C.

The annual average cloud cover is ~60% in the Bac Ha district and >70% in Sa Pa district (observation of the Plant Protection Stations). Consequently, because of the implications for growth and nitrate metabolism it would be useful to measure the intensity of photosynthetically active radiation.

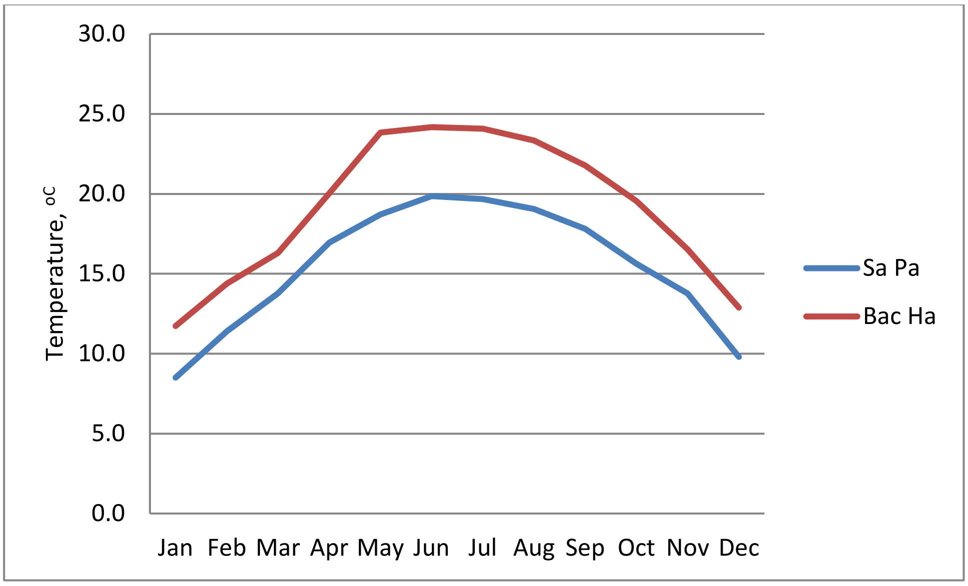

Figure 5. Mean air temperature (from 2001–2009) of Sa Pa (blue line) and Bac Ha (red line) districts. Source: IMH (2010)

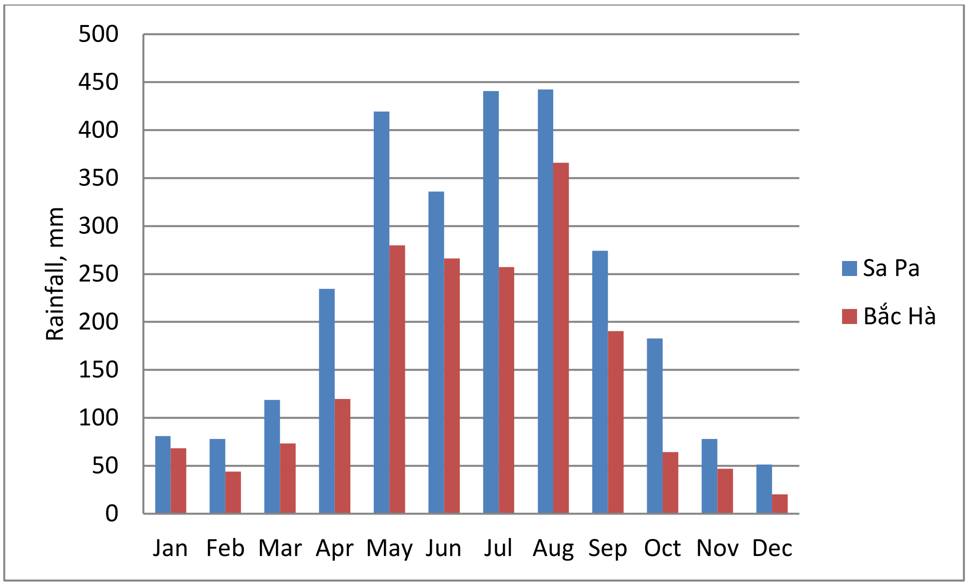

Figure 6. Average monthly rainfall (2001 to 2009) of Sa Pa (blue) and Bac Ha (red) districts. Source: IMH (2010)

7.4 Soils

The Sa Pa and Bac Ha districts have a wide range of soil types; although Acrisols predominate, occupying ~96% of the area of Sa Pa district and ~75% of Bac Ha district, respectively (Tables 6 and 7). Acrisols are, by definition, acidic to strongly acidic and poor in nutrient content (Ho et al., 2006).

Table 6. Soil classification of agricultural land in Sa Pa district for soil map at scale 1/25,000. Source: Ho et al., (2006)

Symbol	Soil names *FAO - UNESCO - WRB*	Area	
		(ha)	(%)
FR	**1. Ferralsols**	**50.46**	**1.05**
FRha	1.1. Haplic Ferralsols	50.46	1.05
FRha.vt	*1. Veti- Haplic Ferralsols*	*50.46*	*1.05*
FRha.vtdyh	1. Hyperdystri- Veti- Haplic Ferralsol	50.46	1.05
AC	**2. Acrisols**	**4,622.19**	**95.73**
ACst	**2.2. Stagnic Acrisols**	***1,525.94***	***31.60***
ACst.ar	*2. Areni- Stagnic Acrisols*	*181.16*	*3.75*
ACst.arha	2. Hapli- Areni- Stagnic Acrisol	181.16	3.75
ACst.vt	***3. Veti- Stagnic Acrisols***	***1,344.78***	***27.85***
ACst.vtha	3. Hapli- Veti- Stagnic Acrisol	1,344.78	27.85
ACha	2.3. Haplic Acrisols	3,096.25	64.12
ACha.um	***4. Umbri- Haplic Acrisols***	***505.12***	***10.46***
ACha.umvt	4. Veti- Umbri- Haplic Acrisol	505.12	10.46
ACha.ar	*5. Areni- Haplic Acrisols*	*90.70*	*1.88*
ACha.arvt	5. Veti- Areni- Haplic Acrisol	90.70	1.88
ACha.vt	***6. Veti- Haplic Acrisols***	***1,409.58***	***29.19***
ACha.vtlen	6. Endolepti- Veti- Haplic Acrisol	450.94	9.34
ACha.vtdyh	7. Hyperdystri- Veti- Haplic Acrisol	958.64	19.85
ACha.flh	***7. Hyperferrali- Haplic Acrisols***	***398.60***	***8.26***
ACha.flhvt	8. Veti- Hyperferrali- Haplic Acrisol	284.96	5.90
ACha.flhro	9. Rhodi- Hyperferrali- Haplic Acrisol	113.64	2.36
ACha.cr	***8. Chromi- Haplic Acrisols***	***692.25***	***14.34***
ACha.crvt	10. Veti- Chromi- Haplic Acrisol	692.25	14.34
RG	**3. Regosols**	**155.64**	**3.22**
RGdy	3.4. Dystric Regosols	155.64	3.22
RGdy.st	*9. Stagni- Dystric Regosols*	*155.64*	*3.22*
RGdy.stum	11. Umbri- Stagni- Dystric Regosol	104.80	2.17
RGdy.stha	12. Hapli- Stagni- Dystric Regosol	50.85	1.05
Total surveyed area		**4,828.29**	**100.00**

Table 7. Soil classification of agricultural land in Bac Ha district for soil map at scale 1/25,000. Source: Ho et al., (2006)

Symbol	**Soil names** *FAO - UNESCO - WRB*	**Area** (ha)	(%)
FL	**1. Fluvisols**	**287.36**	**1.95**
FLgl	*1.1. Gleyic Fluvisols*	18.18	0.12
FLgl.dy	*1. Dystri- Gleyic Fluvisols*	*18.18*	*0.12*
FLgl.dyha	1. Hapli- Dystri- Gleyic Fluvisol	18.18	0.12
FLdy	1.2. Dystric Fluvisols	269.18	1.83
FLdy.ar	*2. Areni- Dystric Fluvisols*	*172.81*	*1.17*
FLdy.arha	2. Hapli- Areni- Dystric Fluvisol	172.81	1.17
FLdy.sl	*3. Silti- Dystric Fluvisols*	*62.66*	*0.43*
FLdy.slst	3. Stagni- Silti- Dystric Fluvisol	40.81	0.28
FLdy.slha	4. Hapli- Silti- Dystric Fluvisol	21.85	0.15
FLdy.st	*4. Stagni- Dystric Fluvisols*	*33.71*	*0.23*
FLdy.stap	5. Abrupti- Stagni- Dystric Fluvisol	33.71	0.23
FR	**2. Ferralsols**	**171.83**	**1.16**
FRro	*2.3. Rhodic Ferralsols*	60.55	0.41
FRro.vt	*5. Veti- Rhodic Ferralsols*	*60.55*	*0.41*
FRro.vtdyh	6. Hyperdystri- Veti- Rhodic Ferralsol	60.55	0.41
FRxa	*2.4.* Xanthic Ferralsols	66.48	0.45
FRxa.vt	*6. Veti- Xanthic Ferralsols*	*66.48*	*0.45*
FRxa.vtdyh	7. Hyperdystri- Veti- Xanthic Ferralsol	66.48	0.45
FRha	2.5. Haplic Ferralsols	44.80	0.30
FRha.vt	*7. Veti- Haplic Ferralsols*	*44.80*	*0.30*
FRha.vtdyh	8. Hyperdystri- Veti- Haplic Ferralsol	44.80	0.30
AC	**3. Acrisols**	**10,985.01**	**74.45**
ACst	*3.6. Stagnic Acrisols*	551.71	3.74
ACst.ar	*8. Areni- Stagnic Acrisols*	*292.17*	*1.98*
ACst.arha	9. Hapli- Areni- Stagnic Acrisol	292.17	1.98
ACst.vt	*9. Veti- Stagnic Acrisols*	*259.54*	*1.76*
ACst.vtha	10. Hapli- Veti- Stagnic Acrisol	259.54	1.76
ACha	***3.7. Haplic Acrisols***	***10,433.33***	***70.71***
ACha.ar	*10. Areni- Haplic Acrisols*	*1,081.01*	*7.33*
ACha.arvt	11. Veti- Areni- Haplic Acrisol	1,081.01	7.33
ACha.sk	*11. Skeleti- Haplic Acrisols*	*369.88*	*25.08*

Symbol	Soil names *FAO - UNESCO - WRB*	Area	
		(ha)	(%)
ACha.skvt	12. Veti- Skeleti- Haplic Acrisol	3,699.88	25.08
ACha.vt	*12. Veti- Haplic Acrisols*	*3,044.50*	*20.63*
ACha.vthu	13. Humi- Veti- Haplic Acrisol	364.99	2.47
ACha.vtdyh	14. Hyperdystri- Veti- Haplic Acrisol	2,679.51	18.16
ACha.flh	*13. Hyperferrali- Haplic Acrisols*	*1,078.86*	*7.31*
ACha.flhlen	15. Endolepti- Hyperferrali - Haplic Acrisol	941.91	6.38
ACha.flhro	16. Rhodi- Hyperferrali- Haplic Acrisol	136.95	0.93
ACha.cr	*14. Chromi- Haplic Acrisols*	*1,529.06*	*10.36*
ACha.crsk	17. Skeleti- Chromi- Haplic Acrisol	477.65	3.24
ACha.crvt	18. Veti- Chromi- Haplic Acrisol	1,051.41	7.13
LV	**4. Luvisols**	**147.99**	**1.00**
LVha	4.8. Haplic Luvisols	148.99	1.00
LVha.vr	*15. Verti- Haplic Luvisols*	*31.18*	*0.21*
LVha.vrcc	19. Calci- Verti- Haplic Luvisol	31.18	0.21
LVha.sk	*16. Skeleti- Haplic Luvisols*	*92.92*	*0.63*
LVha.skcc	20. Calci- Skeleti- Haplic Luvisol	92.92	0.63
LVha.cr	*17. Chromi- Haplic Luvisols*	*23.89*	*0.16*
LVha.crsk	21. Skeleti- Chromi- Haplic Luvisol	23.89	0.16
RG	**5. Regosols**	**3,162.09**	**21.43**
RGar	5.9. Arenic Regosols	963.25	6.53
RGar.dy	*18. Dystri- Arenic Regosols*	*963.25*	*6.53*
RGar.dysk	22. Skeleti- Dystri- Arenic Regosol	630.48	4.27
RGar.dyha	23. Hapli- Dystri- Arenic Regosol	332.77	2.26
RGcc	5.10. Calcic Regosols	140.69	0.95
RGcc.eu	*19. Eutri- Calcic Regosols*	*140.69*	*0.95*
RGcc.eust	24. Stagni- Eutri- Calcic Regosol	140.69	0.95
RGsk	5.11. Skeletic Regosols	250.32	1.70
RGsk.dy	*20. Dystri- Skeletic Regosols*	*250.32*	*1.70*
RGsk.dyha	25. Hapli- Dystri- Skeletic Regosol	250.32	1.70
RGdy	5.12. Dystric Regosols	1,230.32	8.34
RGdy.st	*21. Stagni- Dystric Regosols*	*571.43*	*3.87*
RGdy.star	26. Areni- Stagni- Dystric Regosol	409.07	2.77
RGdy.stsk	27. Skeleti- Stagni- Dystric Regosol	162.36	1.10
RGdy.sk	*22. Skeleti- Dystric Regosols*	*658.88*	*4.47*
RGdy.skha	28. Hapli- Skeleti- Dystric Regosol	658.88	4.47

Symbol	Soil names *FAO - UNESCO - WRB*	Area	
		(ha)	(%)
RGeu	5.13. Eutric Regosols	577.52	3.91
RGeu.sk	*23. Skeleti- Eutric Regosols*	*577.52*	*3.91*
RGeu.skha	29. Hapli- Skeleti- Eutric Regosol	577.52	3.91
Total surveyed area		**14,754.29**	**100.00**

The data for the 15 surface soils (0–10 cm) collected from farms in these districts during the scoping study show that all the soils have pH values in water <7 and mostly the pH in 1 M KCl (pH_{KCl}) is <6.0, i.e. the soils are acidic (Tables 8 and 9). This is consistent with SFRI soil survey data for the Sa Pa and Bac Ha districts (Ho et al., 2006), and with the data of Ha et al., (2006). Acidic pH may be the result of environmental factors alone, but in agricultural soils it is usual that leaching, erosion, N fertiliser use, and the removal of 'basic' cations such as Ca and Mg in harvested crops also contribute. Minimising leaching and erosion, and regular inputs of liming materials are required to counter acidification processes and sustain these farming systems.

In addition, about half the soils are strongly acidic, i.e., have a pH_{KCl} <4.6 (Table 9). For these soils, liming to mitigate the natural/legacy acidity is expected to increase the yield of the (mostly) brassica vegetable crops grown in Sa Pa and Bac Ha. This inference assumes that the acid tolerance of these crops is moderate, like that of cabbage (Maynard & Hochmuth, 2007). Liming/acidity is discussed further in Section 5.2.

Table 8. List of soil samples and soil description at fields in the scoping study

Sample No	Farming system	Soil description
Sa Pa 1	Plum - vegetables	Terraced, soil looks good, black colour, porosity
Sa Pa 2	Vegetables - vegetables	Slopping land + terraced field, soil looks quite good, but stony on the surface and moderate erosion
Sa Pa 3	Vegetables (6 years continuously)	Heavy texture, intensive vegetable production (high mineral fertilizer use)
Sa Pa 4-1	Rice - vegetables (near a small stream)	Light texture, many stones on the surface
Sa Pa 4-2	Plum - vegetables (near the farm house)	Soil looks good and fresh pig manure applied to vegetable crops
Sa Pa 5-1	Rice - vegetables (near the farm house)	Slightly terraced field, soil looks very good with back colour and high porosity
Sa Pa 5-2	Vegetables - maize	High slope field, red soil, heavy soil texture and porosity
Sa Pa 6	Vegetables - maize	High slope field, red soil, heavy texture, and porosity
Bac Ha 7	Fruit trees - vegetables	Garden soil looks quite good
Bac Ha 8	Rice - vegetables (near a small stream)	Slightly terraced field, soil looks good, heavy texture, plastic and sticky
Bac Ha 9	Plum - vegetables	Flat garden, soil looks good, black colour and porosity
Bac Ha 10	Plum-vegetables	Sloping garden, many stones on the surface, shallow cultivated soil layer
Bac Ha 11	Rice - vegetables	Flat field, soil looks very good, black colour and porosity
Bac Ha12	Rice-vegetables	Terrace field, soil looks good
Bac Ha 13	Vegetables (near the Red River)	Flat field, alluvial soils, light texture and good quality

Table 9. Properties of the surface soils (0-10 cm) sampled during the scoping study Jan 2013 (winter)

Sample No	Parameters								
	pH_{H2O}	pH_{KCl}	OC	N total	P_2O_5	K_2O	Al^{3+}	H^+	CEC
			%		*mg/100 g soil*		*meq/100 g soil*		
1	5.01	3.83	3.704	0.273	11.74	20.00	0.92	0.37	9.06
2	5.01	4.20	2.207	0.225	43.11	43.74	0.00	0.17	12.9
3	5.75	4.98	2.719	0.177	41.29	24.22	0.00	0.09	11.1
4-1	5.45	4.20	1.655	0.144	4.56	17.23	0.24	0.25	11.68
4-2	4.84	3.80	1.813	0.304	4.48	22.53	2.32	0.89	20.8
5-1	5.81	4.53	2.443	0.181	3.25	14.94	0.40	0.29	9.52
5-2	5.73	4.05	2.207	0.239	25.79	15.67	0.00	0.17	10.24
6	5.73	4.75	2.167	0.209	0.42	16.51	0.00	0.13	12.72
7	5.87	4.73	1.695	0.216	21.14	60.85	0.00	0.17	8.98
8	5.59	4.70	1.576	0.259	5.97	7.23	0.00	0.09	17.64
9	5.61	4.73	2.089	0.172	22.46	28.2	0.00	0.17	11.62
10	6.69	5.79	1.970	0.166	42.61	22.17	0.00	0.05	10.96
11	5.84	4.63	0.906	0.220	28.43	6.75	0.00	0.09	15.36
12	6.13	5.43	4.296	0.251	5.55	9.76	0.00	0.05	9.72
13	6.30	5.28	2.877	0.220	38.16	30.25	0.00	0.05	16.04

7.5 The major farming systems

The majority of the farmed area in Sa Pa and Bac Ha districts is terraced and cropped to rice during summer and to vegetables during winter. Other cropping systems include temperate fruit-vegetable and vegetable-vegetable, and they are part of this review.

Results of land evaluation (SFRI, 2005) show that vegetables can be grown in three seasons per year: Spring season (February to May), summer season (June to September) and winter season (October to January). However, suitable area for vegetable varies among seasons. Bac Ha and Sa Pa have a small area that is highly suitable (S1), or marginally suitable (S3), for vegetables. Most of agricultural lands are moderately suitable (S2). Due to limitations on soil, monthly rainfall and temperature, the best period for vegetables is from March to September in Bac Ha and from February to October in Sa Pa.

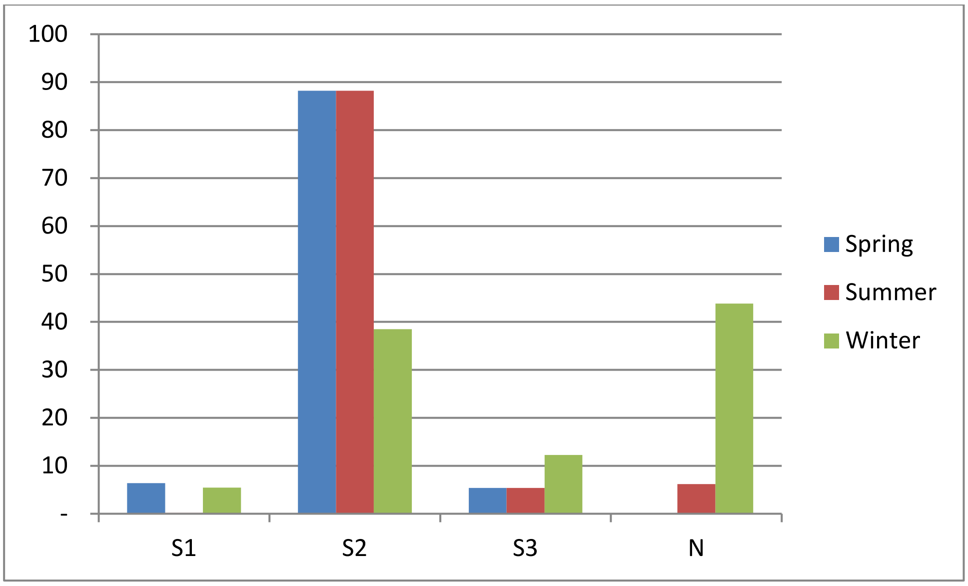

Figure 7.. Percentage of suitable areas for vegetables in Bac Ha and Sa Pa districts, Lao Cai province. S1: highly suitable, S2: moderately suitable, S3: marginally suitable and N: not suitable

7.5.1 Nutrient budgets

Budgets for the elements N, P, K, S, Ca and Mg are a good starting point in assessing the sustainability of farming systems. Nutrient budgets are simply the inputs and removals and interest focuses on the difference between them in the context of current fertility levels. Estimates of the amounts of soil amendments applied annually, and their nutrient contents, were assembled for each of the three farming systems. This process relied on local knowledge supplemented by information gathered during the scoping study (Table 10).

Table 10. Estimation of nutrient content of soil amendments for the three farming systems (kg/ha) (amounts of manure and fertilizer are calculated from the scoping study and the nutrient content of compost/manure is estimated in the Fertilizer Handbook (SFRI, 2005))

Amendment	Fruit-veg	Rice-veg	Veg-veg
Compost/manure			
N	43	104	30
P	19	45	13
K	40	94	289
Fertiliser			
N	27	162	332
P	24	77	113
K	13	120	59
S	44	140	15
Ca, Mg, traces	No data available	No data available	No data available

Soil amendments

Compost/manure amendments contribute substantial nutrient inputs to all three farming systems (Table 5). Consequently, there has been considerable investment in: understanding manure management (Vu et al., 2007), how to retain N during composting and use (Tran et al., 2012; Tran et al., 2013), in documenting the heavy metal content (Table 11), and in promoting the benefits of organic amendments for vegetables (SFRI 2005). The value of organic amendments extends well beyond their nutrient content to increasing the availability of P (ACIAR Project LWR1/ 1994/014) and enhancing soil physical condition resulting in higher yields (Ha et al., 2006). Effects of organic amendments are slow to develop and best measured and demonstrated in long-term field trials in all three farming systems.

Table 11. Heavy metals in compost and other fertilizers. Source: Le V.K (2004)

Heavy metal	Compost *(mg/kg)*	P fertilizer *(mg/kg)*	Lime *(mg/kg)*
As	3 - 25	2 – 1,200	0.1–24
Cd	0.3 - 0,8	0.1 - 170	0.04 – 0.1
Cr	5.2 - 55	66 - 245	10 - 15
Co	0.3 - 24	1 - 12	0.4 - 3
Cu	2 - 60	1 - 300	2 - 125
Hg	0.09 – 0.2	0.01 – 1.2	0.05
Ni	7.8 - 30	7 - 38	10 - 20
Pb	6.6 - 15	7 - 225	20 - 1.250
Zn	15 - 250	50 – 1,450	10 - 450

Chemical fertilisers are widely used and increasingly popular as intensification increases. Common products include both single nutrient, e.g., KCl, and multi-nutrient formulations, e.g., N:P:K mixtures such as 5:10:3 and 16:16:8 (SFRI, 2005). Over-use of N is a concern for the environment and for health, since it increases the risk of products breaching food safety guidelines (SFRI 2005). However, the N budget for the farms visited during the scoping study does not indicate excessive N use (Section 5.1.2). The project will provide an opportunity to resolve this apparent contradiction.

Nutrient removals and balances

The scoping study provided local information about crop yields (Table 12), but not about the elemental composition of the crops. No other source of information about the composition of local crops was found; consequently, nutrient removals were estimated by assuming that crop composition was typical (Reuter and Robinson, 1997) and that the: (i) Quantity of nutrients in fruit was negligible in the context of other uncertainties in the data. (The fruit yield was ~0.3 t DW/ha: scoping study); (ii) Proportion of an orchard cropped to vegetables during winter was ~50%; (iii) Rice straw (~2 t/ha) and grain (~4 t/ha) were removed from the field; and, (iv) Vegetable was cabbage, which yielded ~5 dry t/ha (scoping study).

Table 12. Average yield of crops/fruit trees in Sa Pa and Bac Ha

Crops/trees	Yield (ton/ha)
Rice	4.00
Cabbage	34.70
Cauliflower	18.75
Tomato	11.11
Chayote (for fruit)	75.00
Chayote (for shoot)	22.22
Plum	3.00

The annual nutrient removals for the three farming systems were estimated as above (Table 11). Table 11 also gives the nutrient inputs from compost/manure and fertilisers (summarised from Table 10), and Table 13 presents the nutrient balances.

Table 13. Approximate annual element budgets for the three systems

Element	Element input *(kg of element/ha/y)*	Element removed *(kg of element/ha/y)*	Element balance *(kg of element/ha/y)*
Fruit-vegetables			
N	70	100	Deficit
P	40	20	20
K	50	30	20
S	40	20	20
Ca	unknown	30	unknown
Mg	unknown	20	unknown
Mn	unknown	0.5	unknown
Fe	unknown	0.5	unknown
Cu, Zn, B	unknown	unknown	unknown
Rice-vegetables			
N	270	300	Deficit
P	120	40	80
K	210	60	150
S	140	40	100
Ca	unknown	60	unknown
Mg	unknown	40	unknown
Mn	unknown	1	unknown
Fe	unknown	1	unknown
Cu	unknown	0.1	unknown

Element	Element input (kg of element/ha/y)	Element removed (kg of element/ha/y)	Element balance (kg of element/ha/y)
Zn	unknown	0.3	unknown
B	unknown	0.2	unknown
Vegetables-vegetables			
N	360	400	Deficit
P	130	60	70
K	350	100	250
S	15	60	deficit
Ca	unknown	100	unknown
Mg	unknown	60	unknown
Mn	unknown	2	unknown
Fe	unknown	2	unknown
Cu	unknown	0.2	unknown
Zn	unknown	0.6	unknown
B	unknown	0.4	unknown

The assumptions are that: (1) for nutrients other than N, removals in grain are small for the rice/fruit crop relative to the vegetable crop; (2) the vegetable was cabbage and the yield was 5 dry t/ha, with an average analysis of 0.3% Mg, P and S, 1% K and Ca, 4% N; and small concentrations of Mn, Fe, Cu, Zn and B (Reuter and Robinson 1997); and (3) 60% of applied N is lost within the season of application. Thus the nutrient budgets for N, P, K and S in the three farming systems are approximate (Table 10). Nonetheless, contrary to expectations (SFRI 2005), it appears that N may be under supplied, especially given that the recovery of N is unlikely to exceed ~40%. In contrast, the inputs of P, K and S appear greater than the amounts removed, i.e., these elements may be accumulating in the soil. This may be beneficial, at least in the short term, since the baseline fertility of the soils is probably low (Ha et al., 2006).

The data for Ca, Mg, Mn, Fe, Cu, Zn and B are too uncertain to allow budgets to be estimated. This is a concern because imbalances in Ca and Mg may be associated with acidification and structural instability, and excessive applications of trace elements can cause long-term negative effects on production that are not readily remediated. In crops for which the critical foliar nutrient concentrations are known, deficiencies and toxicities of Mn, Fe, Cu, Zn and B are readily diagnosed using plant analysis. In addition, leads for the remediation of nutrient imbalances can be obtained using glasshouse trials and tested in the field. This is the conceptual approach the project will employ. That is why considerable weight is being given to ensuring that the laboratories at SFRI in Hanoi can service the needs of the project.

In summary, it is important that the project collect data to strengthen the budgets for N, P, K and S, and to enable approximate budgets for Ca and Mg, and perhaps for Mn, Fe, Cu, Zn and B to be developed. The measurements should include sampling the range of the nutrient status of the soils and crops in the three farming systems. The crops sampled must include rice and rice straw removed, and fruit, where these are part of the farming system. Nutrient budgets necessarily contain uncertainties, which over extended periods of time can result in large imbalances if a simple recipe is followed without monitoring fertility trends. Consequently, in the interest of sustainability, ‘adaptive’ field trials should be established and long-term monitoring conducted to detect fertility trends in all three farming systems.

Nutrients for vegetable production.

Nitrogen, P and K fundamentally affect vegetable productivity and quality, and research at Gross Beerenhe vegetable research institute shows that cabbage needs relatively large amounts of these nutrients. But it is not true that the quantity and quality of products increase in direct proportion with the amount applied: indeed excessive applications cause low productivity and quality, shorter shelf life, and undesirable environmental effects. For 3 varieties of Indian green cabbage, 80 kg N/ha, the productivity and quality of all 3 varieties (Thakuria and Gogoi, 1996). Garai (1989) also found that the highest productivity of cabbage was reached at 80 kg N/ha; however, Sharma et al. (1995), found no yield increase beyond 60 kg N /ha. For turnip, 20 kg P/ha gave maximum yield (Gill et al., 1995).

Organic fertilizers can also play a significant role. The SFRI recently demonstrated that application of an organic liquid calcium nitrate fertilizer to crops of cabbage and kohlrabi on degraded soil and Red river alluvial soil increased the productivity up to 17 - 24%. This result confirms earlier findings by the Department of Science and Technology of Vinh Phuc province (2006). Bui Quang Xuan reported that the suitable application dose of N for cabbage is 200 kg N/ha. However, although yield is not always maximised by organic amendments there may be other benefits, e.g. vegetable productivity from manure was 20–25% less than from inorganic fertilizers, but the bio-value was greater, e.g., E vitamin, Ca, P, methionine, total sucrose, K and Fe are 28%, 10%, 13%, 23% 19%, 18% and 77% higher, respectively (Le Thi Khanh, 2009).

7.5.2 Managing the systems

Acidity

Soil is acidified by several processes, including: the nitrification of N inputs, N fixation, the loss of cations that either accompany nitrate during leaching, or are constituents of harvested crops (Upjohn 2005). In Sa Pa and Bac Ha much of the N is applied as urea. The nitrification of urea releases little acid (Upjohn et al. 2005); however, the other causes of acidification remain. The development of toxic levels of acidity is undesirable because it decreases production and the acid layer may not occur near the soil surface, making it more difficult to remediate. That is, sustainability demands that sufficient lime ($CaCO_3$, or other basic materials, is added to prevent the pH from decreasing to the point where toxic Al species are released in quantities sufficient to limit production. The data in Table 5 are indicative that this point has already been reached on some farms. Knowledge of the current acidity status will be reinforced in the field survey during 2014.

Approximate annual maintenance lime requirements were calculated using the data in Table 5 using the principles outlined by Upjohn et al., (2005). The estimated annual lime requirements are: ~100 kg/ha (fruit-vegetables); ~300 kg/ha (rice-vegetables); and ~500 kg/ha (vegetables-vegetables). (These estimates relate to the amount of acid that would be neutralised by the stated quantity of pure $CaCO_3$). Given the importance of pH maintenance to sustainability, the adequacy of the estimated lime requirements should be assessed empirically using long-term field trials in each system. The project should clearly communicate the need for and benefits of maintenance liming.

As the value of pH_{KCl} falls below~4.6, the concentration of toxic Al species in the soil solution begins to increase rapidly (personal communications from George Rayment and Mark Conyers). Therefore, at pH_{KCl} values <4.6, vegetable production may respond to remedial liming. This ‘critical’ pH value is approximate for two reasons. First, pH is not the only factor that influences the concentration of toxic Al species in the soil solution, e.g., increased organic matter suppresses toxicity, whereas increased Cl or SO_4 enhance it. Better prediction of Al-toxicity is possible by using a chemical test specifically for the toxic species: however, for reasons given in the following paragraph, the more usual practice is, instead, to raise the pH_{KCl} to a safe level, e.g. ~5.5. This strategy requires the installation of a lime requirement test in the SFRI laboratories since none is currently in place. It would be sound practice to calibrate this test by equilibrating soils with doses of lime in the greenhouse. Second, it is assumed that the (mostly) brassica winter vegetables grown in Sapa and Bac Ha are, like cabbage, moderately acid tolerant (Maynard & Hochmuth 2007); although there is no knowledge pertinent to the particular varieties grown. The utility of the 'critical' pH_{KCl} of ~4.6 for moderately sensitive crops has the potential to influence farming practice and project outcomes. Consequently, the acid sensitivity of key crop species and varieties should be tested in pot trials at SFRI. Another consideration is the likely effect of liming on soil microbiology and pathogen survival, infection and expression. These considerations points to the importance of including these factors in the survey during 2014.

Liming to a pH_{KCl} of ~5.5 should also benefit plant performance, especially early in the vegetable phase of the rice-vegetable system. This is the case because during the paddy rice phase reduced forms of Fe and Mn occur in the soil solution at concentrations far greater than those in aerobic soils. As the soil becomes aerobic, the dissolved Fe and Mn oxidise, forming insoluble oxides, a process which concomitantly releases acid. (If the pH_{KCl} during aeration falls below ~4.6, toxic Al species are released as described in the preceding paragraph.) The precipitated oxides strongly bind P and Mo, and to a lesser extent S, making them temporarily much less available to plants. Raising the pH_{KCl} to (say) ~5.5 increases the rate of oxidation of Mn and Fe, decreasing the tie-up of P, Mo and S, limits the persistence of any toxic Al species formed, and stabilises exchangeable (plant available) forms of K, Ca and Mg (Moody, 2007). The sequence of reactions described above also informs when in the cropping cycle soil should be sampled to learn about critical changes in key properties.

Remedial liming has the potential to decrease the uptake of Fe, Mn, Cu, Zn and B to such an extent that vegetables may become deficient. (The effect on rice nutrition is expected to be minimal because flooded soils tend to have pH values nearer neutral.) That is, reaping the benefits of liming requires that its effects on trace element availability are monitored and that trace elements are added as called for. Trace element availability is best monitored by foliar analysis; however, foliar analysis does not predict the quantity of a trace element to apply. The 'rate' can be estimated in pot experiments; although, such estimates must be validated in the field. [The population of Lao Cai would benefit from increased concentrations of Ca, Fe and perhaps of Zn in their diet (Marcussen et al., 2013). Moreover, decreased dietary Cd concentrations, a side effect of liming, are also deemed generally beneficial (EFSA 2012)]. Liming also affects soil structure and the mineralisation rate of soil organic matter and the release of its constituent nutrients; consequently, these effects too should be monitored. The trace element and agronomic impacts of liming are best measured and demonstrated in long-term field trials in all three farming systems.

Puddling soils destroys their physical structure and may cause a dense clay pan to form at the base of the tilled layer, supporting a perched water table and restricting root penetration (Timsina and Connor, 2001). In Sa Pa and Bac Ha, the paddy is drained about 3 weeks before harvest. Harvest removes perhaps half of the straw which is used for a wide variety of purposes, such as animal feed and fuel. About 4 weeks after harvest, the soil and the remaining stubble and roots are mounded into beds. Bedding the wet soil is destructive of soil structure and is a time and energy consuming process that would better be avoided. It is assumed, however, that bedding improves aeration, and consequently speeds up the cascade of oxygen-dependent chemical processes described above, enabling seedling establishment sooner after the paddy is drained. This is a question that should be investigated during the project.

In the non-rice systems, the soils are neither puddled nor ponded, except for brief flooding due to heavy rain. The transition between cropping phases is consequently assumed to be less radical in all respects than that of the rice-vegetable system. The non-rice systems may benefit from the installation of permanent beds. Since most of the area may at one time have supported rice, it is likely that hard pans are prevalent in all three cropping systems. In addition, a right angle bend in the roots of cabbages indicates that there is a shallow barrier to root growth. This may be due to compaction. The existence of hard pans and their depth should therefore be investigated. This can conveniently be done using a sharp-tipped steel rod, and SFRI plans to have such a tool available in time for the survey during 2014. The resulting data will indicate the possible impact of hard pans on fruit and vegetable production. If hard pans are deemed to be a production issue, practical remediation strategies will need to be developed and trialled during the project. If hard pans are not the cause of the observed root deformity then other causes will be investigated, e.g. acidity/disease.

The rice/vegetable transition

The chemistry of soil under paddy rice has been studied in considerable depth over an extended period, e.g. Ponnamperuma (1972). In summary, the rate of diffusion of oxygen is about 10^4 times more rapid in the gas than the aqueous phase, so ponding greatly reduces oxygen access to the soil. Consequently, following ponding, continued microbial activity consumes oxygen from the soil atmosphere faster than it can be replaced and the redox potential falls, reducing first nitrate, then the oxides of Mn and Fe. The Mn and Fe oxide phases are associated with P and organics that are co-released into solution. The rate of mineralisation of soil organic matter slows and the products differ from those in aerobic systems, e.g. organic acids, methane, mercaptans and ammonia. In addition, the reduction *per se* consumes hydrogen ions, which causes the pH of acidic soils such as those in Sapa and Bac Ha (Table 4) to rise towards neutrality. That is, it is unlikely that either liming or P fertilisation will benefit rice production. Nonetheless, the high concentrations of Mn and Fe in solution may suppress the uptake of other trace metals, which is another reason to monitor the nutrient sufficiency of the rice crop.

As the soil dries out, gases replace water in soil pores, the diffusion rate of oxygen increases so that it can again become a major constituent of the soil atmosphere. The processes described above then undergo a radical reversal. The Fe is oxidised and precipitates from solution as hydrous oxides that avidly bind P and organics. The oxidation of Fe releases hydrogen ions and the soil pH declines towards its aerobic ‘norm’. (It is noteworthy that the oxidation of Mn is a microbial process whose rate is slower at below pH 6 and that the strength of P binding to the precipitated oxides decreases the higher the pH.) As oxidation proceeds, ammonia is converted to nitrate, which is susceptible to reactions that lead to gaseous losses of N, e.g. as N_2O. The availability of P is slow to return to the aerobic ‘norm’, as this relies on the rate at which the surfaces of the freshly precipitated hydrous oxides become better organised: a process which takes months. Consequently, for acidic soils such as those in Sapa and Bac Ha, it is not unreasonable to postulate that liming may both directly and indirectly benefit the growth of young vegetable seedlings planted after rice, and that the indirect benefits may be the greater. This hypothesis is probably best tested in the field across several seasons to capture inter-seasonal effects such as rain and/or low temperature during the transition period; although one could consider manipulating the system to achieve the desired variation.

7.5.3 Erosion

Soil erosion is serious issue in all regions. The quantity of nutrients lost by erosion can be large, because eroded material contains concentrations of organic matter, N, P and K up to 5, 3 and 2 times higher than in original soil, respectively. Thus nutrient loss through erosion, even on a 4% slope, may easily exceed the removal of nutrients by a crop, especially for Ca, Mg and K as shown for erosion experiments in Missouri (Table 14).

Table 14. Annual erosive nutrient loss in the Missouri Erosion Experiment compared to the yearly removal by the average field crop.

Condition	Nutrient removed per year (kg/ha)					
	N	P	K	Ca	Mg	S
Erosion removal						
- Corn grown continuously	74	20	678	247	98	19
- Rotation: corn - wheat - clover	29	9	240	95	33	7
Crop removal						
- Average for standard rotation	190	35	135	50	25	20

Decades of agricultural research coupled with centuries of farmers' experience have rather clearly identified the major factors affecting accelerated erosion. These factors are included in the Universal Soil Loss Equation:

A = RKLSCP

Of which:

A: the predicted soils loss in metric t/ha/y

R: rainfall and runoff

K: soil erodibility

L: slope length

S: slope gradient or steepness

C: cover and management

P: erosion control practice

Of the two phases of rainfall (R), amount of total rainfall and its intensity, the latter (intensity) is usually more important. The seasonal distribution of rainfall is also critical in determining soil erosion losses. In Bac Ha, and especially in Sa Pa, extreme weather conditions such as whirlwind, flood, hail are reasonable common. Often significant soil erosion follows the excessive runoff generated during these events.

The soil erodibility factor (K), indicates the inherent erodibility of a soil. It gives an indication of the soil loss from a unit plot 22m long with a 9 % slope and continuous fallow culture. It depends on the soil instinct but normally varies from zero to about 0.6. Wischmeier and Smith (1978) computed the K value for each kind of soil as below:

Soil	Source of data	Computed K
Dunkirk silt loam	Geneva, NY	0.69
Keene silt loam	Zanesville, OH	0.48
Lodi loam	Blacksburg, VA	0.39
Cecil sandy clay loam	Watkinsville, GA	0.36
Marshall silt loam	Clarinda, IA	0.33
Hegerstown silty clay loam	State College, PA	0.31
Austin silt	Temple, TX	0.29
Mexico silt loam	McCredie, MO	0.28
Cecil sandy loam	Clemson, SC	0.28
Tifton loamy sand	Tifton, GA	0.10

So that, with the soil types mentioned above, the K value in Sa Pa and Bac Ha may be 0.28 to about 0.6.The topographic factor (L and S) reflects the influence of length and steepness of slope. Wischmeier and Smith (1978) also provided the following values of LS:

Slope (%)	Slope length (m)				
	15.35	**30.5**	**45.75**	**61**	**91.5**
2	0.163	0.201	0.227	0.248	0.280
4	0.303	0.400	0.471	0.528	0.621
6	0.476	0.673	0.824	0.952	1.17
8	0.701	0.992	1.21	1.41	1.72
10	0.968	1.37	1.68	1.94	2.37
12	1.280	1.80	2.21	2.55	3.13

The cover factor (C), indicates the influence of cropping system and management variables on soil loss. Forest and grass are the best natural soil protections followed by forage crops, both legumes and grasses, whose effectiveness lies in their relatively dense cover. Small grains such as wheat and oats are intermediate and offer considerable obstruction to surface wash. Row crops such as corn, soybeans, and potatoes offer relatively little cover during the early growth stages and thereby encourage erosion.

The support practice factor (P) reflects the benefits of contouring, strip cropping and other support factors. The benefits of good cover and management and support practices are obvious when we make an example for calculating the A value for a location in central Iowa on a Marshall silt loam with an average slope of 4% and an average slope length of

30.5. First, assume further that the land is clean tilled and fallowed. Since, the C value and P value both is 1.0 because of no cover or other management practices here. So:

A = (150)(0.33)(0.400)(1.0)(1.0) = 44 t/ha.

If the crop rotation involved wheat – hay – corn – corn and conservation tillage practices (minimum tillage) were used, a reasonable amount of residue would be left on the soil surface. Under these conditions, the C factor may be reduced to about 0.1. Likewise, if the tillage and planting were done on the contour, the P value would drop to about 0.5. With these figures, the soil loss becomes:

A = (150)(0.33)(0.400)(0.1)(0.5) = 2.2 t/ha; 20 times less than the A above.

Wind erosion is quantitated by the equation:

E = f (ICKLV)

where E is the potential quantity of erosion per unit area. It is a function (f) of soil erodibility (I), a local wind erosion climate factor (C), the soil surface roughness (K), width of field (L) and quantity of vegetable cover (V). Although wind and soil characteristics are generally beyond the farmers' control, the other factors are subject to control through the choice of cultural practices. Wind erosion is not a big problem in Sa Pa and Bac Ha in compared with water erosion because of the soil moisture here is quite good and the soil structure is relatively hard. But it does not mean that wind erosion is not a concern in Sa Pa and Bac Ha.

Several soil erosion studies were carried out recently in Lao Cai in general and less broadly in Sa Pa and Bac Ha using GIS and remote sensing technology to assess the soil erodibility. If erodibility was divided into five classes, from weak to very dangerous, the areas identified as being most at risk are concentrated in the communes of Ban Ho, Nam Cang, with a predicted erodibility of 1.5 t/ha/y.

7.6 Recommendations

7.6.1 Production constraints

Given that most of the soils are acidic to strongly acidic, the yields of brassica crops may respond generally to liming amendments, and site-specific responses may occur to particular nutrients, singly or in combination, including: P, K, Ca, Mg, Mo and B. When vegetable crops follow rice, the concentrations of available Fe and Mn will initially be high, perhaps toxic in the case of Mn, and will decline as the soils become aerobic and that decline will continue over weeks as the duration of aeration extends. The behaviour of P and Mo will be in mirror image to that of Fe and Mn, i.e. P and Mo may rapidly become deficient as the system becomes aerobic and gradually become more available. Raising the soil pH to address acid constraints may induce deficiencies of Fe, Mn, Cu, Zn and B. In contrast, raising the pH increases the rate at which soil properties adjust to aeration after flooding. These potential indirect benefits of liming on the thrift of vegetable seedlings may be considerable. Lastly, potential production constraints need to be managed in the context of increasing the dietary intakes of Ca, K, Fe and possibly Zn, and decreasing that of Cd.

To identify the production constraints the project will expand the survey of the nutrient and toxic element status of soils and crops, and investigate the occurrence of hard pans in soils during 2014 to augment the data already collected as baseline data for the Project. The survey locations will represent all three farming systems, i.e. rice-vegetable, temperate fruit-vegetable and vegetable-vegetable at both Sa Pa and Bac Ha. At each site, a minimum of three soil samples will be taken and plants will be sampled on two occasions. The samples will be analysed at the SFRI laboratories in Hanoi. To facilitate data interpretation, only the one indicator plant species, probably cabbage, will be sampled across all the farms surveyed in both districts, so far as is possible. Samples will be analysed for their element composition: total-N and nitrate N, P, K, Ca, Mg, Mn, Fe, Cu and Zn, and if possible for B, Mo, Ni, Cd, As, Se and Co. Nutrient values for the indicator crop, or a closely related species, will be compared with published 'sufficiency' values. The samples will be archived to allow the possibility of reanalysis or analysis for additional components. The sampling sites will be geographically located and the resulting leads will inform decisions including: the nutrients on which attention should be focussed and potential sites for field trials.

Greenhouse experiments will be used to measure the effects of liming on the production and trace element content of crops, validate the laboratory test for lime requirement, and underpin the design of field experiments. The design of such trials will be guided by Asher et al., (2002) who developed a practical approach to solving soil fertility problems for developing countries. The uniformity of field sites will be established and designs will be used that accommodate trends in nutrient availability within a site, as recommended in previous studies, e.g. ACIAR project LWR1/1994/014.

6.2.6.2. Element content of human diets

Interventions to optimise mineral nutrition and increase production of vegetables have the potential to impact on the element content of all the food crops in the rotation and therefore on dietary intakes. The diet of the urban population of Hanoi has recently been assessed and that is the population group nearest geographically to Lao Cai province for which such information is available (Marcussen et al., 2013). In summary, the diet supplied sufficient Cu, Mg, Mn, Mo, Co and P. However, the intakes of Ca and Zn were marginal, and that of Fe was seriously insufficient. The low intakes of Ca, Fe and Zn, together with an otherwise modest Cd intake, raise concern about chronic Cd toxicity in children and in reproductive women (Nawrot et al., 2010). Therefore, treatments given to increase production should, if anything, increase the concentrations of Ca, Fe and Zn, and decrease that of Cd in the main food crops. Data for the adequacy of dietary I, Se and other ultra-trace elements were not traced. This project will archive plant samples to demonstrate the effects of the treatments imposed to increase production or sustainability. The archived samples will be stored so that they could be analysed for these and other trace elements in future.

Acknowledgements

George Rayment and Mark Conyers supplied i the 'critical' values for soil pH_{KCl}.

8 Nutrition-sensitive agriculture workshop

Prepared by Alexandra Peralta and Christian Genova II (University of Adelaide)

8.1 Background and Objectives

Nutrition sensitive agriculture aims to maximise the impact of nutrition outcomes for the poor, while minimising the unintended negative nutritional consequences of agricultural interventions and policies on the poor, especially women and young children (World Bank, 2013). Within an ACIAR project context projects are increasingly looking to measure household consumption, nutritional and health impacts of agricultural value chain interventions. Additionally, there is strong evidence to suggest that empowering women through targeted agricultural interventions is one of the most effective pathways for impacting nutritional outcomes. Evaluating the impact of gender and ethnicity is also critical. This small discussion-centred workshop was designed to bring together researchers and development specialists working in this space to share current research findings, methods (indicators) and approaches, and develop collaborative linkages.

This workshop was organized by the Australian Centre for International Agricultural Research (ACIAR) and the University of Adelaide with the following objectives in mind:

- To discuss the latest developments in measuring nutritional impacts in projects (household and individual diet quality, consumption patterns, micronutrients, food security assessments and anthropometric information);
- To develop food security, consumption, nutrition and health modules for use in ACIAR household surveys; and
- To provide a forum for researchers to collaborate on future research initiatives.

The workshop was co-facilitated by Suzie Newman (University of Adelaide) and Mia Urbano (DFAT).

8.2 Workshop content

Copies of the powerpoint presentations can be found at www.adelaide.edu.au/global-food/workshops/nutrition

Day 1: December 1st 2014, afternoon session.

Presentations centered around two main topics:

- How to measure nutritional outcomes; and
- How to use different indicators to conduct diagnosis of nutritional status.

1. **Examining the relationship between food market environment, diet diversity and diet related diseases among urban Indonesian households.**

   Wendy Umberger, Director Global Food Studies and A/Prof Agricultural and Food Economics (University of Adelaide)

This presentation focussed on the link between agriculture and nutritional outcomes, the different indicators use to measure nutritional outcomes and its limitations, and presented a case study on the effects of supermarkets on consumption of urban households in Indonesia.

Several pathways link agriculture with nutritional outcomes: A World Bank (2013) study identified five different pathways. Out of these five, evidence is strong for the link between empowering women and nutritional outcomes, and some evidence indicates that increased production of nutrient-dense food improves nutrition. The evidence also indicates that increased income and increased agricultural production do not necessarily translate into better nutritional outcomes.

Measuring nutritional outcomes is not an easy task. There are several indicators that have been widely used, with its advantages and disadvantages. For instance, food consumption is measured using household food expenditure, food frequency, hunger scales, World Food Programme food recall and food diaries (24-hour to 4-week recall data) and diet diversity scores used by the World Health Organization, Food and Agriculture Organization (FAO) and the United States Agency for International Development (USAID). These are relatively easy to measure; however they are also time consuming. In addition, food consumption and dietary diversity are not equal to diet quality or nutritional status, and that these indicators in many cases fail to measure individual consumption and intra-household allocation of food and nutrients which is affected by gender, age and power dynamics in the family. Another challenge is capturing information of eating out, and in the case of food expenditure, purchased food does not necessarily translate into consumption – food waste, other uses different than food, e.g. religious offerings. Food consumption indicators should also be measured at different points in time to account for seasonality and other changes of circumstances over a given period of time.

Other set of widely used indicators includes the one that measure diet related health. Anthropometric measures that include wasting, stunting and others, have been use particularly to measure child diet related health in children. BMI measures have also been used for adults, but have been criticised because the BMI can classify as obese individuals that have healthy lives. Other diet-related health indicators include biochemical measures (blood samples to test for iron blood content) and clinical indicators (external physical signs). These indicators are more expensive and difficult to measure, vary by region (e.g. Asia versus Europe), and they are age- and gender-specific.

A case study from Indonesia explored the effects of supermarket purchases on consumption patterns and diet-related health for both adults and children. The sample design included households located in Java Island within a 5-km distance from the supermarkets. Data collection included information on anthropometric measures (height and weight), food expenditures, and place of purchase. The study used BMI z-scores as dependent variable to measure the effect of the percentage of purchases in a supermarket. The results show some evidence supporting the link between supermarket and probability of a child being overweight and obese (especially for high-income households) but not for adults. Controlling for income and education, lower household expenditure shares on healthy foods are associated with high food expenditure shares at supermarkets. The study also found some effects related to age and household wealth, indicating that household's characteristics also have an effect. At certain levels of income increase in income does not necessarily relate to healthier diets. The study conclusions left us with some questions: What are the policy solutions? How to change behaviours? Any future research should consider the individual's diet quality transformation, the dual burden of malnutrition, and the food market environment.

2. Measuring household diet diversity, food consumption and nutrition of household members.

Ellen Goddard, Professor and Co-operative Chair, Agricultural Marketing and Business (University of Alberta)

This presentation evaluates the impacts of an intervention that promoted household gardens. It focussed on studying substitution effects in consumption due to the project intervention. The main research questions were what are those substitution effects and whether households are better off because of the adoption of home gardens. She used health-related diet indicators and consumption indicators, and built indexes to measure concentration of different food groups in consumption, and to compare consumption with the recommended amounts. The results are mixed with respect to the effects of home gardens in consumption of fresh fruits and vegetables. It seems that not necessary the households with home gardens are benefiting from nutritional outcomes. Probably some effects from substitution effects traditional consumption measures cannot capture those outcomes. The study also explored the link between gender and nutrition. The study results suggest mixed effects for female-headed households.

The project was in collaboration with MSSRF looking at agricultural production and how it changes under different climate changes. It was a 3-½ year project promoting 75 interventions, one of which was the promotion of home garden, among tribal communities in three states in India (Kerala, Tamil Nadu, Orissa). Home garden is not new in India. It dates back two centuries and is mainly used for household food consumption and for food sharing with other households. The main focus of the project focus was to increase agricultural production, with the assumption that the link between agricultural production and nutrition was somehow automatic and strong.

To evaluate project impacts on nutritional outcomes, this study collected data from 600 households (500 for the intervention group and 100 for control) on anthropometric measurements and food frequency survey using dietary recall by season for three years. Data was also collected on prices to estimate the value of food purchases and household garden food consumption values.

The results suggest great variety of fruit and vegetables in household gardens, and an increase in production of fruits and vegetables largely due to the intervention. However, the consumption of leafy vegetables remains low , and there is a high consumption of cereals, tubers and sugar. Hence, the following questions were raised: Are the fruits and vegetables actually being consumed? Is there a substitution effect from the intervention?

Three indices were proposed to measure actual consumption of fruits and vegetables and dietary diversity: (a) diet diversity score or food variety score; (b) health food diversity index or berry index; and (c) the health food diversity index which adds to the berry index and weights food by their recommended status in relevant food guides. To address the second question, they looked at the expenditure shares on individual food using Wayanad, Kerala as a case study. The results suggest mixed messages on the impacts of the gardens. Only in Jaypur was there a significant effect of home garden on consumption based on the berry index; however, the findings were inconclusive as the three dietary diversity indices showed different results. There are also inconclusive results from the analysis of expenditure shares. There might be some substitution effects in consumption, but traditional measures do not get these substitution effects.

Therefore, nutritional outcomes are not addressed by just measurement of the quantity produce. The study also found that other factors such as water shortage and pest damage are the main constraints for the adoption of the home gardens.

3. Nutritional status of children in Vietnam – UNICEF data and perspective

Do Hong Phuong, Nutrition Policy Specialist (UNICEF)

This presentation used data from the National Institute of Nutrition (NIN) and from MICS UNICEF for Vietnam to present a diagnosis of the status of nutrition in Vietnam, focusing on children and women. The presenter used data on stunting, wasting, zinc deficiency, and vitamin A deficiency, anthropometric measures, and food consumption. This presentation provides an overview of data available, representative at the country level, and highlights some issues with different indicators. The presentation also highlights some of Vietnam's nutrition problems. The presenter pointed out that consumption data for children tends to be easier to obtain than for other members of the family. And also mentioned that anthropometric measures such as BMI are inadequate for certain groups of the population. For instance for adult women in the highlands of Viet Nam, the BMI show that they have a healthy weight, but this “healthy” weight might be a consequence of stunting or other nutritional deficiencies from early childhood. The presenter provided indicators for six different regions in Vietnam. The Northern area and the Central Highlands present high rates of stunting with particularly acute problem for ethnic minorities.

Stunting has decreased for Vietnamese children, but it is still an issue, in particular for children in mountainous areas and from ethnic groups. Anaemia and the high content of iodized salt in urine are also issues among women and children. The presenter considers the lack of governmental interventions towards improving nutrition status of women and children, and the lack of support from the health system as necessary to address these problems. In the highlands, low quality of diet has not been addressed, and that there are system bottlenecks that prevent advancements toward improving the current situation. The main suggestion from this diagnosis was strengthening interventions for pregnant women and children, with emphasis on vulnerable populations.

4. Nutrition vulnerability – past or future?

Sigrid Wertheim, Director of Marketing (Fresh Studio)

This presentation focussed on the current status of nutrition in Hanoi, it provided an overview of the main issues and of some strategies being implemented with the goal of improving the current nutrition status. It also addressed nutrition and food safety information issues, and different approaches to collect food consumption information. Emphasis was made on nutrition vulnerability in Hanoi, where households are “not eating enough of the right things” and 70% of Hanoi’s population is undernourished. Using consumption indicators, the quantity of vegetables consumed implies healthy diets; however, these vegetables are of poor quality.

An interesting angle from this presentation was the emphasis of learning about the information available for consumers to make decisions when purchasing food. Which information is available with regards to food and nutrition, food safety, and health risks (pesticides and agrochemicals in fruits and vegetables), and risk coping strategies. The presenter raised questions on how to introduce new products and innovations to achieve the goal of a healthy diet (e.g. potato project to increase iron intake by school children). The use of different methods to measure diet information was also highlighted. Methods such as observation, interviews, focus group, household visits, shopping visits, and taste labs can be used to assess food consumption. One suggestion is to complement surveys using different ways to ask questions and to validate the data - forced choice, Likert scale, and constant sum.

Consideration should be given to who purchases food for the household, access to process foods with too much sugar and too much fat. Consideration most also be given to the link between nutrition and wealth, and how it affects nutrition related behaviours and outcomes.

Day 2, December 2nd 2014

Facilitated/Panel discussion: Anthropometrics, micronutrients and food security assessments – selecting appropriate nutrition indicators.

On assessing nutrition knowledge and nutritional awareness:

- Provide adequate and relevant nutritional information to improve nutritional quality by using existing nutrition knowledge questions by WHO and WFP in other studies, combined with FGD and qualitative research to test whether target households understand basic questions.
- Create benchmarks since the average person does not understand which foods are high on vitamin A or other micronutrients.
- In India, mobile phones are commonly used to get information from farmers but not on giving out nutritional information to households on how to balance their meals.
- In Indonesia, balanced information should be provided when promoting dairy consumption. For instance, dairy is also high in sugar which can lead to diabetes and higher obesity rates especially among children in transition economies like Indonesia because of poor advertising.

On assessing diet quality using diet diversity as opposed to measuring micronutrient intake:

- It is easier and less expensive. However, it is recommended to do both. Dietary diversity is a rude measure of diet quality that has been widely used, and should be used parallel with food consumption scores.
- In Australia, one study that had been done with 70 pregnant women looking at their dietary patterns using food frequency and dietary recall information, collecting food samples and measuring them using chemical analysis, and drawing blood at different time periods to see nutrition impact cost $350-$400/person to collect the dataset. This is one reason why most researchers prefer to use diet diversity due to cost consideration.

On using qualitative or quantitative methodologies or both to minimize sample size and get meaningful results:

- It depends on one's research question. One should strive for robustness and corroborate quantitative data with qualitative data as both methods are complementary.
- No exact science in minimizing sample size to justify the use of qualitative data as a substitute for quantitative data. Quantitative data is not sufficient to tell the researcher the whole story, and the same is also true for qualitative data. In FGD for instance, a dominant person in the group can influence the information gathered as people often have this mentality that the way they behave is the same as how other households behave.
- For sequencing, gathering qualitative information is critical before a researcher develops his/her questionnaire, when s/he designs the methods for quantitative data collection, and during follow-up with experts or key informants after quantitative data collection. Qualitative data provides context and behaviour understanding to better design quantitative instruments.

On policies and priorities for improving nutritional status of women and children:

- In Vietnam, nutrition education is the main strategy by NIN complemented by vitamin supplements. They also tailor their nutrition strategies according to the demands of the identified priority areas.
- In terms of who to prioritize when looking at intra-household allocation of food and nutritional status, they look at the lifecycle in Vietnam and start with pre-pregnant mother using supplements. The challenge is how to determine who is going to have a baby, and start from that. Then move to prioritizing children. In India, the government designed effective programs targeting teenage women, ensuring that they are not disadvantaged in terms of food access. Previous efforts targeting women and children had backfired; hence, this new strategy,

On nutrition-related activities in Vietnam:

- On UNICEF promoting breastfeeding and vetoing infant formula and its effect on mothers who are unable to breastfeed, the organization does not intend to ban the sale of infant formula, only minimize placements of advertisements.
- On how interventions that aim to increase livelihoods/income affect the time mothers spent on breastfeeding, a UNICEF gender study will soon be available that details the time spent by mothers on farm and non-farm activities.
- Certain ethnic groups in the central coastal areas view vegetables as not beneficial to children, especially for infants, with the impression that it causes colds.
- On designing better and meaningful ways to measure nutrition knowledge outcomes, it is important to gain understanding on what the main information sources are for consumers, and their understanding and the accuracy of the information they are using for making decisions. However, there is this challenge of designing simple questions to determine the knowledge about food nutrients and cooking time.
- In Vietnam, they have these 10 statements on nutrition that guides Vietnamese on how much quantities of a certain food type to eat, e.g. ordinary salt versus iodized salt, more nutrient-density food like meat, among others. Results of the project SMILING on children however found that although food access is not a problem, children do not get sufficient amounts of zinc and iron; hence the provision of iron supplements.
- Fresh Studio, a consulting group in Vietnam, will start gathering their 2015 panel data that includes a study on the use of food labels (in store labels) and personal relations. They want to determine if households use these labels in their diet and if nutrition knowledge and food safety and interest have increased – coping strategies on safety and the role of social networks. Cooking and food preparation will also be included in the data collection.

Other issue raised during the Q&A portions:

- Aside from the adiposity index, another suggestion is to use the waist and hip circumference as commonly used in Australia.

5. The importance of measuring nutritional impacts of projects.

Rodd Dyer, Research Program Manager - Agribusiness (ACIAR).

The presentation focussed on how nutrition-sensitive agriculture fits within ACIAR programs and aligns with the new aid programs priorities. The priorities of the Australian aid program that align with nutrition sensitive agriculture are empowering women and the promotion of economic prosperity. The discussion centered on the need to use similar indicators to conduct analysis on the impacts of agricultural interventions on nutrition and the requirement of guidelines and methods to measure and evaluate agricultural nutrition project impacts. These guidelines should incorporate the importance of collecting baseline data, the use of a counterfactual, and emphasize the methods for conducting rigorous analysis (both quantitative and qualitative methods). A suggestion was made regarding collecting baseline data in priority areas where different projects will be implemented. This will have two main advantages: allow more accurate diagnosis of the study sites, and conducting rigorous studies that incorporate panel data (observations on the same households/areas in several points in time).

Other priorities of the ACIAR Agribusiness Program priorities to be considered include engaging the private sector, and linking farmers to markets. In addition, the objectives of poverty reduction, improvement of incomes and livelihoods of poor farmers in rural communities, linking farmers to markets, and more efficient and inclusive value chains could be aligned with nutritional sensitive agriculture objectives.

Finally, ACIAR requires building the capacity that will allow them to incorporate nutrition-sensitive agriculture into the program, as well as gender components related to the link women empowerment and nutrition. The discussion also emphasised the need of communication between institutions, to take advantage of available information for analysis, and to improve sample design. Communication between institutions should start from project design and look into the impact pathways to determine outputs and outcomes.

Nutritional indicators from a development perspective

These presentations relate to the work of different NGOs and Government agencies working towards improving nutrition outcomes by means of different agricultural interventions. These interventions focus on targeting women and children. They use indicators of diet quality, food consumption, and diet-health related indicators to target individuals in population, to conduct diagnosis, and for monitoring and evaluation purposes. These presentations emphasize the need of coordination with and involvement of governmental organizations, to share information, strategies and recommendations.

6. Nutritional programming in Yen Bai and Dien Bien

World Vision

Nutrition interventions are complex. They incorporate the participation of health professionals, and require working directly with women, the implementation of feeding programs for children at school, and empowering of women and the community. This presentation focussed on the interventions World Vision is undertaking in the highlands of Vietnam, focusing on working with ethnic minorities, where high levels of infant mortality, stunting and wasting among children are prevalent. The NGO focuses on women and children well-being, and has developed a strategy towards achieving improvements in child nutrition outcomes and child protection from infectious diseases. The interventions promoted include preparation of foods rich in micronutrients, child nutrition education, management of small livestock, and fish.

The project strategy relies on group interventions. It uses what the project calls a nutrition club model. It is a community-based intervention, where communities receive visits by health care providers, for education purposes and monitoring of child development. The groups within the communities receive education on nutrition and food preparation. The goal of this approach is to generate a sense of ownership, and promote the active participation of government health providers.

7. Nutritional Impacts arising from interventions that seek to empower women

Vietnam Women's Union

The Vietnam Women's Union (VWU) has a network that operates throughout Vietnam at four administrative levels: central, provincial, district and commune. It promotes women empowerment, stresses the importance of women's role to achieve improvements in nutritional outcomes, facilitates women's access to the health system, and promotes nutrition interventions within self-help groups, initially formed with the goal of promoting savings and increasing women's access to credit.

VWU promotes the importance of women's nutrition, particularly during the reproductive part of their lives. It works together with other governmental organizations, for instance with NIN and the Health Ministry to promote the importance of breast-feeding and to target pregnant women in their programs. They also conduct monitoring and evaluation of their initiatives and use the information that is collected and share with other governmental organizations.

8. Hellen Keller International

The presenter described a project that implemented nutrition sensitive agricultural interventions. The goal of Hellen Keller International is to combat the causes of blindness and malnutrition, addressing issues of vitamin A intake. In its interventions this NGO links the production of nutritious foods with nutrition education, training in food preparation, and the use of low cost inputs, to improve nutrition outcomes. The main challenges faced have been the local community habits. Increasing food production by itself will not result in improvement in nutrition outcomes when the local communities do not use vegetables for feeding children, and usually collect vegetables in the wild instead of buying or growing them. More understanding of where and how food is obtained and use is required to design effective interventions.

To promote its interventions Hellen Keller International promotes women group formation. Women are trained to grow nutritious foods year round, and to sale production surpluses to increase incomes. They also receive training in animal husbandry, particularly the management of small animals to provide sources of protein for women and young children.

9. Empowering women for nutrition-sensitive agricultural interventions

Mia Urbano, Department of Foreign Affairs and Trade (DFAT)

In South East Asia, there still remain high levels of gender inequality, and low nutritional status for women and children. Women farmers lack access to assets, and this limits the impacts of some agricultural and nutrition interventions.

What do we mean by women empowerment, is just a sexy word? Women empowerment has different components that can be used as a guide to determine what does this concept mean, how do we measure it and determine changes towards improving it. How to conduct gender related interventions with ethnic groups, and what is the sustainability and long lasting effects?

Women's empowering index includes a wide set of variables: Production (decision making), resources (ownership and control: assets, credit), income (sole of joint control), leadership (membership in organizations), time (time allocation among different activities).

Agricultural interventions can have some adverse impacts: Increase in women workload, impacts over pregnancy and diversion on infant feeding. Women will not pursue off farm earning activities (redistributions that will harm women).

Examples of nutrition-related studies in the pipeline

10. Farmer cluster groups, child nutrition and health

Pedro Alviola, Associate Professor, University of the Philippines Mindanao

Design of an impact evaluation of farming clusters on nutrition outcomes. Farming clusters are formed to take advantage of economies of scale in production and commercialization, to increase farmers bargaining power, and to reduce transaction costs. The main goal is to increase households' incomes by increasing prices of selling with the cluster instead of individually. The evaluation aims to compare incomes of participants and non-participants. It also aims to include nutritional outcomes. The idea is to test whether the increases in income result in increases in purchases of fruits, vegetables and meet, and therefore in diet improvements.

The proposed method for impact evaluation is propensity score matching, to control for selection bias on observable characteristics. The presentation triggered a discussion on whether this method will be the more suitable for the evaluation. Since the researcher will have the opportunity to collect his own data, and that there is the possibility of more clusters being formed in the future, the use of difference in difference or of experimental methods was suggested.

11. Assessing economic access, dietary composition and drivers of fruit and vegetable consumption in Vietnam

Christian Genova, Wendy Umberger and Suzie Newman, University of Adelaide

This PhD research proposal will look into the fruit and vegetable consumption patterns of ethnic minorities in two districts in Lao Cai province. Many of these ethnic minorities are resource-poor, which means that food costs make all the difference. While health professionals actively promote healthy and balanced diet, i.e. increasing fruit and vegetable consumption, most people in developing countries live below the poverty line (US$1.5/day) and do not meet the minimum recommended levels because they are more expensive compared to other foods.

Previous studies have shown how high and volatile prices reduce food accessibility of households in both urban and rural households in low-income countries; how a household's socioeconomic status affects diet cost and diet quality in both developed and developing countries (the poorer a household, the higher the share of food expenditure in their household budget, the lower their diet quality becomes); and how other factors like race/ethnicity, one's fruit and vegetable preferences and maternal fruit and vegetable intake consistently affect fruit and vegetable intake of low-income youths in several countries.

Vietnam has seen a significant improvement especially in reducing the number of people living below poverty and the share of undernourished between 1990 and 2012. The effects however vary by urban and rural areas, by region and by ethnicity. Many poor households can still be found in the northern highlands where most ethnic minorities are geographically concentrated. These households tend to have low fruit and vegetable intake (87g/capita/year) and high rates of malnutrition (stunting, underweight and wasting). While one study explains that these groups are poor due to "spatial poverty trap", other studies argue that the returns to education are simply lower as compared to ethnic majorities like the Kihn and the Chinese. They also resist any state interventions that aim to improve their livelihoods and cling to their traditional knowledge. Nevertheless, many of these rural households in the northern region grow vegetables for their home consumption. Therefore, research that examines why their fruit and vegetable intake is still very low compared to the minimum recommendation of 400g/capita/day is needed because it can identify whether the problem is due to physical access, economic access or other factors. For those with limited (or no) market access, this research can help understand the link between production, consumption and nutrition, and explain why there is high incidence of malnutrition if physical access is not a problem. From a policy perspective, this research can show how different socioeconomic groups especially these vulnerable groups are affected by changing supply and prices, and provide policy recommendations to promote development of an affordable diet in Vietnam looking at “alternative (indigenous)” vegetables that are culturally and socially acceptable for these ethnic minority groups.

This research will interview n=500 ethnic households in Sa Pa and Bac Ha districts in Lao Cai province using the following methodologies: 24-hour food recall for a 7-day food diary to understand their dietary composition and nutritional information; and the Health Belief Model to determine what influences these households to eat fruits and vegetables.

Facilitated discussion

Strategic approach based on reflections from all participants:

- Quantitative information: summary of the key measure/indicators
- On sampling approaches and sampling issues: since composition of food is seasonally driven, caution in drawing conclusions for one season only. Suggestion is to collect data multiple times in a year. It may be expensive in getting seasonal fluctuations in income and consumption (e.g. 2x per year or 4x per year or monthly), but useful to test variations. Also ensure robustness in collecting information by starting with qualitative methods to properly phrase the questions.
- On inclusion of certain essential variables like age, gender and ethnicity. Gender and nutritional outcomes should be properly incorporated in the design.
- On the use of existing data and methods: utilize Vietnam’s existing national data collected by World Vision, UNICEF and NIN, and prevent reinventing the wheel. Nevertheless, need to invest significantly in the first round of survey especially on module development. Methods for measuring nutrition are also well-established.
- On collaboration with other agencies: other agencies should collaborate and document existing related work on nutrition. Brainstorm with people willing to sacrifice time and experiences. Monitor information from different organizations.
- On collecting baseline information: collect all baseline regional data one time (all indicators) instead of piecemeal.
- Agreement on outcome indicators especially on consumption and diet diversity

9 Proposal development and consultation

The aim of this SRA was as a bridging project for the development of a multi-program Agribusiness (AGB) and Soil Management Crop Nutrition (SMCN) project looking at enhancing the profitability and sustainability of vegetable-based farming systems in NW Vietnam. The brief was to build on the outcomes and success of *AGB/2006/112 Increasing the safe production, promotion and utilisation of indigenous vegetables by women in Vietnam and Australia.*

In October 2012 – a project concept note was prepared for discussion with existing *AGB/2006/112* and prospective project partners. The intent was to build on the existing partnerships but to add to the Vietnamese team additional research skills in market analysis, economics, soils and postharvest research. In November 2012, individual consultations were undertaken with institute leaders and key researchers from the following institutions:

- The Vietnam Women's Union (VWU)
- The Vietnamese Academy of Agricultural Sciences (VAAS) including the Field Crops Research Institute (FCRI) and its research centre the Centre for Agrarian Systems Research and Development (CASRAD).
- The Fruit and Vegetable Research Institute (FAVRI)
- The National Institute of Medicinal Materials (NIMM)
- The Institute for of Policy and Strategy for Agricultural Rural Development (IPSARD) – Centre for Agricultural Policy (CAP)
- The Vietnam National University of Agriculture (VNUA)
- Plant Protection sub-Department, Lao Cai (PPsD, Lao Cai) and Plant Protection sub-Department, Phu Tho (PPsD, Phu Tho).

From these consultations, the core team of partners worked together to develop the phase 1 and 2 proposal documents, with scoping activities undertaken for the market analysis (see Section 6) and farming systems components (see Section 7)

On the Australian/International team additional skills were added in economics, consumer research and value chain analysis (University of Adelaide), farming systems and soil science (UQ), soil chemistry (consultant), plant pathology (NSW DPI), gender (DFAT), participatory action research (consultant) and FBS and upscaling (CIAT).

The phase 1 proposal successfully negotiated IHR in March 2013 and the phase 2 in January 2014. The summary from the phase 2 document is included below.

9.1 Project summary

9.1.1 Issue

The vegetable sector in NW Vietnam faces a number of challenges: rapidly transforming markets; poor competiveness relative to peri-urban and regional producers; heightened food safety demands; poor infrastructure, logistics; and environmental sustainability (nutrient depleted soils, erosion, water availability and quality). This region also encompasses some of the poorest provinces in Vietnam with Lao Cai having 40% of the population below the poverty line (GSO, 2010). Chronic malnutrition in these communities is also a problem with 1 in 3 children under five suffering from stunting (NIN, 2009). Ethnic minorities particularly H'mong, Tay, Nung and Thai dominate the highlands region and engaging with these communities to improve their livelihoods is a key focus area of the Government and more particularly the Vietnam Women's Union.

9.1.2 Opportunity

Enhancing the role that vegetables play in rice-based and temperate fruit farming systems provides an opportunity for smallholders to improve net household income by engaging with high-value local, provincial, urban and export markets. At present, there is limited engagement of these smallholders with markets outside their local district. However, to increase the productivity and sustainability of these farming systems needs integrated resource and disease management practices best suited to local conditions. Specific research issues to be addressed include management of soil and water constraints for optimizing nutrient availability to crops across different crop rotations (eg. rice-vegetables; temperate fruit-vegetables). Increasing household vegetable production and consumption may also address the nutritional food security issues that many of these local communities face. This project has been initiated following the recommendations of the final review of AGB/2006/112 which provided a strong case for a new phase of multi-disciplinary research.

9.1.3 Objectives and expected outputs

The overall aim of the project is to enhance the profitability and sustainability of smallholder vegetable farmers in north western Vietnam through improved market engagement and integrated resource and disease management practices. The project will particularly focus on women and ethnic minorities engaged in horticultural value chains in Sa Pa and Bac Ha in Lao Cai province.

1. To identify market opportunities and consumer preferences for indigenous and conventional vegetables in local, provincial, urban and export markets;

2. To develop and promote competitive and efficient marketing models that deliver high quality safe vegetables, meet consumer demand and benefit smallholders (particularly women and ethnic minorities);

3. To develop and demonstrate whole-farm management practices that improve sustainability, productivity and household livelihoods in (i) rice-vegetable, (ii) temperate fruit-vegetable and (iii) vegetable-only systems

4. To develop sustainable models for up-scaling the Farmer Business School (particularly targeting women small holders) and building researcher capacity in research, development and extension.

The project will deliver a comprehensive market analysis for indigenous and conventional vegetables enabling opportunities for smallholders to be readily identified. Value chain and postharvest interventions will be tested across four marketing models. Baseline data will be collected for the three farming systems (rice-vegetable; temperate fruit-vegetable and vegetable-only) including: socioeconomic characteristics (including household consumption); crop production and agronomy (including yield); soil characteristics (physical and chemical); water (availability and quality); nutrient balance; soil-borne disease severity and sustainability indicators for soil and nutrients (risk assessment). A modelling approach will be used to develop and optimise soil, water and nutrient management for each of these systems. Likewise recommendations for effective management of soil-borne diseases will be developed. A full socio-economic analysis will also be undertaken, that will explore the influences of and links between household income, vegetable production, market engagement and home consumption.

9.1.4 Expected impacts and implementation

One of the major opportunities for NW producers is meeting untapped market demand driven by rapid urbanisation. Market demand for vegetables in NW Vietnam is estimated at 648 000 tonnes or VND 5.2 trillion (USD 241 million). At present Lao Cai farmers supply <1% of this market. Were this to increase to 3%, that would equate to USD 7.2 million or USD 718 per farming household.

In Lao Cai province, both provincial and district government policy is designed to increase the level of year round vegetable production. To achieve this most farmers who are looking to make this change are transitioning from a rice-vegetable to vegetable-only system. Data generated in this project will enable farmers to implement this more effectively and to gain an understanding of the economic benefits realised by the two systems. With 2662 ha of single-rice crop and 1350 ha currently under vegetable production in Sa Pa there is scope to substantially increase the land devoted to vegetable-only production. Increasing production (through increased land area) by 30% would equate to an additional 8200 tonnes (USD 3.1 million) for Sa Pa alone.

Potential social impacts include: 1) reduced need to supplement farm income with other income thereby enabling families to stay together in their local community; 2) increased consumption of vegetables leading to improved nutrition (reduced stunting in children); and 3) improved social cohesion of ethnic minorities in their communities.

Women play a key role in horticulture production and marketing. Earlier research in AGB/2006/112 clearly demonstrated that women are involved in the decision making in all aspects of day-to-day farming life (Fresh Studio, 2009) with 62-93% of women being primarily responsible for marketing and selling produce (depending on commune). This project is likely to have substantial benefits for women in these communities.

The project builds on partnerships established during AGB/2006/112, adding skills in soil science, postharvest and market research. The project will be led by the University of Adelaide (UoA) and the Vietnam Women's Union (VWU). Project partners will include: Soil and Fertiliser Research Institute (SFRI); Fruit and Vegetable Research Institute (FAVRI); National Institute of Medicinal Materials (NIMM); Center for Agricultural Policy (CAP)/Institute of Policy and Strategy for Agricultural and Rural Development (IPSARD); Hanoi Agricultural University (HUA); Plant Protection sub-Department, Lao Cai (PPsD, Lao Cai); and University of Queensland (UoQ).

The project commenced with an inception meeting in February 2014 where the Australian Minister for Foreign Affairs together with the President of the Vietnam Women's Union officially launched the project.

10 Australian component

For the phase 1 design, we put together a cross-project initiative designed to improve the food safety of leafy vegetables through the development of rapid low-cost field tests and improved management of on-farm microbiological risks. The broad concept is detailed below for the sake of completeness. However at phase 2 the Australian component was removed from the project to enable other components (particularly soil management and crop nutrition) to access the funding they needed.

Partners

New South Wales Department of Primary Industries (NSW DPI), University of Newcastle – Organic Electronics Centre and New South Wales Food Authority.

Scope

In 2009-10 the gross value of vegetable production in NSW was $375.2 million. Food safety is of increasing concern to NSW consumers, particularly given the increasing rate of foodborne illnesses attributed to fresh produce overseas. Recent high profile cases include an E. coli 0104:H7 outbreak in Germany where Spanish cucumbers were initially blamed as the cause but subsequent investigation found that the true cause was locally-produced fenugreek seed sprouts from a single farm grown from seeds imported from Egypt. These outbreaks are not only detrimental to public health but are often difficult to trace leading to costly false associations and ultimately a decline in consumer confidence in making fresh produce purchases. The University of Florida has costed foodborne illness from produce in the USA at $1.4 billion annually (the 4th highest).

To maintain consumer confidence in NSW fresh produce a proactive approach is warranted. Enhancing the food safety of fresh food supply chains is an industry priority. Fresh cut vegetables and seed sprouts have been identified as some of the most high risk products and businesses processing such product are regulated in NSW. But hazards also exist on-farm presenting food safety risks such as management of on-site systems of sewage management (OSSM) in some peri-urban situations and incorrect use of fertilisers.

As part of the ACIAR project *AGB/2012/030 Towards more profitable and sustainable vegetable-based farming systems in north-western Vietnam and Australia* we are looking to scope a new program addressing food safety issues associated with vegetables in NSW. This will complement other initiatives being undertaken for the NSW melon industry.

The program will have several components ranging from blue sky research (organic electronics) through to practical on-farm research. The program will look to work in 3 main areas:

1. Developing techniques for rapid detection of microbiological food contaminants

Organic electronics based on polymer semi-conductors provides an extremely low cost means of amplifying chemical signals. Physically this technology exists as electronic circuits printed on plain paper. Recent applications have been the development of a glucose sensor to monitor blood glucose levels. This component will explore the potential to utilise this technology to test for food pathogens such as *Escherichia coli* or *Listeria monocytogenes*. The first phase of this work (2 years) will involve the development of a prototype sensor. This phase will look at identifying what we can detect (eg. what metabolite or similar is the pathogen generating that is specific to that pathogen) and then developing the detection mechanism. The outcome would be a prototype sensor. The next phase of the work would then be lab trials comparing the detection ability of the prototype sensor with existing tests. If these were successful the next phase will be large scale field trialling. The fresh food value chain in SE Asia would provide a robust testing ground for this food safety innovation.

2. Improving disinfestation techniques and postharvest handling practices for fresh produce to minimise the risk of foodborne illnesses

Postharvest washes and some storage methods (eg. modified atmosphere) can contaminate or enhance the survival of food pathogens. This component will look to build on earlier DPI Victoria work looking at evaluating the extent of this risk in current farming systems, improving disinfestation techniques and developing appropriate postharvest management strategies to minimise the risk posed by these pathogens.

3. Reducing microbiological contamination through improved on-farm practices.

This component will look to evaluate the risk peri-urban farm practices play in potential food microbiological contamination. A number of risks exist including the use of poorly composted materials and contamination of water or soil by leakage from on-site systems of sewage management (OSSM). This component will look to evaluate the risk and then develop improved on-farm practices designed to minimise the risk. Development of effective extension packages will be a key component of this work.

Supplementary research to underpin soils and disease component for new project

10.1 Improving on-farm practices for high quality Asian vegetables

Report submitted by Sophie Parks, and Len Tesoriero, NSW Department of Primary Industries, Ourimbah and Paul Milham

The objective of this research is to improve production of leafy vegetables to ensure a high quality product (ie minimise nitrate accumulation) and to reduce root rots in production, increasing profitability. This work was carried out at the Central Coast Primary Industries Centre, Ourimbah.

We examined nitrate and reduced N in shoots of three of the leafy vegetables: pakchoi [*Brassica rapa* L.ssp Chinensis (L.) var. Sumo], amaranth (*Amaranthus tricolor* L.), and coriander (*Coriandrum sativum* L.) in response to nitrate concentration of the hydroponic solution. For these three vegetables, the positive linear relationship between shoot nitrate and shoot water suggests that nitrate is being used in osmotic adjustment. It is possible to investigate the physiological responses of plants to osmotic potential, independent of salt concentration, using high concentrations of polyethylene glycol (PEG) in the hydroponic solution. However at these concentrations, PEG may affect the properties of the salt solutions commonly used in hydroponics. The impact of PEG on the activity of nitrate and calcium ions in solution and on the volume of the solution is currently under investigation. This work will allow hydroponic experiments to be designed to examine the role of plant nitrate in osmotic adjustment. This trial will be completed by August 2015.

For the work on root rots, the disease expression of *Pythium* isolates in individual plants was planned at Ourimbah using standard techniques. The relationship between infection and elements of the production system, including oxygenation of the nutrient solution was to be examined as part of a student project but the student has not commenced, delaying this work. However, progress has been made on the development of a biological assay to determine the virulence and host range of important wilt disease strains of the fungus *Fusarium oxysporum*. The assay has confirmed pathogenicity of Fusarium oxysporum isolates on rock melons. After application of ammonium fertiliser, known to exacerbate the disease response, the disease expression was elevated in severity.

11 Conclusions and recommendations

11.1 Conclusions

AGB/2012/030 has enabled a comprehensive scoping study to be undertaken to develop *AGB/2012/059 Towards more profitable and sustainable vegetable farming systems.* Key elements of this have included:

- The design, development and approval of phase 1 and phase 2 documentation and the finalisation of the project design in January 2014. Whilst this SRA covered the full design of AGB/2012/059 additional resources were provided for the scoping of objective 1 (Market Analysis) and objective 3 (Farming Systems).
- Development and design of the market analysis component including a review of a review of the informational needs of supply and demand side data for conventional and indigenous vegetables, the design and pre-testing of a semi-structured questionnaire for wholesalers and retailers.
- Prioritisation of the key issues facing rice-vegetable, temperate fruit-vegetable and vegetable-only farming systems. Given that most of the soils are acidic to strongly acidic, the yields of brassica crops may respond generally to liming amendments, and site-specific responses may occur to particular nutrients, singly or in combination, including: P, K, Ca, Mg, Mo and B. When vegetable crops follow rice, the concentrations of available Fe and Mn will initially be high, perhaps toxic in the case of Mn, and will decline as the soils become aerobic and that decline will continue over weeks as the duration of aeration extends. The behaviour of P and Mo will be in mirror image to that of Fe and Mn, i.e. P and Mo may rapidly become deficient as the system becomes aerobic and gradually become more available. Raising the soil pH to address acid constraints may induce deficiencies of Fe, Mn, Cu, Zn and B. In contrast, raising the pH increases the rate at which soil properties adjust to aeration after flooding. These potential indirect benefits of liming on the thrift of vegetable seedlings may be considerable. Lastly, potential production constraints need to be managed in the context of increasing the dietary intakes of Ca, K, Fe and possibly Zn, and decreasing that of Cd.
- To identify the production constraints the project will expand the survey of the nutrient and toxic element status of soils and crops, and investigate the occurrence of hard pans in soils during 2014 to augment the data already collected as baseline data for the Project. The survey locations will represent all three farming systems, i.e. rice-vegetable, temperate fruit-vegetable and vegetable-vegetable at both Sa Pa and Bac Ha. At each site, a minimum of three soil samples will be taken and plants will be sampled on two occasions. The samples will be analysed at the SFRI laboratories in Hanoi. To facilitate data interpretation, only the one indicator plant species, probably cabbage, will be sampled across all the farms surveyed in both districts, so far as is possible. Samples will be analysed for their element composition: total-N and nitrate N, P, K, Ca, Mg, Mn, Fe, Cu and Zn, and if possible for B, Mo, Ni, Cd, As, Se and Co. Nutrient values for the indicator crop, or a closely related species, will be compared with published ‘sufficiency’ values. The samples will be archived to allow the possibility of reanalysis or analysis for additional components. The sampling sites will be geographically located and the resulting leads will inform decisions including: the nutrients on which attention should be focussed and potential sites for field trials.
- The *Nutrition sensitive agriculture workshop* provided a forum to bring academics and development practitioners together to review the current state of play and develop and critique some research concepts. One of these was the PhD proposal developed by Christian Genova (University of Adelaide) that was subsequently incorporated in the project AGB-2012-059.

11.2 Recommendations

The scoping study and recommendations have been incorporated into the design of AGB-2012-059. The bridging project AGB-2012-030 has provided the funds and resources to enable a full consultation process with Vietnamese project partners and enabled some scoping activities to be undertaken to improve the design of the phase 1 and phase 2 proposals. Similar initiatives should be considered by ACIAR to enable projects to develop sound and robust project documents.

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13 Appendixes

13.1 Appendix 1: Hanoi market survey check-list

- Opportunities for developing supply of vegetables and indigenous vegetables from smallholder producers in NW Vietnam
- Opportunities to link retailers and wholesalers to these suppliers and assist retailers with developing their market
- Identify project partners from the private sector who are interested in working with the project.

1. Size and value of Hanoi market for 6 conventional vegetables – current and future – in winter

Ranking

Vegetable	Rank of Importance	Peak Selling Months	Change in volume from 3 years ago (increase/Decrease) %	Current Price Range per Unit	

Vegetables (Oct-Dec), current volume, price range per unit, seasonality (months)

What are they currently selling? What is it priced at? How do we expect it to change (3 years)?

How has demand for this changed in your store changed in the last 3 years?

2. **Gain insight on the different and potential market segments for conventional and indigenous selected vegetables**

Are there any quality issues (6 vegetables) related to vegetables that you would like to see producers address? Why? Eg. consumers are concerned shelf-life, variety, eating quality, appearance, safety,

Who do you currently buy from? How many do you buy from? What determines who you buy from? Where do you source your vegetables from? How long have you sourced from them?

Retailers' and wholesalers' perspective of consumer demands and how this may be changing, including products, product quality attributes, willingness-to-pay, consumer characteristics

3. **Could you promote your business on the basis of sourcing indigenous produce and helping indigenous farmers or farmers from a specific region?**
   - Why or why not?
   - What types of products or region do you think would have the most potential? Why?
   - What do you think would be the key issues in developing the supply chain for these products?

4. **Are your customers interested in indigenous vegetables? Why or why not?**
   - If yes, what products do you think they would be interested in? Why or why not?

5. **How could we increase consumers' interest / demand for indigenous vegetables or vegetables from a specific region?**