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project

Increasing the safe production, promotion and utilisation of indigenous vegetables by women in Vietnam and Australia

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1 Acknowledgments

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2 Executive summary

Indigenous vegetables (IVs) provide smallholders, particularly women with the opportunity to engage in high-value urban markets. Consumer demand for these vegetables is increasing, as IV's are perceived as novel, safe and nutritious with substantial health benefits. Likewise provincial and local markets are also expanding through increased tourism enabling these smallholders to also capitalise on higher demand in their own regions. To exploit this commercial potential, farmers need to be able deliver a quality product to market.

The aim of this project was to develop and test models that improve the profitability of women farmers supplying indigenous vegetables into transforming markets. The project also sought to develop effective communication strategies for women farmers that encourage practice-change, in both the production and marketing of their crop.

The role of women in agriculture, and how their livelihoods are influenced by agriculture; the role of traditional knowledge and products and how this interacts with rapidly transforming markets; and consumer and government requirements and responses for food safety are key issues in international development and are of strategic concern in Vietnam.

The project was a partnership led by the Vietnam Women's Union (VWU) and NSW Department of Primary Industries (NSW DPI). The Vietnamese Academy of Agricultural Science (VAAS), the National Institute of Medicinal Materials (NIMM); Field Crops Research Institute (FCRI) including CASRAD and Phu Tho and Lao Cai Plant Protection sub-Departments partnered in the project. Fresh Studio was also engaged as a consultant to the project.

In mid-2009, the project was redesigned, reshaping it as a research for development style project. The objectives of the redesigned project were to:

- Develop models that enable a competitive market position for smallholder women farmers in a transforming market.
- Gain a greater understanding of consumer benefits from indigenous vegetables
- Improve on-farm and through chain management to deliver safe quality products into a transforming market
- Develop communication strategies that facilitate practice-change in women smallholders

Following the project re-design, a series of scoping activities were undertaken including:

- Developing an initial list of 22 potential indigenous vegetables (11 in each of Phu Tho and Lao Cai) for further consideration
- Undertaking a needs analysis of women farmers (176 interviews) in the six communes the project operates in
- Documenting indigenous knowledge about the production of these vegetables
- Evaluating the market potential of the selected vegetables
- Determining the production constraints to producing these vegetables in a semi-commercial way

In November 2009, a *Revitalisation Workshop* was held where the results from the scoping study were presented and discussed, and the direction for the next phase of the project determined. At the workshop a list of 6 vegetables (3 from each province) were selected and agreed upon for the project to focus on. The vegetables selected were cai meo (*Brassica juncea*), bap cai xoe (*Brassica oleracea*), khoi tu (*Lycium chinense*), khoai

tang (*Colocasia esculenta*), bo khai (*Erythropala scandens*) and a local bittermelon (*Momordica charantia*), providing a good cross-section of vegetables types (fruit, root and leafy). A workshop proceedings was produced documenting the research, stakeholder engagement and the decision making process.

Project research and extension activities have centred on 3 key areas:

1. Value Chain Analysis (VCA) and developing appropriate market interventions

Following two VCA studies – the first looking at the market potential of indigenous vegetables and the second specifically looking at the 6 selected vegetables – a stakeholder workshop was held in Sa Pa, Lao Cai in August 2010 to consider *How do we bring about change in the marketing and production of indigenous vegetables*? The workshop attracted 63 participants including government officials, farmers, collectors, wholesalers, retailers and representatives from consumer groups. Through a series of facilitated activities, participants were asked to identify the priority production and marketing issues and put forward ideas for the types of marketing interventions that should be looked at. Priorities identified by stakeholders were then used to set the research direction for the remainder of the project. Key activities for the marketing team have centred around: 1) understanding consumer preferences; 2) developing local and regional marketing opportunities and 3) developing a *Farmer Marketing Group*. Examples of activities have included: 1) sensory evaluation of cai meo and khoai tang to identify consumer preferences; 2) an Indigenous Vegetable Restaurant Challenge – where restaurants competed in a cook-off designed to showcase the 3 indigenous vegetables from Lao Cai and 3) the formation of a *Farmer Marketing Group* in Na Hoi commune, Bac Ha.

2. Developing 'best-bet' management practices for the production of the 6 selected indigenous vegetables

Nearly 40 research or demonstration trials have been undertaken to address key constraints in the production of indigenous vegetables including propagation, nutrition, plant density, crop management and postharvest handling. Recommendations from these trials have not only assisted farmers as they transition towards semi-commercial production of indigenous vegetables but are also feeding into the development of the production modules for the *Farmer Business School* (*FBS*).

The Australian component has looked at the potential of emerging Asian vegetables (including bitter melon, gogi and gac) and, together with a Horticulture Australia project, has looked at managing nitrate accumulation in Asian vegetables.

3. Developing a Farmer Business School (FBS)

The 'hub' of our research for development activities is the *Farmer Business School* (*FBS*) that covers both business and production aspects of indigenous vegetable production. The *Indigenous Vegetables FBS* is modulised and flexible enabling trainers to utilise the resource as they see best. The resource library for each module includes a: 1) Trainers Guide - Theory; 2) Trainers Guide – Practical (step-by-step instructions on how to undertake the training and in some cases 3) a farmer resource. In total 15 manuals were produced and a DVD set on *Value chains – Why I should work with others?* The IV *Farmer Business School* (*FBS*) was then piloted in 6 communes in Phu Tho and Lao Cai.

3 Background

The role of women in agriculture, and how their livelihoods are influenced by agriculture; the role of traditional knowledge and products and how this interacts with rapidly transforming markets; and consumer and government requirements and responses for food safety are key issues in international development and are of strategic concern in Vietnam. Although a number of development programs in Vietnam have a focus on women in agriculture, very few, if any, incorporate the use of traditional knowledge and products. It is noted that FAO are currently undertaking a scoping study throughout Vietnam on the use of traditional knowledge and products, however this is broad ranging and includes handicraft and tourism as well as agriculture. It is unlikely that this would identify areas of research for development. Of increasing importance within Vietnam is the development of higher standards of food safety systems. Although significant effort is being placed on implementing Good Agricultural Practice (GAP) systems, whether it is GlobalGAP, VietGAP or 'GAPlight', there is still a requirement to underpin these, and other, systems, to deliver sound and appropriate food safety systems for Vietnamese consumers.

This focus on indigenous vegetables with appropriate food safety systems will play a part in the Vietnamese government and the Vietnamese Women's Union need to enhance the status, education and participation of women in the workforce as a key to poverty alleviation in Rural and Ethnic minority communities (Vietnam National Action Plan 1997).

The Vietnam Country Gender Report highlighted the need for greater recognition of the increasingly important role of Women in the agricultural sector and the need to develop creative solutions to support women farmers more proactively. In Vietnam women's labour in contributing to the majority of the family income in the agricultural sector. This project is addressing the productivity of this labour with the purpose of increasing the income for rural families.

This project brings a focus to the key global issues of, women in agriculture, traditional products and food safety, in the Vietnamese context and will enable improved market engagement of women farmers in the North West of Vietnam, through improved food safety systems that delivers indigenous vegetable products to purchasing consumers.

The project is also likely to provide further insight into the engagement of ethnic minorities into these transforming agricultural systems, as many of the women farmers are part of an ethnic minority.

Women farmers, particularly those in ethnic minority groups of the north west highlands of Vietnam are the key beneficiaries of the project, with likely livelihood impacts, however Vietnamese consumers are also a key benefactor with improved food safety systems and availability of traditional products, many with traditional health benefits.

Global demand for horticultural products is rising and, although, the supply of fruits and vegetables has increased continually, there remains a shortfall in supply (Weinberger and Lumpkin 2006). Despite the extensive amount of intensive agriculture in the peri-urban districts around Hanoi, it is only meeting approximately 10% of the demands for fruits and vegetables by the residents of Hanoi (AVRDC 2004). This short fall in supply has meant production centres have been established at greater distance to the Hanoi market, such as in Hoa Binh, Phu Tho and Lao Cai. These centres supply both the Hanoi market (although there are logistical constraints in getting quality product to market) and more recently recognising the value in supply provincial markets closer to production areas. These production centres focus on introduced vegetables, such as tomatoes, cabbage and beans, but they are also developing capacity in traditional products such as chayote.

Average per capita daily consumption of vegetables is 275g in northern Vietnam and 244g in the south (Ali et al. 2005), which is below recommended level of 400g per day (Weinberger and Lumpkin 2006). A recent study (Fresh Studio, 2009) found that school canteens served only 8g of vegetables per day to students. As such, there is scope to increase vegetable consumption in Vietnam, with likely health and nutritional benefits.

With Vietnam's rich biodiversity of indigenous crop plants consumed as vegetables, spices and herbs there is opportunity to 'value-add' to increase vegetable consumption by including indigenous products in improved diets. Consumers will benefit and those suppliers of indigenous vegetables will also benefit, in this case the supply base in development is women farmers in Phu Tho and Lao Cai. Many of these indigenous vegetables are rich in micronutrients and vitamins, others may have health benefits, and therefore increased consumption could benefit public health.

There is limited supply of indigenous vegetables into modern marketing channels. The majority of existing supply is collected from forests and traded locally. As the product is 'collected' from the forest it is considered 'natural' with consumers' believing it is 'safe' as there has not been the use of chemicals in production. As this project supports the development of more intensive cultivation of indigenous vegetables, with the potential to use more modern farming practices, which may include chemicals, it is likely that there will be a negative consumer reaction to the increased safety risk. This increased consumer concern needs to be managed in two ways, firstly to underpin the safety of the supply chain by developing appropriate systems that deliver recognized 'safe' products into a more profitable market and to develop brand management strategies to appropriately engage the consumer. Recent work (Fresh Studio, 2009) would suggest that a brand management strategy focused on 'Vietnamese Grown' and an insight into the people and relationships throughout the supply chain (and how it got to the consumer) would be an appropriate strategy to evaluate.

Clearly there are a number of research for development issues that are addressed within this project. These include:

1. Developing systems that deliver safe quality products, by having both on-farm and through chains systems that create and maintain safety products
2. Is there livelihood benefits in increasing the role for women in more geographically isolated areas to supply indigenous products into higher value markets?
3. How do women farmers and those from ethnic minorities engage in rapidly transforming market and how can this be developed into more profitable and sustainable engagement?
4. What are the market drivers that will increase the long term supply of indigenous vegetables into profitable markets and how can smallholder women farmers deliver on these market drivers?

The project was requested by the VWU with the support of the Vice President of Vietnam who was also the President of the Vietnam Women's Union, during her visit to ACIAR in November 2006.

The project will continue to have a strong Australian component, looking at developing the potential of new Asian vegetables for the wider Australian market. The Asian vegetable industry in Australia is expanding rapidly with an estimated value in 2003 of $136 million, with half the industry located in NSW (Hassall and Associates, 2003). Bitter melon is one of the emerging crops, with production in the Northern Territory increasing from 138 tonnes in 1994, to 1610 tonnes in 2005. Average returns to growers have also increased during this period with bitter melon currently returning $2.50/kg (Lee, 2007). Much of the Northern Territory production is exported to the southern states (41%) and so there is the potential for protected cropping to provide NSW producers entry into this lucrative early

market. This project will look at developing protected cropping systems for bitter melon to and evaluate the performance and market potential of bitter melon varieties.

Food safety is also a key theme of the Australian component. Nitrate accumulation in Asian vegetables is relatively high compared to other vegetables (Parks *et al.*, 2008). Whilst there are no direct links between vegetable derived nitrates and health concerns, high nitrates are considered undesirable with the European Community imposing maximum limits for some vegetables (Santarmaria, 2006). In conjunction with a HAL funded project VG07153 'Nutrient management of Asian vegetables', this project will look to develop critical nitrate concentrations for optimum growth in some Asian vegetables that can be used in practice to prevent nitrate accumulation,

This complements NSW DPI's current R&D portfolio in greenhouse horticulture, food safety and market access. The project addresses several of the key strategies in the *NSW DPI Corporate Plan 2008-2011* including:

- Develop innovative technologies and production systems and drive their adoption
- Develop and facilitate adoption of scientific solutions and better management practices for pests, diseases, weeds and chemical contamination
- Establish and strengthen strategic research and industry alliances to deliver productive, sustainable and cost effective technologies.

The emphasis on peri-urban farmers also fits with NSW DPI's role in the retention of agriculture in the Sydney Basin.

Lessons gained from the Vietnamese component also have implications for the Vietnamese farming community in the Sydney Basin, improved market chain systems for Asian vegetables and in the development of improved communication outcomes.

This project, *Enhancing the role and income of women in the safe production, utilisation and market development of indigenous Vietnamese vegetables* (AGB/2006/112) forms a key part of *Developing market opportunities for communities in the northern and north-western highlands of Vietnam,* which is Subprogram 5 of ACIAR's Annual Operational Plan, as it develops and supports women farmers in the north western highlands of Vietnam engaging with more profitable markets with indigenous products likely to provide livelihood benefits.

The research for development strategy is based upon the utilization and development of Farmer Field Schools (FFS), but seeks to build and expand this model into what could be described as a 'Farmer Business School' (FBS). Historically, FFS are based on improved on-farm management with farmers engaged in a participatory manner, primarily meaning they are part of the decision making process. This on-farm focus is beneficial, but in neglects critical aspects of livelihoods improvement with limited connectivity to market and an inability to resolve constraints that limit this market connection. As such, the strategy for this project is to transform the FFS model into a FBS by incorporating aspects and activities that relate to better market engagement and a through chain participatory approach to solving constraints that limit the flow of product and information through the supply chain.

To achieve this, 'pieces' of the FBS firstly need to be built. Therefore the initial stages of the project will gain a much greater insight and conduct suitable analysis of:

1. Market and consumer analysis of indigenous vegetables
2. Needs/Wants assessment of women farmers
3. An understanding of traditional knowledge and practices
4. 'Best bet' management practices for improved cultivation
5. Lessons learnt from the process of FFS and how this could be used for the development of FBS

Following the development of the pieces (initial 6 – 12 months of the project) the FBS models will be tested and developed in 3 communes in each of Phu Tho and Lao Cai provinces (therefore in 6 locations in total) with a focus on 4 – 10 vegetables in total. The final 6 months of the project will be developing FBS models that are suitable for women farmers producing indigenous vegetables that can be used by NGOs (e.g. ADDA who already have a strong FFS focus), international donor agencies (e.g. DANIDA in their highland project) and government agencies (e.g. PPsD in the delivery of their FFS based training and FCRI in their extension training throughout Vietnam).

Currently very little is known about the cultivation of indigenous vegetables, how they will be integrated into a transforming market, what will drive consumers to purchase and if this will have any benefit on the livelihoods of women farmers involved in supply of these indigenous vegetables.

Although there is little known about these issues, the project has put in place a participatory approach to gain the knowledge, from a technical, social and economic perspective that will provide underpinning knowledge to be used in future development activities, which are outside the scope of ACIAR's mandate.

However, some background information is known as a result of a scoping study to review the role of women and assess constraints in the production of indigenous Vietnamese vegetables (CP/2006/113). One result of this study was a list of potential indigenous vegetables. This will have to be re-developed in the re-designed project.

It is also likely that information gained in projects such as *Diseases of crops in the central provinces; diagnosis, extension and control* (CP/2002/115) will be beneficial in technical aspects of indigenous vegetable production but also in areas such as improved extension methodology which could be included in the development of FBS.

This re-designed project will also be required to link to ACIAR programmatic intent in the North West Highlands of Vietnam. The first project in the North West program is *Improved market engagement for sustainable upland production systems in the North West Highlands of Vietnam* (AGB/2008/002). AGB/2008/002 focuses on maize and temperate fruit based systems, with activities in Son La and Lai Chau. It takes a market driven approach to resolving natural resource constraints in the 2 identified systems and underpins this with enabling improved practice change at the small holder level. The strategic link between the 2 projects will be in mechanisms to support practice change at the smallholder level, with the involvement of ethnic minorities. At an activity level the linkage between the 2 projects will be developed in 2 ways: people, and methodology. Firstly people. At an executive level, VAAS is an important partner in both projects. But within the structure of VAAS, CASRAD will play an important role in market analysis and improving mechanisms for smallholders to engage with the market and therefore provides an important linkage. The methodologies developed to engage smallholder (women, men, ethnic minorities etc) and support more sustainable and profitable practice change will be able to be shared across projects and this will be the prime responsibility of the project leaders. It will be important to share experiences through shared activities (e.g. joint project partner workshops).

The partnership of the national Vietnamese Women's Union (VWU) and the collaborative linkage to commune based Women's Union representatives is the primary mechanism for promoting adoption of project outputs and overcoming any identified constraints. At the consumer end, the VWU will use its well development communication and promotional expertise to pursue the market strategy developed within the project to promote the use and indigenous vegetables. This is likely to focus on other members of the Union – women consumers as a target demographic. At the supply end, the commune based teams, which include commune Women's Union representative, Vice Chairman of People's Committee, Extension worker and Representative of women farmers, will be the primary mechanism to promote the use of project outputs. This will be a useful mechanism as it will have technical (extension worker), social (woman farmer), political

(People's Committee) and advocacy (Women's Union) to enable many of the constraints to be overcome.

The focus on the transition from FFS to FBS with the required knowledge and testing of approaches balances the linkage between research and extension. The approach incorporates a known approach, such as FFS which partners such as PPsD who are very familiar with, development of new agricultural knowledge, with agencies such as FCRI who are familiar with, and incorporates new approach such as being market orientated, which CASRAD have a significant amount of experience with. It also uses a non-research agency, the VWU, to promote the adoption of results to members of the union, rather than those generally involved in smallholder agriculture in Vietnam.

As mentioned, this project follows on from a scoping study to review the role of women and assess constraints in the production of indigenous Vietnamese vegetables (CP/2006/113). It will also utilise findings and experience developed in Diseases of crops in the central provinces; diagnosis, extension and control (CP/2002/115).

This project will also draw on information and experiences from related ACIAR projects dealing with vegetables in Vietnam, such as 'Targeting crop protection research and development (R & D) towards social change amongst ethnic minority communities in Central Vietnam' (CP/2006/084). The extension of 'Improving postharvest quality of temperate fruits in Vietnam and Australia' (AGB/2002/086), includes the study of the learning needs of the ethnic minority groups in the same region this project is operating.

The findings of a scoping study to identify agricultural R&D needs and opportunities of rural upland communities in north-western Vietnam (CP/2007/123) will provide useful insights for expansion of this project into NW uplands, as it will characterize the agricultural systems of NW uplands communities, (principally ethnic minority), identify collaborative institutions and individuals and build R&D capacity of individuals within the farming communities.

The project will build on information and experiences of scientists in the previous AusAid CARD/ NSW DPI project 004/04 VIE 'Improving the safety and quality of Vietnamese vegetables', by utilising relevant findings in the project and expanding their use to other vegetable crops.

The AusAID CARD 021/06VIE "Reducing pesticide residues, improving yield, quality and marketing of Cucurbit and Brassica vegetable crops in northern central Vietnam through improved varieties, GAP principles and farmer focused training" and AusAID CARD 025/06VIE "Improvement of Vietnamese vegetable production using GAP principles for seed and seedling production and superior hybrid varieties" projects are looking at improving vegetable production using GAP, and identifying existing supply chains and recognising opportunities to connect with and expand these chains. Both of these projects although working on common rather than indigenous vegetables will be able to provide insights into marketing and GAP principles that will be applicable to vegetables within this project. These projects have developed a marketing pathway directly with the Metro supermarket chain that could provide a platform for indigenous vegetable marketing through Metro.

The CIRAD-MALICA project will have direct benefit to this project by providing insights into consumer's access to and choices in supermarkets, with CASRAD provided the institutional linkage.

Staff trained in participatory extension under the farmer field school model in the FAO National Vegetable Integrated Pest Management program in Vietnam will be employed to train the trainers and farmers in participatory techniques, which will be incorporated into the FBS model.

4 Objectives

The aim of the project is to develop and test models that improve the profitability of women farmers supplying indigenous vegetables into transforming markets. The project will also develop effective communication strategies for women farmers that encourage practice-change, in both the production and marketing of their crop.

The objectives of the project are to:

1. Develop models that enable a competitive market position for smallholder women farmers in a transforming market.
    1.1. Broad rapid market appraisal to develop a market driven priority list, with reasoning for selection
    1.2. In depth analysis of market requirements of identified priorities
    1.3. Analysis of supply chain constraints that prevent the delivery of indigenous vegetables into profitable markets
    1.4. Develop whole-chain marketing strategies (including brand development) that enable the development of a competitive position
2. Gain a greater understanding of consumer benefits from indigenous vegetables
    2.1. From rapid market appraisal, extract understanding of health drivers of consumer preferences
    2.2. Identify linkage between consumer preference and product attribute
    2.3. Analyse product attributes that deliver consumer preference
    2.4. Understanding other strategies to deliver consumer benefit (e.g. value adding, processing)
3. Improve on-farm and through chain management to deliver safe, quality products into a transforming market
    3.1. Identify and test ‘best bet’ on farm management practices to produce market identified indigenous vegetable
    3.2. Develop strategies that improve safe product at the on-farm level
    3.3. Identify and test improved through chain management to maintain quality and food safety
    3.4. Identify and develop emerging Asian vegetables for the wider Australian market
4. Develop communication strategies that facilitate practice-change in women smallholders
    4.1. Benchmark current information and communication sources
    4.2. Identify and test novel and improved communication approaches
    4.3. Publish case study improvements

5 Methodology

5.1 Project framework

Figure 5.1 depicts the phases of the project cycle. The project was redesigned in August 2009 with subsequent scoping studies being undertaken August-October 2009. The results from the scoping study together with the *Revitalisation Workshop* held in November 2009 then set the direction for the remainder of the project. The methodology is described in the following sections using this framework as the scaffolding.

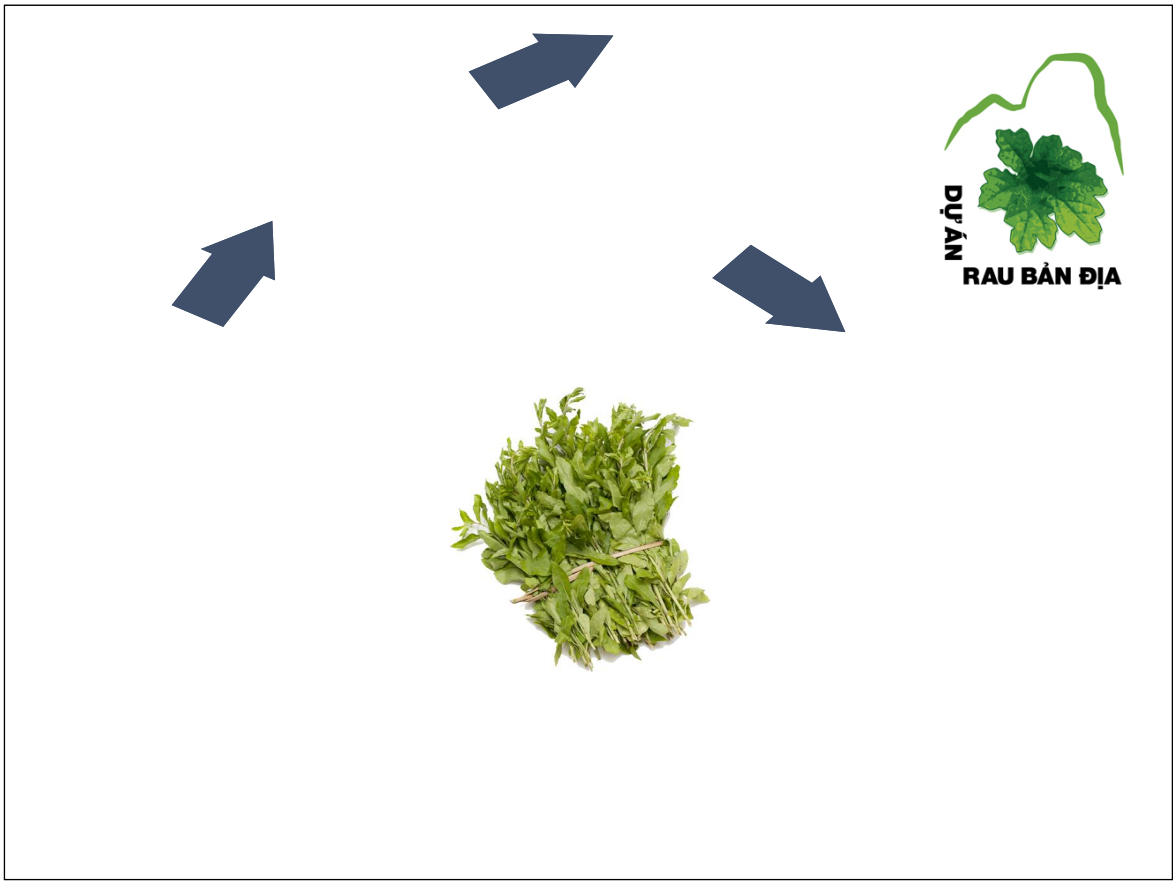


Figure 5.1 Project framework

5.1.1 Provincial focus and commune selection

The earlier phase of AGB/2006/112 (April 2008-May 2009) had focussed exclusively on Phu Tho province and it was decided following the project re-design (May-June, 2009) that in order to facilitate a smooth transition that the project would continue to operate in the 3 communes previously identified in this province, namely, Xuan Son, Xuan Dai and Minh Dai communes in Tan Son district.

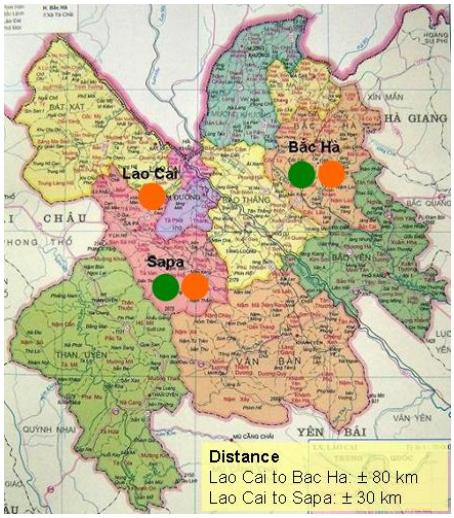


Figure 5-2 Lao Cai province

Figure 5-3 Phu Tho province

Table 5-1 Research locations

Province	District (commune)	Production assessment	*Market assessment*
Hanoi	Hanoi		●
Lao Cai	Bac Ha (Na Hoi, Ta Chai)	●	●
	Lao Cai		●
	Sa Pa	●	●
Phu Tho	Tan Son (Xuan Son, Xuan Dai, Minh Dai)	●	●
	Thanh Son		●
	Viet Tri		●

To more closely align the project with ACIAR's North West Highlands Program, work was also initiated in Lao Cai province. In consultation with the VWU and PPsD Lao Cai a set of guidelines were developed to assist with commune selection. The criteria used were:

- Capacity of women farmers; identifying interested and innovative farmers who have the potential to become key leaders
- Reasonable access to markets
- Willingness of commune and village leadership to collaborate and share knowledge and ideas
- Connections with VWU
- Links with local established extension departments
- Farmers with experience growing vegetables and preferably indigenous vegetables
- Links to other projects including ACIAR projects

Likewise 3 communes were selected in Lao Cai province – Na Hoi and Ta Chai communes in Bac Ha district and Sa Pa commune in Sa Pa district (Figure 5.3).

5.1.2 Identifying which indigenous vegetables to work on

An initial vegetable list was prepared by DARD and PPsD of 8-12 potential indigenous vegetables in each province that the project could work on. The provision of this list enabled a more targeted evaluation of the marketing potential and production constraints

of these vegetables during the scoping study. The results from the scoping study were then presented at the *Revitalisation Workshop* which then ratified the selection of 3 vegetables in each province for the remaining life of the project.

5.1.3 Scoping study – Research Phase I

The scoping study had 3 major objectives:

- Undertake a **needs analysis** of the women farmers in selected communes (PPsD and VWU)
- Identify the **marketing potential** of these vegetables (CASRAD and Fresh Studio Innovations Asia). A rapid value chain appraisal and market assessment of indigenous vegetables were the vehicles used to undertake this analysis. The potential medicinal value was also evaluated (NIMM).
- Identify the **technical or production constraints** of producing these vegetables. Current knowledge on indigenous production of these vegetables was documented and the likely constraints to producing them in a more semi-commercial/commercial sense identified (FCRI, NIMM, PPsD, VWU).

To fast-track the scoping study Fresh Studio Innovations Asia was contracted to:

- provide expertise in marketing and value chain analysis that was deemed critical to the successful implementation of the analyses undertaken as part of the scoping phase
- partner with CASRAD in undertaking the value chain analysis, sharing knowledge and ideas and further building this institutions capacity to undertake this type of work

The research team was sub-divided into two teams with the **technical team** starting at the production end of the supply chain and the **marketing team** starting at the consumer end of the supply chain (Figure 5-4 and 5-5). Throughout the field work phase, information was constantly shared between the teams facilitating greater understanding of indigenous vegetable supply chains

Figure 5-4 Field research – dual approach

1. **Technical team** ○ Needs assessment ▪ Livelihood ▪ Environment ○ Product and production assessment ▪ Product benefits ▪ Production constraints ▪ Capacity/traditional knowledge	2. **Marketing team** ○ Sales and distribution assessment ▪ Market structure ▪ Current practices ▪ Needs and requirements ○ Consumption assessment ▪ Current practices ▪ Perceptions and knowledge ▪ Needs
Fresh STUDIO INNOVATIONS ASIA; NSW GOVERNMENT Department of Primary Industries	Fresh STUDIO INNOVATIONS ASIA; CASR@D

Figure 5-5 Evaluations undertaken by each research team

Needs analysis and production assessment

A questionnaire was designed that covered socio-economic factors, household decision making, land use, knowledge of indigenous vegetables and their production practices. In total 176 farmer households were interviewed across the 6 communes (approximately 30 farmer households per commune). Farm visits and informal discussions with representatives at commune and district level were also used to gather information on traditional production methods and technical constraints.

Figure 5-6 Farmer interview

Figure 5-7 Vegetable field visit

Market assessment

Expert interviews were conducted with collectors, traders, retailers, wholesalers, restaurants, medicine shops and a pharmaceutical company. Intercept interviews were conducted with consumers. These consumers were approached at point-of-sale to obtain a better understanding of their top of mind considerations when selecting and buying vegetables. In addition to the initial consumer insights generated through the intercept interviews, two consumer focus groups were organised in a restaurant setting.

Figure 5-8 Consumer intercept interview

Figure 5-9 Retailer interview

Table 5-2 Summary of interviews

Interviewee	*No. of respondents*
Farmer households	*176*
Consumers[a]	*38*
Restaurants	*22*
Retailers	*22*
Traders	*15*
Staff of Commune Agricultural Dept.	*6*
Medicine shops	*2*
Pharmaceutical companies	*1*

Data encoding and analysis

A decoding sheet was made to interpret the interview transcripts and a SPSS database was created to analyse the data. For the supply chain and market assessment respondents were catergorised and decoding sheets were created in Excel for each category after which the analysis was done manually. After analysing the production assessment and market assessment first separately, the results were cross-analysed in order to develop the poster set (16 posters) and develop the recommendations.

Full details on the methodology utilised in the *Scoping Study* can be found in:

- Fresh Studio Innovations Asia (2009) Market assessment for indigenous vegetables. 80pp. (Appendix 11-1)

5.1.4 Revitalisation Workshop

In November 2009, a *Revitalisation Workshop* was held where the results from the scoping study were presented and discussed, and the direction for the next phase of the project determined. The workshop was attended by project partners and a cross-section of stakeholders including provincial, district and commune representatives, farmers, collectors, wholesalers and retailers.

The objectives of the workshop were:

1. To present and discuss the results from the scoping study with stakeholders (including cross-checking of data with stakeholders during the roving poster session)
2. Following a robust analysis of the production constraints and marketing opportunities for the short-listed indigenous vegetables, selecting 4-6 vegetables to work on for the remainder of the project
3. To develop detailed work plans for the production, marketing and Farmer Business School (FBS) research teams

5.1.5 Research Phase II

Marketing component

This component was led by CASRAD with key inputs from VWU, PPsD Phu Tho, PPsD Lao Cai and NSW DPI.

Undertaking a more in-depth market analysis for the 6 selected vegetables.

Following on from the rapid value chain analysis undertaken during the scoping study, the team decided to focus on the 6 value chains for the selected vegetables – khoai tang, muop dang and bo khai in Phu Tho province and cai meo, bap cai xoe and khoi tu in Lao Cai province. The objective of this analysis was not only to provide information on the different value chains but to also identify potential marketing opportunities/interventions for each of the vegetables, some of which could be pursued in later stages of the project.

In December 2009, the CASRAD team organised a two day training workshop on value chain analysis for the wider research team. The program covered: approaches to value chain analysis (including relevant examples); value chain mapping; conducting field work; interviewing skills and developing an action plan for the field work in Phu Tho and Lao Cai.

The training program also provided an opportunity for the team to work together to develop a standardised approach and agree on methodologies to be used. Given the geographic focus of the project (3 communes in each of 2 provinces) the team decided to start at the production end of the chain and work their way downstream. For each crop, key stakeholders were interviewed (Table 5-3), statistics collected from each of the production regions, and observation visits made to production areas and markets. Information was then collated and presented as a roving poster session (8 posters) at the *Stakeholder Workshop* in Sa Pa in August 2010.

Table 5-3 Summary of number of stakeholders interviewed for each vegetable supply chain

Stakeholders	No. of interviews/supply chain
Farmers	30
Collectors and wholesalers	5 – 10
Retailers	5 – 10
Restaurants	3 – 5
Consumers	20 – 30

Production component

The production team draws researchers and extension specialists from VAAS, FCRI, NIMM, PPsD Phu Tho, PPsD Lao Cai and NSW DPI.

Developing 'best bet' management practices for the 6 selected vegetables.

Eleven trials were instigated during this research phase (November 2009 – August 2010) addressing a range of production constraints including propagation, nutrition, plant density and crop management. Table 5-4 summarises the trials undertaken during this period. Detailed methodologies for each of the trials are provided in individual trial reports (in Vietnamese) that can be obtained from the authors upon request.

Table 5-4 Production trials instigated during research phase II (November 2009 – August 2010)

Trial	Objective	Details
Khoai tang - *Colocasia esculenta*, noduled taro		
1. Fertiliser I Jan-Nov 2010 Xuan Son, Tan Son	To develop a successful fertiliser strategy for the production of khoai tang	5 fertililser treatments: • No fertiliser • Current practice: 5.5 tons manure & 138.5 kg NPK per ha • 19.4 tons manure & 485 kg NPK19.4 tons manure per ha • 20 tons manure, 1400 kg NPK, 54kg Urea & 54 kg KCl per ha Completely Randomised Block Design with 3 replicates
2. Fertiliser I Jan-Nov 2010 Xuan Dai, Tan Son	As above	As above
3. Planting density Jan-Nov 2010 Xuan Dai, Tan Son	To determine the most appropriate planting density for semi-commercial khoai tang production	3 planting densities: • 36 000 plants/ha • 30 000 plants/ha • 25 600 plants/ha Completely Randomised Block Design with 3 replicates
Muop dang - *Mormordica charantia*, bitter melon		
4. Planting density Apr-Aug 2010 Xuan Dai, Tan Son	To determine the most productive planting density for muop dang	3 planting densities: • 30 770 plants/ha • 25 640 plants/ha • 22 000 plants/ha Completely Randomised Block Design with 5 replicates
Bo khai - *Erythropalum scandens,* vine plant		
5. Propagation I Jun-Sept 2010 Xuan Son, Tan Son	To develop appropriate techniques for propagating bo khai from cuttings	14 treatment combinations • 2 cutting ages (semi-hardwood and hardwood) • 2 types of hormones (IBA and NAA) and • 3 hormone concentrations (0.5ppm, 1.0ppm and 1.5ppm) Completely Randomised Block Design with 5 replicates
Cai meo - *Brassica juncea*, H'mong mustard - leafy red and green varieties		
6. Variety evaluation Nov 2009 – Feb 2010 Temperate Fruit and Vegetable Research Center, Sa Pa	To evaluate the development of different cai meo varieties	Random mix of 4 different types of cai meo was planted in 3 replicated plots Measure: growing period, colour, flowering time, plant height, yield.
7. Producing off-season cai meo with direct sowing technique Apr-May 2010 Temperate Fruit and Vegetable Research Center, Sa Pa	To evaluate cai meo production with direct sowing technique as an option for Apr – Jul period	Cai meo was directly sown in 3 replicated plots Measure: plant height, number of leaves, yield.
8. Planting time Apr 2010 – Feb 2012 Temperate Fruit and	To evaluate the potential for year round production of cai meo	4 planting time treatments: • 8th May • 15th August

Vegetable Research Center, Sa Pa		• 5th October • 24th December 3 replicates per each treatment
Bap cai xoe, *Brassica sp*, unfolded cabbage		
9. Planting season July 2010 – Feb 2011 Na Hoi, Bac Ha	To evaluate the potential for year round production of bap cai xoe	4 planting time treatments: • Early season (July) • Mid season (September) • Late season (November) • Off-season (June) 3 replicates per each treatment
Khoi tu, *Lycium chinense*, Vietnamese gogi berry or box thorn		
10. Propagation Apr-Jun 2010 Sa Pa	To develop the best technique for propagating khoi tu using cuttings	21 treatment combinations of: • 3 cutting ages (softwood, semi-hardwood and hardwood) • 3 types of hormones (IBA and NAA) and • 3 hormone concentrations (0.5ppm, 1.0ppm and 1.5ppm) Completely Randomised Block Design with 5 replicates
11. Fertiliser I Jun 2010 – Feb 2012 NIMM Research Centre, Sa Pa	To develop an optimum fertiliser strategy for khoi tu production	4 fertiliser options: • Control – soil with no amendments • NPK 5:10:3 at the rate of 300 kg/ha • Liquid animal manure watered around plants weekly • NPK 5:10:3 at the rate of 300kg/ha, plus liquid animal manure watered around plants weekly Completely Randomised Block Design with 5 replicates

Farmer Business School (FBS) component

Designing and developing a Farmer Business School (FBS).

The 'hub' of the research for development activities is the development of Farmer Business Schools (FBS). The FBS is the vehicle through which most project training was delivered. Initial activities focussed on developing the 'content' (what will the training cover? and what will resources look like?) and the 'process' (how will the training be delivered?) of the FBS. A desk-top review looking at other FBS and FFS resources was undertaken. In January 2010, consultations with groups of women farmers (25-30) in each of the project communes to find out their training needs and preferences have also been used to shape the design of the FBS.

5.1.6 Stakeholder Workshop

How do we bring about change in the marketing and production of indigenous vegetables? This was the key focus of a **Stakeholder Workshop** held in Sa Pa in August 2010. The workshop attracted 63 participants including government officials, farmers, collectors, wholesalers, retailers and representatives from consumer groups.

The project team presented their latest research findings from both the production trials and value chain analyses that had been undertaken on the six vegetables under study (In Lao Cai - cai meo (*Brassica juncea*), bap cai xoe (*Brassica sp.*), khoi tu (*Lycium chinense*)

and in Phu Tho - khoai tang (Col*ocasia esculenta*), bo khai (*Erythropala scandens*) and a local bittermelon (*Momordica charantia*)). Through a series of facilitated activities, participants were then asked to identify the priority production and marketing issues and put forward ideas for the types of marketing interventions that should be looked at. This was then utilized by the project team in their planning day following the workshop to develop work plans for the remaining life of the project.

Leading into the workshop, the Crawford Fund and ACIAR provided funding for Professors Barbara Chambers and John Spriggs from University of Canberra to run a training course on *Facilitation Training using a Collaborative Problem Solving Methodology (CPSM)*(Chambers and Spriggs, 2011). CPSM is a participatory approach that pulls together value chain stakeholders to determine the key issues, priorities and action plans. This empowers stakeholders to drive the change process. Specifically, in the case of our project we have used it to identify key marketing and production issues for indigenous vegetables and to select potential marketing interventions.

Full details on the Stakeholder Workshop can be found in Appendix 11-6.

5.1.7 Research Phase III and Farmer Business School (FBS)

Marketing Component

Priorities identified by stakeholders were used to set the research direction and the marketing interventions to be tested for the remainder of the project. Activities focussed in 3 key areas:

1. Understanding consumer preferences – Cai meo and Khoai tang consumer taste panels

To gain a better understanding of consumer preferences two consumer taste panels were held:

1. Khoai tang, Thanh Son, Phu Tho, 27th November 2010

The khoai tang degustation event was primarily a promotional event. However, consumers were also presented with raw (unpeeled and peeled), boiled and taro soup using 3 sources of product (Yen Luong, Tan Son and Khoai mon). Ninety eight people sampled the product. For the unpeeled product they were asked to evaluate appearance, ease of peeling, colour, size, overall quality and their preferred sample. Likewise for the peeled samples they were asked to evaluate colour, stickiness, overall quality and preferred sample. For the cooked samples, consumers evaluated the product for colour, stickiness, starchiness, tastiness, flavour, softness, overall taste and preferred sample.

2. Cai meo, Lao Cai city, Lao Cai, 28th December 2010

The cai meo taste panel was designed to provide insight into consumer responses to different bitterness levels. Empirical evidence had suggested that some consumers find cai meo too bitter. To determine if this was the case 110 ‘walk-in’ consumers were surveyed in Nguyen du market, Lao Cai city. They were presented with 3 cooked samples of cai meo of different ages (the older the product the more bitter it is). Each treatment was allocated a 3 digit code with sample order being randomised (ensuring that each sample had an equal chance of being tasted first or last). Following the tasting they were presented with 3 raw samples of cai meo and asked their purchasing preferences. Facilitators were trained in taste panel conduct.

2. Building local and regional markets – the Indigenous Vegetables Restaurant Challenge including development of recipe cards and logo/branding

3. Establishment of a Farmer Marketing Group – the Indigenous Products Co-operative, Na Hoi, Bac Ha

Production Component

A further 29 replicated and demonstration trials were instigated during this research phase (August 2010 – August 2012). Table 5-5 summarises the trials undertaken during this period. Detailed methodologies for each of the trials are provided in individual trial reports (in Vietnamese) that are available from the authors upon request.

Table 5-5 Production trials (replicated) instigated during Research Phase III (August 2010-August 2012)

Trial	Objective	Details
Khoai tang - *Colocasia esculenta*, noduled taro		
12. Storage of planting materials Nov 2010 – Jan 2011 Xuan Son, Tan Sơn	To find out the most suitable option for storage of planting materials	3 storage treatments: • hanging in net bag • storing on the floor • storing in sand 3 replicates, 30 corms/replicate
13. Storage of planting materials Nov 2010 – Jan 2011 Minh Dai, Tan Sơn	As above	As above
14. Fertiliser II Jan – Nov 2011 Xuan Son, Tan Son	To develop an appropriate fertiliser rate for khoai tang	3 fertiliser treatments: • 19.39 tons compost/ha • 19.39 tons compost + 485 kg NPK (6 :10 :3)/ha • 20 tons compost + 1400kg NPK (6:10:3) + 54 kg Urê + 54 kg Kaliclorua)/ha Completely Randomised Block Design with 3 replicates
15. Fertiliser II Jan – Nov 2011 Xuan Dai, Tan Son	As above	As above
16. Postharvest storage Nov 2011 – Jan 2012 Gia Loc, Hai Duong	To evaluate the storage potential of khoai tang	2 storage treatments: • 12^{o}C (In cold room) • Room condition 8 replicates, 10 corms/replicate
17. Harvesting time Mar – Nov 2012 Xuan Dai, Tan Son	To find out the most suitable harvesting time for khoai tang in Tan Son	3 harvesting time treatments: • September • October • November Completely Randomised Block Design with 3 replicates
Muop dang - *Mormordica charantia*, bitter melon		
18. Trellising type Aug 2010 – terminated Sep 2010 Xuan Dai, Tan Son	To develop the best trellis option for growing bitter melon	2 trellis types and density treatments: • A shape trellis • Horizontal trellis Completely Randomised Block Design with 3 replicates
19. Trellising type and density Apr – Aug 2011 Xuan Dai, Tan Son	To develop the best trellis option and appropriate density for growing bitter melon	4 trellis types and density treatments: • A shape trellis, distance between row: 1m, between plants: 1m (1mx1m) • A shape trellis, 1mx2m • Horizontal trellis, 1mx1m • Horizontal trellis, 1mx2m Completely Randomised Block Design with 3 replicates

Bo khai - *Erythropalum scandens,* vine plant		
20. Propagation 2 Feb – May 2011 Xuan Son, Tan Son	To develop appropriate techniques for propagating bo khai from cuttings	14 treatment combinations • 2 cutting ages (semi-hardwood and hardwood) • 2 types of hormones (IBA and NAA) and • 3 hormone concentrations (0.5ppm, 1.0ppm and 1.5ppm) Completely Randomised Block Design with 5 replicates
21. Propagation 3 Nov 2011 – Mar 2012 Thanh Tri, Ha Noi	To develop appropriate techniques for propagating bo khai from cuttings	14 treatment combinations • 2 types of commercial hormone (Richgro and Clonex) • 3 cutting lengths • 3 cutting ages
Cai meo - *Brassica juncea*, H'mong mustard - leafy red and green varieties		
22. Fertiliser Aug – Nov 2010 Sa Pa, Sa Pa	To develop an optimum fertiliser application strategy for cai meo	4 fertiliser treatments: • No fertiliser • NPK 600kg/ha • Manure 10 tons/ha • Manure 10 tons/ha + NPK 600 kg/ha Completely Randomised Block Design with 3 replicates
Bap cai xoe, *Brassica sp*, unfolded cabbage		
23. Fertiliser Aug – Nov 2010 Na Hoi, Bac Ha	To develop an optimum fertiliser application strategy for bap cai xoe	fertiliser treatments: • No fertiliser • NPK 600kg/ha • Manure 10 tons/ha • Manure 10 tons/ha + NPK 600 kg/ha Completely Randomised Block Design with 3 replicates
Khoi tu, *Lycium chinense*, Vietnamese gogi berry or box thorn		
24. Fertiliser 2 (replicated trial) Feb 2011 – Aug 2012 Sa Pa town, Sa Pa	Developing an optimum fertiliser application strategy for khoi tu	4 fertiliser options: • Control – soil with no amendments • NPK 5:10:3 at the rate of 300 kg/ha • Liquid animal manure watered around plants weekly • NPK 5:10:3 at the rate of 300kg/ha, plus liquid animal manure watered around plants weekly Completely Randomised Block Design with 3 replicates

Table 5-6 Production trials (demonstration) instigated during Research Phase III (August 2010-August 2012)

Trial	Objective	Details
Khoai tang - *Colocasia esculenta*, noduled taro		
25. Improving khoai tang production Mar – Nov 2011 Xuan Son, Tan Sơn	To demonstrate that khoai tang production can be improved by good management practice	Area: 500m^2 Compare traditional practice with recommended practice developed by the project team
26. Producing khoai tang at a semi-commercial scale Mar – Nov 2012 Xuan Son, Tan Sơn	To demonstrate newly developed production techniques for FBS farmer training	Area: 800m^2 Compare traditional practice with recommended practice developed by project team
Muop dang - *Mormordica charantia*, bitter melon		
27. Cultivating indigenous bitter melon in home garden Apr - Aug 2011 Xuan Dai, Tan Son	To demonstrate that local bitter melon which used to grow wildly in forests can be successfully produced in home garden	Area: 500m^2 Compare traditional practice with recommended practice developed by project team
28. Producing indigenous bitter melon at a semi-commercial scale Apr – Aug 2011 Xuan Dai, Tan Son	To develop the best trellis option and appropriate density for growing bitter melon	Area: 500m^2 Compare traditional practice with recommended practice developed by project team
Bo khai - *Erythropalum scandens,* vine plant		
29. Cultivating bo khai in home garden 2011 - 2012 Xuan Son, Tan Son	To demonstrate that local bo khai which used to grow wildly in forests can be successfully produced in home garden	Area: 80m^2 Bo khai was planted from cutting, grown in prepared beds with trellises
Cai meo - *Brassica juncea*, H'mong mustard - leafy red and green varieties		
30. Improving cai meo production in home garden Dec 2010 – Jan 2011 Sa Pa, Sa Pa	To demonstrate that cai meo production can be improved by good management practice	Area: 200m^2 Compare traditional practice with recommended practice developed by project team
Bap cai xoe, *Brassica sp*, unfolded cabbage		
31. Off-season production May – Sep 2011 Na Hoi, Bac Ha	To demonstrate that cai bap xoe can be produced in off-season period	Area: 90m^2 Evaluate the development and yield of cai bap xoe in off-season
Khoi tu, *Lycium chinense*, Vietnamese gogi berry or box thorn		
32. Growing khoi tu in home garden Feb 2011 – Feb 2012 Sa Pa, Sa Pa	To introduce khoi tu as a new cash crop for the H'Mong farmer in Sa Pa	Area: 150m^2
33. Growing khoi tu in home garden May 2011 – Feb 2012 Na Hoi, Bac Ha	To introduce khoi tu as a new cash crop for the women farmers in Bac Ha	Area: 200m^2
Cropping systems		
34. Stonefruit tree – vegetable intercropping Jun 2010 – Jun 2011 Ta Chai, Bac Ha	To demonstrate appropriate stonefruit tree – vegetable intercropping practice	Area: 140m^2 Compare scenarios: -Current practice: Intercrop with intensive root system planted right up to the tree butt -Optimised current practice: Intercrop with non-intensive root system planted away from the tree bases - Optimised indigenous vegetable intercrop
35. Growing vegetables after rice	To demonstrate that the farmers can improve their	Area: 720m^2 Plant cai meo and cabbage in

Oct 2010 – Mar 2011 Sa Pa, Sa Pa	income by growing vegetables in rice land in winter	rice terraces after rice season.
36. Growing vegetables after rice Nov 2011 – Mar 2012 Sa Pa, Sa Pa	To demonstrate that the farmers can improve their income by growing vegetables in rice land in winter	Area: 1500m^2 Plant cai meo and cabbage in rice terraces after rice season.
37. Growing vegetable following VietGAP protocols Nov 2011 – Mar 2012 Na Hoi, Bac Ha	To demonstrate that the Di Thang farmer group can work together to produce safe vegetables which meet VietGAP requirements	Area: 1500m^2 A group of Di Thang cooperative women farmers work together producing vegetables in a shared land.

Economic analysis of research and demonstration trials

A gross margin analysis was undertaken for a selection of research trials, enabling the economic performance of the treatments to be compared. This also included a sensitivity analysis.

Farmer Business School (FBS) Component

1. FBS Design

a. FBS Content

Given the success of the *Composting Workshops* conducted by PPsD Phu Tho in the earlier phase of the project, it was decided to utilise this to develop a model template to facilitate discussion on what each module should look like. Mr Le Toan prepared two manuals on composting, one covering practical considerations for the trainer and the other covering the technical aspects of composting. These documents were then reviewed and reworked. VWU then organised manual design. These preliminary documents were then circulated to the team for comment. They were also used for piloting the compost training in Lao Cai, with comments from the pilot training then being incorporated into the final documents. The materials designed for the composting module then acted as a template for the remaining modules. A cross-discipline project team met to determine potential modules for the FBS, covering both production and business aspects.

b. FBS Process

Ms Michelle Smith prepared a draft discussion paper on the FBS process. This paper examined: what is currently known; available resources and develops a concept for what a FBS will look like in the context of this project. This served as a starting point for the development of the IV FBS. A desk top review of current materials and processes was also undertaken. As a team we had much discussion on what our FBS should look like and then formulated our concept. This concept has also been presented to other projects (eg. Counter seasonal vegetables) and at the Regional Learning Workshop in Indonesia (November 2010),

To help shape the FBS and determine the training needs of women farmers, a series of farmer meetings were held in each of the project communes (Xuan Son, Minh Dai, Xuan Dai, Na Hoi, Ta Chai and Sa Pa) in Phu Tho and Lao Cai in late January/early February 2010.

The VWU also prepared a draft report on practice change entitled The Vietnam Women's Union with activities on encouraging practice change (May 2010).

2. Development of the FBS resource library

a. FBS Writing Workshops for Production Team

In January 2011, two 2-day writing workshops were held to assist team members with developing the production modules for the FBS. The first focussed on developing the

Trainers Guide – Theory whilst the second focussed on developing the Trainers Guide – Practical. A common template for each manual type was developed during the writing workshop (this template also met the requirements of VietGAP production protocols). The workshop not only provided team members with new skills but also enabled them to get away from the work place and focus on writing.

Following the workshop, writing teams produced their selected modules. These modules were then translated into English and technical content reviewed. Following revision of the text modules were then back translated into Vietnamese and sent to the designer.

b. FBS Resource library

The FBS Resource library comprises 11 modules covering both production and business aspects of indigenous vegetable production.

Most modules (except 'Games', 'Planning and Budgeting' and 'Microfinance' where a single training guide has been produced) include:

1. A Trainer's Guide – Theory: detailing what a trainer needs to know to teach this module. This guide incorporates learnings from the research trials.

2. A Trainer's Guide – Practical: providing the trainer with options for how to do the training including possible field trials, delivery options etc.

and in some cases

3. A farmer resource – designed to remind farmers of the training they have received (eg. compost noodle box)

For the Value Chains module we decided to produce a DVD. This DVD is based on the Ray Collins and Tony Dunne's CD *Agribusiness supply chains – learning from others* and we have looked to develop a similar Vietnamese resource. The Value Chains DVD module includes a Trainers DVD covering value chain theory and a series of case studies illustrating supply chain principles. A second DVD has been produced for a standard DVD player that just includes the case study footage. Central to the successful development of this resource is the selection of suitable Vietnamese case studies that illustrate these value chain principles. To that end 16 potential case studies have been researched by the marketing team, with in-depth interviews undertaken using a standard template. Following this initial research, a meeting was held to discuss the case studies and select those for inclusion on the DVD. A matrix detailing the value chain principles that each case study illustrates was developed to aid this process ensuring that each of the supply chain principles was adequately illustrated by the different case studies. Story boards were then produced for the 7 case studies selected and these were then filmed. In parallel with this the theory section was developed. This included the commissioning of some cartoons.

c. Composting pilot

Le Toan (PPsD, Phu Tho) facilitated a 1.5 day TOT in Lao Cai on composting from the 11th -12th March 2011. Sixteen trainers from Bac Ha, Sa Pa and Lao Cai attended this workshop. These trainers then trained 3 farmer groups in Bac Ha and Sa Pa. Feedback via a debrief session following the composting TOT was incorporated into the draft training modules and also used to enhance future TOT's.

3. FBS rollout in Phu Tho

The flexible design of the IV FBS means that modules can be pulled together to meet the needs of the different communes. In our pilot FBS's in the 6 communes in which the project operates different training packages will be put together depending on the demands of the commune. In 2011, the khoai tang and muop dang training was piloted in Phu Tho and the composting module piloted in Lao Cai. The Farmer Marketing Group also undertook a study tour to Hanoi in September 2011.

Implementing plans for each province were prepared by PPsD Phu Tho and PPsD Lao Cai detailing how the TOT training was to be undertaken in each province including program, number of trainers etc. Each province took a different approach to FBS implementation. Mr Toan, a FAO accredited FFS Master Train designed the TOT and FBS implementation program in Phu Tho. The program parallels similar FFS programs, with regular training interspersed regularly throughout the life of the crop. Essentially the program was an FFS program with the inclusion of some business skills. A TOT (5 days) was held in Phu Tho in April 2012 covering participatory approaches, khoai tang and muop dang production. Seventeen trainers drawn from communes, PPsD, Extension Center and VWU (commune level and training centre) took part in the training. Pilot FBS's were then held in Xuan Son (23 trainees), Xuan Dai (20 trainees) and Minh Dai (15 trainees). In Xuan Son the training (March-October, 2012) focussed on Khoai tang and included all FBS modules. In Xuan Dai the training (March-September, 2012) focussed on Muop dang and included all FBS modules, whilst in Minh Dai training focussed on the marketing, business plans and composting modules.

4. FBS rollout in Lao Cai

In Lai Cai, the training (both TOT and farmer training was implemented over a 12 week period (June-August 2012), with the TOT training taking place a couple of days before each of the farmer trainings.

5.2 Australian Component

5.2.1 Review of on-farm tools for measuring plant nitrate (addresses 3.2 b)

Nitrogen supply to crops impacts on the synthesis of the green photosynthetic pigment, chlorophyll, and on plant nitrate concentration. Insufficient N supply decreases nitrate concentrations, chlorophyll synthesis and plant productivity. Excess N supply causes undesirably high nitrate concentrations in leafy vegetables and does not increase chlorophyll concentration. Consequently, analysis tools have been developed to determine the nitrogen status of crops. These were reviewed using the scientific literature to determine which are most suitable for on-farm use in the measurement of plant nitrate. The three included nitrate-selective electrodes, nitrate-sensitive test strips, and chlorophyll meters.

5.2.2 Evaluate leafy Asian vegetables in hydroponic systems (addresses 3.4b)

Three hydroponic systems were used to evaluate the production of leafy Asian vegetables.

1) For Kang Kong grown in still solution hydroponics, plants were suspended over 20 L tanks lined with a black garbage bag to prevent algal growth. The tank was filled with nutrient solution. The solution was filled up to the crown of the roots and not refilled for the entire crop.

2) Centella was grown in a substrate system with a recirculated nutrient solution. In this study, plants were grown in a mix of coir and perlite, in a crate, positioned directly over a tank which captured the runoff from holes in the crate. The solution was pumped from the tank below and back up to the drippers feeding the crop. Several of these crates can be placed over a larger tank, or each crate and tank unit can be connected with irrigation piping, and the pump located in one of the end tanks.

3) Ten types of leafy Asian vegetables produced in Nutrient Film Technique (NFT): Thai Basil (variety Siam Queen), Bunching Onion, Coriander, Choy Sum, Mustard Cabbage, Pak Choy (varieties Sumo, Yangtze, and Miyako), En Choy, and Tat Soi.

The Huett's lettuce formula (common in lettuce production), was used to make the nutrient solution for all systems.

5.2.3 Determine the nitrogen nutrition of some leafy Asian vegetables and methods for on-farm measurement of plant nitrate (addresses 3.2b & 3.4b)

The aim of this study was to 1) evaluate the N nutrition of three leafy vegetables: coriander (*Coriandrum sativum* L.), amaranth (*Amaranthus tricolor* L.) and pakchoi [*Brassica rapa* L.ssp Chinensis (L.) var. Sumo], grown in a hydroponic system (NFT), and 2) evaluate the suitability of the nitrate concentration in plant sap of these vegetables as a crop N management tool. The effect of nitrate supply in the external solution (30-300mg/L nitrate-N) on marketable plant yield, the concentration of total N and nitrate in shoots, and the nitrate concentration of plant sap was investigated.

5.2.4 Evaluate bitter melon as an Australian greenhouse crop (addresses 3.4a)

Two greenhouse experiments were carried out at the NSW Department of Primary Industries research station in Narara, NSW, Australia (151°19'E, 33°23'S). The aim of the first experiment was to demonstrate a range of bitter melon varieties as a greenhouse crop and to demonstrate how the greenhouse system could be used to overcome the problem senescence during a temperate winter. Twenty varieties were used and plants were grown in bags of coir substrate with nutrient solution fed through drippers. The aim of the second experiment was to specifically evaluate the production and quality characteristics of six bitter melon varieties selected from the first experiment, hand pollinated and grown under similar greenhouse conditions to the first experiment. The six varieties, White, Hanuman, Jade, Big Top Medium, Niddhi and Indra, were evaluated for their phenolic compounds and antioxidant activity components by Newcastle University PhD student, Selin Tan. Four of these varieties (White, Hanuman, Jade, Niddhi) were evaluated for bitterness and tastiness by 26 consumers using a hedonic scale questionnaire. The six varieties were also shown to a Sydney Basin Vietnamese farmer who chose one variety to evaluate on-farm.

5.2.5 Evaluate gac as an Australian greenhouse crop (addresses 3.4a)

This study aimed to investigate some agronomic techniques in growing and propagating Gac to highlight potential practices for increasing Gac yields. A further aim was to demonstrate how a hydroponic greenhouse system could be used to overcome the problem of dormancy and senescence during a temperate winter. Two greenhouse experiments were carried out at the NSW Department of Primary Industries research station in Narara, NSW, Australia (151°19'E, 33°23'S). In the first experiment, a crop was produced from seed using methods used for bitter melon. For the second experiment, propagation was attempted using cuttings taken from the three female Gac plants identified from the first experiment. Cuttings were dipped into one of two indole-3-butyric acid (IBA) hormone treatments, powder (3g/kg) or gel (3mL/L), and were grown in rock wool, potting mix, water, or closed media sachet. The controls were not treated with hormone.

6 Achievements against activities and outputs/milestones

Objective 1: Develop models that enable a competitive market position for smallholder women farmers in a transforming market

No.	Activity	outputs/ milestones	completion date	Comments
1.1	Broad rapid market appraisal to develop market driven priority list, with reasoning for selection	Identification of indigenous vegetables with market development potential	November 2009	An initial list of 22 potential indigenous vegetables was prepared in consultation with DARD/PPsD in Phu Tho and Lai Cai. As part of the *Scoping Study* (August – October 2009) a Value Chain Appraisal and market assessment was undertaken for these vegetables. This study also identified other potential vegetables for inclusion. Additionally the technical or production constraints to producing these vegetables were evaluated. A needs analysis was also undertaken of women farmers (176 interviews) in the 6 selected communes. Following compilation of the results from the scoping study, they were presented as a roving poster session by Fresh Studio Innovations Asia at the *Revitalisation Workshop* in November 2009 enabling further discussion and refinement of the analysis. At the workshop a list of 6 vegetables (3 from each province) were then selected for the project to focus on. The vegetables selected were Cai meo, Bap cai xae, Khoi tu, Bo khai, Khoai tang and Muop dang. Full details on the *Scoping Study* can be found in the report prepared by Fresh Studio Innovations Asia *Market assessment for indigenous vegetables* (Appendix 11-1) and reasoning for the selection of said vegetables in the paper prepared by Phan Thuy Hien and Suzie Newman entitled *The next step – selecting vegetables for the next phase of AGB/2006/112* for in the proceedings (electronic) from the *Revitalisation Workshop*.

No.	Activity	outputs/ milestones	completion date	Comments
1.2	In depth analysis of market requirements of identified priorities	Detailed market assessment of selected vegetables	July 2010	Following the Value Chain Analysis undertaken as a part of the *Scoping Study*, a more in-depth analysis of the 6 vegetables was undertaken by CASRAD and PPsD Phu Tho and Lao Cai. In preparation for this a training workshop on Value Chain Analysis was organised by CASRAD for project partners in December 2009. Results from the VCA were then presented in a roving poster session at the *Stakeholder Workshop* in August 2010. This enabled stakeholders to review the data and armed with this together with their own experiences to propose appropriate marketing interventions. Reports addressing this milestone include: 1.*Market assessment for indigenous vegetables* (Appendix 11-1) *2.* Posters (16) from *Revitalisation Workshop* (Appendix 11-2) 3. Posters (8) from *Stakeholder Workshop* (Appendix 11-3) *4. Market analysis of potential of indigenous vegetables in local and urban areas* (6 reports in Vietnamese). 5. *A market study: establishing economic benchmarks and the market potential of selected indigenous vegetables in Xuan Dai, Xuan Son and Minh Dai communes* (not included)

No.	Activity	outputs/ milestones	completion date	Comments
1.3	Analysis of supply chain constraints that prevent the delivery of indigenous vegetables into profitable markets	Constraints identified that limit market engagement	February 2010	*Supply limitations* and *poor quality* were the major **physical** constraints identified that limit market engagement. Moving towards semi-commercial production systems will ultimately increase supply. To achieve this a number of production constraints have been identified for the 6 selected vegetables including: 1) availability of uniform planting material; 2) lack of information on suitable propagation methods; 3) lack of information on optimum production methods for these vegetables; 4) specific pest and disease problems and 5) poor postharvest management. To address these constraints the *Production and Postharvest Team* developed a series of trials addressing key issues for each vegetable. See *Summary of production trials* (Appendix 11-5) *Research plans – Production and postharvest team* (not included) and Production and Postharvest Work Plan 2010 (not included). Additionally a number of **marketing** constraints have also been identified. These include: 1) limited engagement with collectors and traders; 2) poorly developed supply chain; 3) lack of knowledge by urban consumers in how to use indigenous vegetables; and a 4) lack of production differentiation (marketed together with 'everyday vegetables').

No.	Activity	outputs/ milestones	completion date	Comments
1.4	Develop whole-chain marketing strategies (including brand development) that enable the development of a competitive position	Marketing strategies for selected vegetables	October 2011	**Value Chain Analysis** The results from the value chain analysis were presented as a roving poster session (attached as Appendix 11-3) at the *Stakeholder Workshop* in Sa Pa in August 2010. CASRAD has also produced reports in Vietnamese on each of the six vegetables (completed May 2011). **Stakeholder identification of marketing interventions** As part of the *Stakeholder Workshop*, participants from a cross-section of the indigenous vegetables industry (farmers, collectors, wholesalers, retailers (including Hapromart and Senmart), government officials) were asked to identify potential marketing interventions. They highlighted the following 4 areas: ● Building relationships with supply chain partners (networking, meetings, group marketing initiatives) ● Raising consumer awareness (promotional activities, product information) ● Developing a quality control system ● Researching postharvest techniques to maintain IV quality from farm to market. Full details are provided in the *Stakeholder Workshop Report* attached in Appendix 11-5 (see page 19 of workshop report). In response to this we have undertaken the following activities: **Establishment of a Farmer Marketing Group (FMG) in Na Hoi commune, Bac Ha, Lao Cai** 1. *September - December 2010*: Formation of informal Farmer Marketing Group comprising 23 farmers including 3 internal collectors/farmers. Links established with Tan Than Co-operative (Lao Cai), Ecomart and VinaGap (Hanoi) with group regularly sending product (on a small scale) to each of these traders. Ecomart also looking at off-season vegetable production with these farmers. 2. *March – June 2011*: Farmer Business School (FBS) commences with Compost module with this FMG
				3. *September 2011*: Collector/farmer study tour to Hanoi to visit safe vegetable production sites (Hoa Binh Co-operative and Thanh Xuan Commune Organic producers), Long Bien wholesale market and

No.	Activity	outputs/ milestones	completion date	Comments
				specialist retailers (including Mrs Suu's shop, Ecomart and VinaGap) and supermarket (Big C) 4. *October 2011*: FMG gained access to some of the commune rice lands enabling the group to have a shared production area. Established VietGAP demonstration site as a starting point for getting VietGAP accreditation. Building of pre-processing facilities to enable the FMG to comply with safe vegetable standards. 5. *November 2011*: Launch of Indigenous Products Cooperative (Di Thang) – contracts signed with Ecomart, VinaGAP and Mrs Suu – Hanoi based retailers. The Cooperative also received their Safe Vegetable Certificate at this time. More recently the Co-op has also started supplying to Big Green. Total volume of vegetables reaches 100 tonnes (70 tonnes to Hanoi and 30 tonnes to Lao Cai). 6. *March 2012*: Refinement of indigenous vegetables project logo (removal of the word project) to enable retailers to use it on packaging materials for IV 7. *March 2012*: DARD, Lao Cai and Peoples Committee Bac Ha organise a workshop to develop a plan for the production and marketing of indigenous vegetables in Bac Ha. 8. *April 2012*; Bac Ha People's Committee assign 2 ha of land for the production of off-season vegetable production (including indigenous vegetables). The Co-operative has now grown to 42 farmers with more looking to join. 9. *May – August 2012*: FBS training continues. A paper was presented at the 7th Asian Society of Agricultural Economists (ASAE) conference in Hanoi in October 2011 (Appendix 11-6) - *Pham Thi Hanh Tho, Dao The Anh and Suzie Newman (2011) Developing a customer driven value chain for indigenous vegetables produced by women farmer group in Lao Cai province* . **Building local markets – Indigenous Vegetables Restaurant Challenge** Given that there is currently a limited supply of IV, most of our marketing strategies have been directed at the

No.	Activity	outputs/ milestones	completion date	Comments
				local or regional (Lao Cai) level. Given Vietnamese consumers tendency to try and buy local products when they travel, Sa Pa has unique promotional opportunities for IV's. As part of an effort to build consumer awareness and to link with local restaurants in Sa Pa, an IV Cooking Challenge was held in Sa Pa on the 30th December 2010. Six restaurants participated producing 22 dishes using cai meo, bap cai xoe and khoi tu. Invited guests, locals and tourists took part in a tasting and competition to decide on the best dishes. Lao Cai television produced a 8-10 minute segment on the event. Several of the restaurants have now added these dishes to their menus. There is also interest in developed a larger event for Sa Pa promoting regionally produced products. **Recipe Promotional Cards** To increase consumer awareness of IV's we produced a set of recipe cards utilising recipes from the IV Restaurant Cooking Challenge. Each recipe card also include some introductory information on the vegetable. An initial print run of 1000 of each of 9 cards (see Appendix 11-7) has been produced for distribution at point of sale. The cards include an 'Available from' section where vendors can include their details.

PC = partner country, A = Australia

Objective 2: Gain a greater understanding of consumer benefits from indigenous vegetables.

no.	Activity	outputs/ milestones	completion date	Comments
2.1	From rapid market appraisal, extract understanding of consumer benefits of indigenous vegetables	Report identifying consumer perceived consumer benefits from indigenous vegetables	August 2010	As part of the *Scoping Study*, intercept interviews (38) and focus groups (2) were used to develop a profile of the urban indigenous vegetable consumer (refer 5.2 in report prepared by Fresh Studio Innovation Asia, attached as Appendix 11-1). Further information was also gathered during the follow up evaluation of the 6 vegetables undertaken by CASRAD and PPsD Phu Tho and Lao Cai. Additionally a survey of 200 consumers was undertaken by CASRAD in the earlier phase of the project.
2.2	Identify linkage between consumer preference and product attribute	Substantiating the link between consumer perception and product attribute	December 2010	**Consumer preferences** To gain a better understanding of consumer preferences two consumer taste panels were held: 3. Khoai tang, Thanh Son, Phu Tho, 27th November 2010 4. Cai meo, Lao Cai city, Lao Cai, 28th December 2010 The cai meo taste panel was designed to provide insight into consumer responses to different bitterness levels. Empirical evidence had suggested that some consumers find cai meo too bitter. To determine if this was the case 110 'walk-in' consumers were surveyed in Nguyen du market, Lao Cai city. They were presented with 3 cooked samples of cai meo of different ages (the older the product the more bitter it is). Following the tasting they were presented with 3 raw samples of cai meo and asked their purchasing preferences. Forty one percent of consumers preferred the 'old' or more bitter sample. Despite this, the results from the taste panel would suggest that are two different markets for this product – those who like to use the more bitter product in cooked dishes and those who like to use the younger sweeter product as a the wrap for fresh spring rolls. Two reports (in Vietnamese) have been produced by CASRAD detailing the results of these trials: 1. *Sau NT (March 2011) Report – Cai Meo Taste Panel. 15pp.* (attached as Appendix 11-8) 2. *Quoc Anh L (2010) Report – Khoai Tang Taste Panel. 28pp.* **IV Nutritional Information** NIMM have completed nutritional testing of 5 of the 6 indigenous vegetables. This information has been utilised on the recipe cards and in the FBS manuals.

no.	Activity	outputs/ milestones	completion date	Comments
2.3	Analysis of product attributes that deliver consumer preference	Detailed analysis of product attributes to substantiate consumer preferences	December 2011	Information on this has been collected throughout the life of the project through consumer surveys, focus groups, consumer taste panels and feedback from the Hanoi Consumer Association and retailers. Indigenous vegetables are prized by consumers for their uniqueness and so it is important for the product to retain this point of differentiation. In the case of khoai tang this relates to its shape, bright yellow internal colour and sticky texture. For muop dang characteristic fruit size and shape is also critical. When fruit deviated from this – collectors questioned whether or not the crop was in fact muop dang. Bitterness is also prized, along with the health benefits of muop dang. They are also perceived by consumers as being safe – so it is likely that the implementation of food safety schemes such as VietGAP will enhance their reputation. In a society where food safety is questioned this is an important market advantage and is partially related to their point of production (being produced by ethnic minorities in the mountain regions). Throughout the life of the project – key quality attributes have been defined, nutritional analyses undertaken and medicinal benefits documented. This information has been incorporated into FBS manuals and recipe cards.

PC = partner country, A = Australia

Objective 3: Improve on-farm and through chain management to deliver safe, quality products to market.

no.	Activity	outputs/ milestones	completion date	Comments
3.1	Identify and test 'best bet' on farm management practices to produce market preferred indigenous vegetables	Improved farm management cultivation practices	October 2011	Documenting indigenous knowledge and identifying production constraints was a key feature of the *Scoping Study* undertaken in 2009. Key results are documented in the report prepared by Fresh Studio Innovation Asia, attached as Appendix 11-1 and in a paper produced for the *Revitalisation Workshop* entitled *Traditional knowledge and current constraints to indigenous vegetable production* prepared by the FCRI team. To date 38 replicated and demonstration trials have been undertaken on the 6 vegetables (a summary is attached in Appendix 11-4). Additionally, gross margins have been undertaken to look at the economic benefits associated with these practices (Appendix 11- Recommendations from the trial work have been incorporated into the 7 FBS production modules (refer to section on FBS).
3.2 (a)	Develop strategies that improve safe product at the on-farm level (in Vietnam)	Publication of on farm food safety manual for the production of indigenous vegetables	June 2012	As part of the Indigenous Vegetables FBS – a module has been prepared on Food Safety. Its publication has been delayed till the next project due to changes in food safety regulations in Vietnam, necessitating its updating once the law is implemented.

no.	Activity	outputs/ milestones	completion date	Comments
3.2 (b)	Develop strategies that improve safe product at the on-farm level (in Australia)	Data on nitrate accumulation in leafy Asian vegetables (A)	December 2011	Three scientific papers detail the findings from this work (Appendix 11-10): *1.* Parks SE and Spohr LJ (2011) Sap nitrate in frozen-thawed and refrigerated stems of *Amaranthus tricolor* is indicative of nitrate fertiliser supply. Journal of Plant Nutrition is in press. 2. Parks SE, DE Irving and Milham PJ (2012). A critical evaluation of on-farm rapid tests for measuring nitrate in leafy vegetables. *Scientia Horticulturae* 134: 1-6. A scientific paper on N nutrition and nitrate accumulation in coriander, pak choy and en choy is in draft. This will be ready for submission by July 2012. The following extension publication looks at how to successfully manage leafy Asian vegetables in hydroponic systems. *1.* Parks SE and Murray CM (2011). Leafy Asian vegetables and their nutrition in hydroponics. Industry and Investment, NSW. 21pp. The final version of this report will include recommendations on specific research activities to further develop crop nitrate tests for on-farm use.
3.3	Identify and test improved through chain management to maintain quality and food safety	Supply chain that effectively delivery safe product to market	February 2012	Researching postharvest techniques to maintain IV quality from farm to market has consistently been identified as an area of further research at both the *Stakeholder Workshop*, in our ongoing work with the *Indigenous Products Cooperative* in Na Hoi and through our discussions with Hanoi retailers. Within the context of this project we have undertaken: • A postharvest trial to determine the postharvest storage potential of khoai tang • Incorporated recommendations for improved postharvest management in our FBS manuals • Developing an FBS module specifically on Food Safety • Working with the *Indigenous Products Cooperative* to enable them to get Safe Vegetable accreditation and ultimately VietGAP accreditation.

no.	Activity	outputs/ milestones	completion date	Comments
3.4 (a)	Identify and develop emerging Asian vegetables for the wider Australian market	Report on the development of bitter melon for the Australian market (A)	December 2011	Several reports and papers have been produced including: 1. A paper for the *Revitalisation Workshop Proceedings*: *A case study of greenhouse bitter melon in NSW, Australia,* detailing an experiment (completed in 2008) in which 20 varieties of bitter melon were trialled and a small consumer survey undertaken. 2. An article on this work was also published in the industry magazine *Vegetables Australia* (Appendix 11-10). 3. Data from the bitter melon experiment evaluating production of six varieties will be written up as a scientific paper by October 2012 The final report will recommend specific research activities to further develop the bitter melon industry in Australia. Data from the experiment evaluating Khoi tu (gogi) hedging will be written up as a report by October 2012. A scientific paper - Parks SE, Murray CT, Gale D, Al-Khawaldeh B and Spohr LJ (2012). Propagation and production of Gac (Momordica cochinchinensis Spreng.), a greenhouse case study was submitted to Experimental Agriculture 30/03/2012.
3.4 (b)	Identify and develop emerging Asian vegetables for the wider Australian market	Report on the development of leafy Asian vegetables in NFT systems for the Australian market (A)	December 2010	With co-funding from the HAL project *VG07153 Nutrient Management in Asian Vegetables*, the following industry report has been released – Parks SE and Murray CM (2011). Leafy Asian vegetables and their nutrition in hydroponics. Industry and Investment, NSW. 21pp.

PC = partner country, A = Australia

Objective 4: Develop communication strategies that enable women smallholder to change practice.

no.	Activity	outputs/ milestones	completion date	Comments
4.1	Benchmark current information and communication sources	Report on current information exchange and influence of information	June 2010	**Farmer Business School (FBS) Development** The Farmer Business School (FBS) is the vehicle through which most project training is delivered. Early activities focussed on the development of the 'content' and 'process' of the FBS. *FBS Content* Given the success of the Composting Workshops conducted by PPsD Phu Tho in the earlier phase of the project, it was decided to utilise this to develop a model template to facilitate discussion on what each module should look like. Mr Le Toan prepared two manuals on composting, one covering practical considerations for the trainer and the other covering the technical aspects of composting. These documents were then reviewed and reworked. VWU then organised manual design. These preliminary documents were then circulated to the team for comment. They were also used for piloting the Compost training in Lao Cai, with comments from the pilot training then being incorporated into the final documents. The materials designed for the composting module then acted as a template for the remaining modules. A list of potential topics for the FBS was also developed, covering both production and business aspects. *FBS Process* Ms Michelle Smith prepared a draft discussion paper on the FBS process. This paper examined: what is currently known; available resources and develops a concept for what a FBS will look like in the context of this project. This served as a starting point for the development of the IV FBS. A desk top review of current materials and processes was also undertaken. As a team we had much discussion on what our FBS should look like and then formulated our concept. This concept has also been presented to other projects (eg. Counterseasonal vegetables) and at the Regional Learning Workshop in Indonesia (November 2010), To help shape the FBS and determine the training needs of women farmers, a series of farmer meetings were held in each of the project communes in Phu Tho and Lao Cai in late January/early February 2010.

no.	Activity	outputs/ milestones	completion date	Comments
				The VWU also prepared a draft report on practice change entitled *The Vietnam Women's Union with activities on encouraging practice change* (May 2010).
		b. Report detailing commune profiles and training needs and preferences of each commune	October 2011	This information has been incorporated in *Market analysis of potential of indigenous vegetables in local and urban areas*. A separate report was also produced on training preferences following the series of consultations with each of the communes in January 2010. This information will also be incorporated into the final version of this report.
4.2	Identify and test better practice communication approaches	a.New communication strategies used in FBS	Ongoing	
		b. Development of a Value Chains DVD utilising Vietnamese case studies to demonstrate supply chain management principles. This resource will be modelled on Collins and Dunne (2002).	May 2012	**Value Chains DVD** Based on the Ray Collins and Tony Dunne's CD *Agribusiness supply chains – learning from others*, we have looked to develop a similar Vietnamese resource. The Value Chains DVD will include a Trainers DVD that will include a theory section, case studies illustrating supply chain principles and workbook resources. A second DVD will also be produced for a standard DVD player that will just include the case study footage. Central to the successful development of this resource is the selection of suitable Vietnamese case studies that illustrate these value chain principles. To that end 16 potential case studies have been researched by the marketing team, with in-depth interviews undertaken using a standard template. Following this initial research, a meeting was held to discuss the case studies and select those for inclusion on the DVD. A matrix detailing the value chain principles that each case study illustrates was developed to aid this process ensuring that each of the supply chain principles was adequately illustrated by the different case studies.. Story boards were then produced for the 7 case studies selected and these were then filmed. In parallel with this the theory section and workbook were developed. This included the commissioning of some cartoons. The DVD is now in the final stages of production and we anticipate it being completed within the next month.

no.	Activity	outputs/ milestones	completion date	Comments
4.3		c. Completion of FBS resource library	July 2012	**FBS Writing Workshops for Production Team** In January 2011, two writing workshops were held to assist team members with developing the production modules for the FBS. The first focussed on developing the Trainers Guide – Theory whilst the second focussed on developing the Trainers Guide – Practical. A common template for each manual type was developed during the writing workshop. The workshop not only provided team members with new skills but also enabled them to get away from the work place and focus on writing. A report on these workshops is attached in Appendix 11-12. **FBS Resource library** The FBS Resource library will comprise 12 modules: 1. 5 vegetable production modules on each of the vegetables (completed January – May 2012) 2. Composting (completed 2011) 3. Games (completed January 2012) 4. Food safety (anticipated completion May 2012) 5. Value chains DVD (anticipated completion May 2012) 6. Planning and budgeting (anticipated completion June 2012) 7. Basic business and marketing skills (SNV resource) 8. Microfinance Most modules (except 'How to use the indigenous vegetables FBS', Games and Microfinance) include: 1. A *Trainer's Guide – Theory*: detailing what a trainer needs to know to teach this module. This guide incorporates learnings from the research trials. 2. A *Trainer's Guide – Practical* providing the trainer with options for how to do the training including possible field trials, delivery options etc. 3. A farmer resource – these are still under development but they are being modelled on the *compost noodle box* – this resource was designed to remind the farmers of the key messages they learned in the 4 session compost training – that also included making their own compost.

no.	Activity	outputs/ milestones	completion date	Comments
		d. TOT's on business and production components completed	July 2012	**Composting pilot** Le Toan (PPsD, Phu Tho) facilitated a 1.5 day TOT in Lao Cai on composting from the 11th -12th March 2011. Sixteen trainers from Bac Ha, Sa Pa and Lao Cai attended this workshop. These trainers then trained 3 farmer groups in Bac Ha and Sa Pa. Feedback via a debrief session following the composting TOT was incorporated into the draft training modules and also used to enhance future TOT's. **TOT's in Phu Tho and Lao Cai** Implementing plans for each province were prepared by PPsD Phu Tho and PPsD Lao Cai detailing how TOT training was to be undertaken in each province including program, number of trainers etc. In Phu Tho, two 5 day TOT's are planned with the first held in April 2012 covering participatory approaches, khoai tang and muop dang production. The second TOT is planned for June 2012 and will cover the remaining topics (business and food safety). In Lao Cai, TOT training will commence this month with TOT training for the 30 trainers paralleling the farmer training. The training (both TOT and farmer training) will be implemented over a 12 week period, with the TOT training taking place a couple of days before each of the farmer trainings.
		e. Piloting of each FBS modules in selected project communes		**FBS pilots** The flexible design of the IV FBS means that modules can be pulled together to meet the needs of the different communes. In our pilot FBS's in the 6 communes in which the project operates different training packages will be put together depending on the demands of the commune. The final phase of piloting will be completed in August 2012. In 2011, the khoai tang and muop dang training was piloted in Phu Tho and the composting module piloted in Lao Cai. The Farmer Marketing Group also undertook a study tour to Hanoi in September 2011. **Monitoring and Evaluation** The M&E framework has been prepared for the FBS and is detailed in Appendix 11-16 *Evaluation strategy – Farmer and trainer.*
4.3	Publish case study improvements	Case studies published	August 2012	Not completed – will be undertaken as part of AGB-2012-059.

7 Key results and discussion

7.1 Objective 1: Develop models that enable a competitive market position for smallholder women farmers in a transforming market.

Refer to Appendices: 11-1, 11-2, 11-3, 11-4, 11-5, 11-6 and 11-7. Also the *Revitalisation Workshop Proceedings 2009* (attached CD)

7.1.1 Broad rapid market appraisal to develop a market driven priority list, with reasoning for selection

Definition of indigenous vegetables

The World Indigenous Vegetables Report (2006) refers to indigenous vegetables as:

"*Vegetable species native to or originating from a particular region or environment. It includes species that are naturalized or varieties that have evolved from materials introduced to the region from another geographical area over a long period of time. High-yielding vegetables as products of scientific breeding are not indigenous.*"

However the perception by different stakeholders in the chain was somewhat different (Table 7-1) with producers and technical experts focussing on *technical aspects*: origin, history and cultivation whilst retailers, restaurants and consumers focussed more on *personal benefits*: origin, food safety and taste. Understanding the perceptions of the market is critical for producers to be able to successfully enter these markets.

Table 7-1. Different perceptions by stakeholders of what is meant by the term 'indigenous vegetables'

Order	Production assessment		*Market assessment*		
	Technical expert	Farmer	Retailer	Restaurant	*Consumer*
1	Origin (33%)	History (46%)	Taste (29%)	Origin (30%)	*Origin (28%)*
2	History (21%)	Origin (38%)	Food safety (18%)	Food safety (20%)	*Food safety (23%)*
3	*Small scale (12%)*	*Naturally grown (6%)*	*Origin (17%)*	*Taste (16%)*	*Taste (16%)*

Identification of indigenous vegetables with market development potential

An initial list of 22 potential indigenous vegetables was prepared in consultation with DARD/PPsD including local district economic divisions in Phu Tho and Lao Cai (see Table 7-2 column 'project list'). The *Rapid Value Chain Analysis* also identified further potential vegetables. Table 7-2 shows which indigenous vegetables were mentioned in the RVCA by different actors in the chain. Additionally the technical or production constraints to producing these vegetables were evaluated. A needs analysis was also undertaken of women farmers (176 interviews) in the 6 selected communes.

Table 7-2. Indigenous vegetables mentioned by different actors

Indigenous vegetable	Project list	Farmer			Consumer		Retailer		Trader	Restaurant
		Bac Ha	Sapa	Tan Son	Rural	Urban	Rural	Urban		
Bi ngo / Bi nuong / Bi do	yes	10%	33%	27%	7%	5%	12%	0%	13%	5%
Ca chua bi	yes	0%	0%	0%	3%	0%	0%	0%	0%	9%
Cai bap xoe/ Bap cai dia phuong (Cai nam)/ Cai xoe	yes	64%	7%	0%	3%	0%	12%	0%	0%	18%
Cai meo trang/ cai trang	yes	71%	63%	6%	0%	0%	0%	0%	0%	0%
Cai meo, cai meo xanh, cai nuong, cai dang, cai cay, cai xanh	yes	83%	83%	72%	43%	24%	29%	40%	33%	50%
Cu khoi/khoi tu	yes	2%	0%	0%	3%	0%	6%	0%	7%	0%
Dua chuot	yes	8%	0%	0%	17%	0%	12%	0%	7%	14%
Hat doi	yes	0%	0%	3%	3%	10%	0%	0%	0%	5%
Hat sen	yes	0%	0%	0%	0%	5%	0%	0%	0%	0%
Khoai thom / khoai tang/khoai mon nuong	yes	0%	0%	49%	17%	14%	35%	20%	33%	9%
Muop Dang	yes	0%	0%	28%	17%	10%	12%	0%	7%	0%
Nac nay	yes	0%	0%	1%	3%	38%	6%	0%	0%	9%
Rau bo khai	yes	0%	0%	3%	3%	33%	0%	20%	0%	18%
Rau don	yes	0%	0%	5%	17%	10%	0%	0%	7%	5%
Rau nhuom xoi	yes	0%	0%	0%	0%	5%	0%	0%	0%	5%
Rau sam	yes	0%	0%	0%	3%	0%	0%	0%	0%	0%
Rau sang	yes	0%	0%	13%	17%	43%	12%	20%	13%	9%
Bap cai	no	22%	3%	1%	13%	0%	6%	0%	20%	5%
Cai lan/ngong cai lan	no	0%	0%	0%	0%	14%	0%	0%	20%	0%
Cai ngong	no	0%	0%	0%	13%	0%	0%	0%	0%	9%
Cai xoong	no	0%	0%	0%	3%	0%	12%	0%	13%	5%
Khoai mat quy	no	0%	0%	0%	7%	0%	12%	0%	0%	0%
Mang	no	0%	0%	0%	3%	10%	0%	0%	13%	5%
Ngon su su	no	0%	0%	0%	3%	43%	18%	0%	13%	9%
Rau bi	no	0%	0%	0%	13%	0%	0%	0%	0%	5%
Rau ngot	no	2%	0%	9%	0%	0%	0%	0%	0%	0%
Su Hao	no	0%	0%	0%	13%	0%	6%	0%	13%	5%
Qua su su	*no*	*15%*	*23%*	*1%*	*17%*	*29%*	*6%*	*0%*	*20%*	*9%*

Following compilation of the results from the scoping study, they were presented as a roving poster session by Fresh Studio Innovations Asia at the *Revitalisation Workshop* in November 2009 enabling further discussion and refinement of the analysis. At the workshop a list of 6 vegetables (3 from each province) were then selected for the project to focus on. The vegetables selected were Cai meo, Bap cai xoe, Khoi tu, Bo khai, Khoai

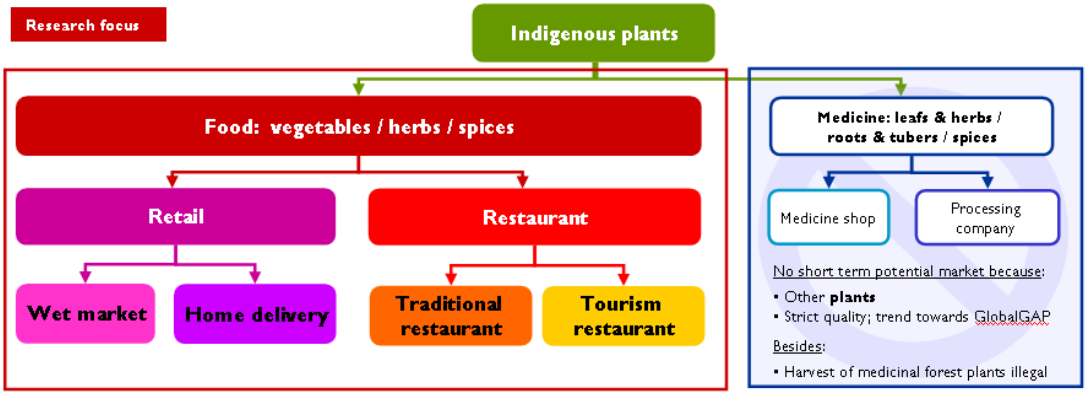
tang and Muop dang. Full details on the *Scoping Study* can be found in the report prepared by Fresh Studio Innovations Asia *Market assessment for indigenous vegetables* (Appendix 11-1) and reasoning for the selection of said vegetables in the paper prepared by Phan Thuy Hien and Suzie Newman entitled *The next step – selecting vegetables for the next phase of AGB/2006/112* for in the proceedings (electronic) from the *Revitalisation Workshop*.

7.1.2 In depth analysis of market requirements of identified priorities

A focus on indigenous vegetables for fresh food

Indigenous plants can be either used as a food or as medicinal products (Figure 7-1). Both avenues were explored in this study, however early in the life of the project it was decided to focus on indigenous vegetables as fresh food. Part of the rationale for this decision was that at that point in time smallholder farmers were more likely to derive greater livelihood benefit from this channel. The medicinal products channel is dominated by large players with higher entry requirements for suppliers including the implementation of Global GAP standards where products are being exported. However whilst we did not pursue this channel at this point in time the use of indigenous plants as medicinal products is likely to gain increasing momentum into the future and it should be revisited.

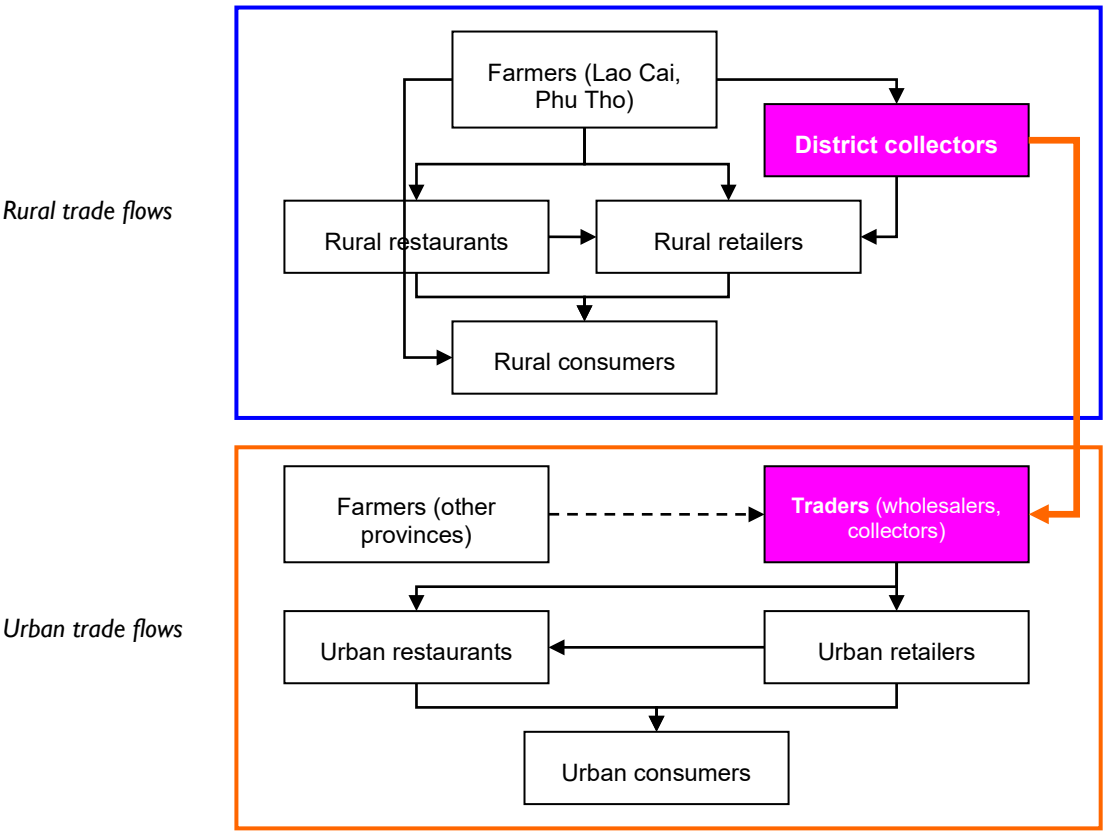
Figure 7-1. Utilisation of indigenous plants



Supply chain map for indigenous vegetables

Figure 7-2 depicts the supply chain map for fresh indigenous vegetables. This map is based on interviews with close to 100 supply chain actors and observational visits to markets in Sa Pa, Bac Ha, Lao Cai, Tan Son, Thanh Son, Viet Tri and Hanoi.

Figure 7-2. Supply chain map for indigenous vegetables



Farmers mainly grow indigenous vegetables for their own consumption (Table 7-3) with some selling to local collectors and restaurants and others selling to district collectors for distribution to other provinces and urban areas.

Table 7-3. Utilisation and distribution of indigenous vegetables

Rationale of farmer household to grow vegetables	Frequency	Percentage
For consumption by own family	142	95%
For selling to local retailers, restaurants and consumers	39	26%
For selling to collectors	5	3%
All of the above	5	3%
Total valid responses	**149**	

Source: Interviews with 176 farmer households in Lao Cai and Phu Tho (AGB-2006-112 RVCA, 2009)

In rural areas indigenous vegetables are sourced directly from farmers or at local markets while urban markets are mainly supplied by traders who link up with district collectors. Traders supply to traditional retailers and restaurants who then serve to consumers.

Urban indigenous vegetable trade depends heavily on bus connections and private cars travelling between production areas and urban markets. If small trucks are used for transportation indigenous vegetables are likely to be mixed with ordinary vegetables in order to reduce the transportation cost.

Freshness, reliability of supply (volume and quality), price, and good appearance are 4 main selection criteria for indigenous vegetable.

Indigenous vegetables cater for high value urban markets, but poor practices result in low quality and high postharvest losses. Good quality indigenous vegetables can be sold for high prices in urban markets. The key to good quality is postharvest and therefore good postharvest practices are the key in accessing high value urban markets.

Common wishes of retailers across all interview locations with regards to the availability of indigenous vegetables include:

- Year-round availability
- More stable sourcing (volume/ quality)
- Wider product range
- Reasonable prices
- Info about products

Urban retailers are less knowledgeable about the taste and health benefits of indigenous vegetables than rural retailers. For new products retailers first prefer to taste and receive information about health benefits.

For new products restaurants first prefer to check the fitting with their dishes, with their customer taste and the quality supplied. If the restaurant is satisfied, further requirements are as follows:

- Good quality supply (fresh, good appearance)
- Consistent volume supply (as ordered)
- Regular supplier
- Some ingredients available year-round

(This section has been extracted from 'Market assessment for indigenous vegetables' (Fresh Studio 2009). The full report can be found in Appendix 11-1).

Revisiting value chain analysis for the 6 selected vegetables

Following the initial scoping study, a more in-depth value chain analysis was undertaken for the six vegetables understudy – khoai tang, muop dang and bo khai in Phu Tho, and cai meo, bap cai xoe and khoi tu in Lao Cai. Individual reports (in Vietnamese) were compiled for each of the six vegetables. Results from the VCA were then presented as a *Roving Poster Session* (Appendix 11-3) at the Stakeholder Workshop in August 2010. This enabled stakeholders to review the data and armed with this together with their own experiences to propose appropriate marketing interventions. Below are brief synopses for each of the vegetables, a detailed analysis can be found in the individual product reports (available upon request)

Khoai tang

Khoai tang consumption is concentrated in the production area with low supply limiting the spread to other provinces and urban areas. Very few consumers in Hanoi have even heard of khoai tang as a variety of taro. Some consumers even mistake khoai tang for wild taro, which is inedible and obviously an undesirable association.

Of the three communes investigated in this study, two Yen Luong and Thuong Cuu have created central trading points in the villages or commune. However in Vinh Tien commune, production is still quite limited and so there is no central trading point. Investing in a central trading point is critical to ongoing expansion of taro production.

The retailers are concentrated mainly in town centers or local markets such as Vang market (Thanh Son) and Hoang Xa market (Thanh Thuy). On average, about 5-6 retailers / market are directly participating in the indigenous khoai tang value chain. On average retailers sell 40 kg of khoai tang per day during the season, with collectors selling 265 kg per day. When expressed on a seasonal basis retailers sell 4250 kg per season and collectors 11,722 kg per season. Collectors predominantly purchase directly from farmers and together buy 72% of the crop. On average a collector buys from 18-19 farmers.

There is good market potential for khoai tang as there is a well-established market for other taro varieties and some preference shown for khoai tang. It receives good prices because it is seen as a specialty and consumers value the indigenous aspect. Most chain members expressed interest in increasing their involvement, be it in production or buying and selling.

However the growth of the market is limited by poor postharvest management, resulting in a limited shelf life. Farmers can only afford to produce what they can sell locally directly after harvesting. Likewise collectors and retailers can only buy what they can sell in a couple of days.

Muop dang

Muop dang - indigenous bitter melon is not consumed in large quantities. Common bitter melon is widely consumed across Vietnam; however consumers outside the production district are unable to distinguish between the two types and are unaware of the indigenous variety. This contrasts with consumers in the production area where there is a high consumer awareness and a clear preference for the indigenous variety. Local consumers prefer it because it is cleaner, the taste is more aromatic and it is crispier than the common varieties. Some consumers also prefer the indigenous variety because of perceived health benefits.

Production is limited to semi-commercial and wild collection, limiting the amount of product available for sale even in local markets. Given it’s lack of distinction from hybrid varieties in urban and regional markets, expansion is likely to be limited to local markets unless the indigenous variety proves to be high in compounds that have medicinal value.

Bo khai

Bo khai is produced through-out North-East Vietnam including Cao Bang, Lang Son, Ha Giang, Tuyen Quang, Phu Tho, Bac Kan, Thai Nguyen and Bac Giang. It is also produced in the Central Highlands. Despite it’s relatively large geographic spread, there is very limited production resulting in simplistic and opportunistic marketing chains. Much of the bo khai consumed is from wild harvesting, but increasingly small pockets of production are starting to emerge in communes such as Xuan Son.

Bap Cai Xoe

Bap cai xoe is a popular vegetable crop in Bac Ha, Lao Cai, being widely consumed locally both at home and in restaurants. Bap cai xoe is harvested sequentially with individual leaves harvested and finally the flower stalk. In Bac Ha, there are local collectors and collectors from other regions. Bac Ha based collectors have close relationships with the local growers and take the product to Lao Cai and the local Sunday market in Bac Ha. During the week and on Saturdays the collectors are trading about 50-60 bunches each, on Sundays they are trading about 75-90 bunches. Collectors from outside Bac Ha buy bap cai xoe along with other types of vegetables, with bap cai xoe accounting for 15-20% (40-50 bunches) of their purchases each time they come to Bac Ha. These collectors buy from the local market or directly from growers. The average

retailing price in Bac Ha is from 2000 – 2500 VND/bunch and the price in Lao Cai is from 2500 – 3000 VND/bunch. Whilst bap cai xoe is an emerging crop, it can be utilised as a 'speciality crop' or as an 'everyday' vegetable. It may also be seen as a substitute crop for some of the other popular 'everyday' brassicas.

Cai meo

Cai meo is transitioning to semi-commercial production, with farmers in Sa Pa town looking to grow the crop year round. With an average price of 17,000 VND/kg (2010) this makes cai meo a highly profitable crop. During the off-season prices are particularly high. Unfortunately Sa Pa commune producers (primarily Mong) are not capitalising on the full market potential of the crop, primarily producing it during the main season and for home consumption. This results in Mong farmers getting much lower returns for the crop and therefore less likely to invest in off-season production. Despite this of the six vegetables under study cai meo is the most likely to be a commercial success.

Khoi tu

Khoi tu is traditionally grown along fence lines or collected from wild sources so to date there has been limited value chain development. At present, growers are selling directly to retailers, restaurants or consumers. Most of the product available in the market is sourced from those who are looking to produce khoi tu as more of a semi-commercial crop. Households that rely more on wild collection are primarily using it for their own consumption. In Sa Pa market, 6-7 of the 15 retailers sell khoi tu regularly. Each retailer has a relationship with 2-3 khoi tu growers with whom they will normally trade. Trade of khoi tu occurs every morning when the growers bring the khoi tu to the market on motorbike. The trading volume varies from 15-30 bunches of about 0.5kg each. Orders are rarely larger than this as the vegetable cannot be stored so retailers must sell what they buy in the same day. Prices vary considerably for khoi tu, with local restaurants paying considerably less than tourists and other buyers.

7.1.3 Analysis of supply chain constraints that prevent the delivery of indigenous vegetables into profitable markets

Supply limitations and poor quality were the major **physical** constraints identified that limit market engagement. Moving towards semi-commercial production systems will ultimately increase supply. To achieve this a number of production constraints have been identified for the 6 selected vegetables including:

1. availability of uniform planting material;
2. lack of information on suitable propagation methods;
3. lack of information on optimum production methods for these vegetables;
4. specific pest and disease problems and
5. poor postharvest management.

To address these constraints the *Production and Postharvest Team* developed a series of trials addressing key issues for each vegetable. See Summary of production trials (Appendix 11-5).

Additionally a number of **marketing** constraints have also been identified. These include:

1. limited engagement with collectors and traders;
2. poorly developed supply chain;
3. lack of knowledge by urban consumers in how to use indigenous vegetables; and
4. lack of production differentiation (marketed together with 'everyday vegetables').

7.1.4 Develop whole-chain marketing strategies (including brand development) that enable the development of a competitive position

Stakeholder identification of marketing interventions

As part of the Stakeholder Workshop, participants from a cross-section of the indigenous vegetables industry (farmers, collectors, wholesalers, retailers (including Hapromart and Senmart), government officials) were asked to identify potential marketing interventions. They highlighted the following 4 areas:

- Building relationships with supply chain partners (networking, meetings, group marketing initiatives)
- Raising consumer awareness (promotional activities, product information)
- Developing a quality control system
- Researching postharvest techniques to maintain IV quality from farm to market.

Full details are provided in the *Stakeholder Workshop Report* attached in Appendix 11-6 (see page 19 of workshop report).

In response to this we have undertaken the following activities:

1. Establishment of a Farmer Marketing Group (FMG) in Na Hoi commune, Bac Ha, Lao Cai;
2. Building local markets – Indigenous Vegetables Restaurant Challenge;
3. Development and provision of promotional recipe cards;

Establishment of a Farmer Marketing Group (FMG) in Na Hoi commune, Bac Ha, Lao Cai.

During a *Training Needs Analysis (TIA)* undertaken in 2010 as part of the *Farmer Business School (FBS)* design, a group of farmers in Na Hoi, Bac Ha expressed a desire to form a *Farmer Marketing Group (FMG)*. They believed that this initiative would enable them to be more competitive and to collectively increase production of indigenous vegetables and other products. Initially (September-December 2010) the group was an informal *FMG* comprising 23 farmers including 3 internal collectors. During this time links were established with Tan Than Co-operative (Lao Cai), Ecomart and VinaGap (Hanoi) with the group regularly sending product (on a small scale) to each of these traders. At the same time, Ecomart was also looking at off-season vegetable production with these farmers. This informal *FMG* was an initial recipient of the project's *FBS* training commencing with the Compost module from March – June 2011. This engagement in formal training also provided a platform for group members to approach project extension personnel and technical specialists regarding production or marketing challenges the group or individuals within it were facing. One of the challenges the group was facing was connection to market and so in September 2011 the project organised a collector/farmer study tour to Hanoi to visit safe vegetable production sites (Hoa Binh Co-operative and Thanh Xuan Commune Organic producers), Long Bien wholesale market and specialist retailers (including Mrs Suu's shop, Ecomart and VinaGap) and supermarket (Big C). This visit led to an expansion in the FMG's Hanoi marketing connections and ultimately to ongoing contracts with several retailers. It also provided the group with insight into the requirements of safe vegetable production through visits to Hanoi based producer groups producing safe vegetables.

In 2011, one of the key challenges that the group faced was a lack of land to expand production. So in October 2011 the FMG gained access to some of the commune rice lands enabling the group to have a shared production area. They also established VietGAP demonstration site as a starting point for getting VietGAP accreditation. Having seen the pre-processing the facilities in Hanoi required for safe vegetable production the

group built pre-processing facilities to enable the FMG to comply with safe vegetable standards.

In late 2011, the FMG decided that it wanted to transition from an informal FMG to a cooperative. In November 2011 they had the launch of Indigenous Products Cooperative (Di Thang). At this launch contracts were also signed with Ecomart, VinaGAP and Mrs Suu – Hanoi based retailers. The Cooperative also received their Safe Vegetable Certificate at this time. More recently the Co-op has also started supplying to Big Green. Total volume of vegetables reaches 100 tonnes (70 tonnes to Hanoi and 30 tonnes to Lao Cai).

In March 2012, the Di Thang Cooperative decide to utilise a modified version of the indigenous vegetable project logo (removal of the word project) to enable retailers to use it on packaging materials for IV. Also at this time DARD, Lao Cai and Peoples Committee Bac Ha organise a workshop to develop a plan for the production and marketing of indigenous vegetables in Bac Ha. Once again land availability is a limiting factor and so in April 2012 the Bac Ha People's Committee assign 2 ha of land for the production of off-season vegetable production (including indigenous vegetables). The Co-operative has now grown to 42 farmers with more looking to join. Di Thang Cooperative also is one of the pilot sites for the full *Farmer Business School (FBS)* implemented by the project.

The success of this approach was presented as a paper at the 7th Asian Society of Agricultural Economists (ASAE) conference in Hanoi in October 2011 (Appendix 11-7) -

Pham Thi Hanh Tho, Dao The Anh and Suzie Newman (2011) Developing a customer driven value chain for indigenous vegetables produced by women farmer group in Lao Cai province

Building local markets – Indigenous Vegetables Restaurant Challenge

Given that there is currently a limited supply of IV, most of our marketing strategies have been directed at the local or regional (Lao Cai) level. Given Vietnamese consumers tendency to try and buy local products when they travel, Sa Pa has unique promotional opportunities for IV's. As part of an effort to build consumer awareness and to link with local restaurants in Sa Pa, an IV Cooking Challenge was held in Sa Pa on the 30th December 2010. Six restaurants participated producing 22 dishes using cai meo, bap cai xoe and khoi tu. Invited guests, locals and tourists took part in a tasting and competition to decide on the best dishes. Lao Cai television produced a 8-10 minute segment on the event. Several of the restaurants have now added these dishes to their menus. There is also interest in developed a larger event for Sa Pa promoting regionally produced products.

Recipe Promotional Cards

To increase consumer awareness of IV's we produced a set of recipe cards utilising recipes from the IV Restaurant Cooking Challenge. Each recipe card also include some introductory information on the vegetable. An initial print run of 1000 of each of 9 cards (see Appendix 11-8) has been produced for distribution at point of sale. The cards include an 'Available from' section where vendors can include their details.

7.2 Gain a greater understanding of consumer benefits from indigenous vegetables

Refer to Appendices: 11-1, 11-9 and 11-16. Also the Revitalisation Workshop Proceedings 2009 (attached CD)

7.2.1 From rapid market appraisal extract understanding of consumer benefits of indigenous vegetables

(*Extracted from Market Assessment for Indigenous Vegetables Section 5.2 in report prepared by Fresh Studio Innovation Asia, attached as Appendix 11-1*)

As part of the *Scoping study* intercept interviews (38) and focus groups (20) were used to develop a profile of the urban indigenous vegetables consumer (refer 5.2 in report prepared by Fresh Studio Innovation Asia, attached as Appendix 11-1).

Urban consumers consumed indigenous vegetables because they were distinctly different from ordinary or 'everyday' vegetables. They had a preference for the strong taste of indigenous vegetables. IV's are mainly consumed on special occasions, however 91% of consumers in the two focus groups, not only wanted to consume them on special occasions but also preferred to prepared and consume indigenous vegetables at home. However they have limited knowledge on where to buy indigenous vegetables.

In general urban consumers of indigenous vegetables:

- Like discovering new things (incl. travelling)
- Care about health
- Care about family
- Like fine dining (gourmet)/ care about food safety

Furthermore urban consumers of indigenous vegetables … production areas:

- …originate from…
- …have relatives in…
- …work in…
- …travel to…

Consumers, especially urban consumers, are unaware of the intrinsic values of indigenous vegetables. Especially the health (medicinal) benefits of indigenous vegetables are largely unknown with urban consumers, but Vietnamese consumers in general are eager to know more and try new things (curiosity).

And thus those consumers are not willing to pay higher prices for values that they do not know.

Therefore there is a need for marketing in order to promote those values to retailers and restaurants and ultimately end consumers in order to grow the market.

For consumers who are familiar with indigenous vegetables and its values, unique selling points are the taste and health benefits, with the latter being associated mostly with food safety (Table 7-4), because most consumers perceive indigenous vegetables to be produced without (grown naturally) or with minimal use of agro-chemicals.

Table 7-4. Unique selling points of indigenous vegetables

	Taste	***Health***
Production area	Important **Daily** experience	*Food safety* ***Medicinal** value*
Urban area	*Important* ***Special***	*Food safety* ***??***

7.2.2 Identify linkage between consumer preference and product attribute

To gain a better understanding of consumer preferences two consumer taste panels were held:

1. Khoai tang, Thanh Son, Phu Tho, 27th November 2010

2. Cai meo, Lao Cai city, Lao Cai, 28th December 2010

The cai meo taste panel was designed to provide insight into consumer responses to different bitterness levels. Empirical evidence had suggested that some consumers find cai meo too bitter. To determine if this was the case 110 'walk-in' consumers were surveyed in Nguyen du market, Lao Cai city. They were presented with 3 cooked samples of cai meo of different ages (the older the product the more bitter it is). Following the tasting they were presented with 3 raw samples of cai meo and asked their purchasing preferences. As anticipated the results indicated that the flavour profile of cai meo changes with plant age, with consumers able to clearly discern these differences. The younger samples (15/100 and 23/100) were found to be less bitter than older samples (52/100, $P<0.001$). Forty one percent of consumers preferred the 'old' or more bitter sample. Despite this, the results from the taste panel would suggest that are two different markets for this product – those who like to use the more bitter product in cooked dishes and those who like to use the younger sweeter product as a the wrap for fresh spring rolls.

Two reports (in Vietnamese) have been produced by CASRAD detailing the results of these trials:

1.Sau NT (2011) *Report – Cai Meo Taste Panel*. 15pp. (attached as Appendix 11-8)

2.Quoc Anh L (2010) *Report – Khoai Tang Taste Panel*. 28pp.

7.2.3 Analysis of product attributes that deliver consumer preference

Information on this has been collected throughout the life of the project through consumer surveys, focus groups, consumer taste panels and feedback from the Hanoi Consumer Association and retailers. Indigenous vegetables are prized by consumers for their uniqueness and so it is important for the product to retain this point of differentiation. In the case of khoai tang this relates to its shape, bright yellow internal colour and sticky texture. For muop dang characteristic fruit size and shape is also critical. When fruit deviated from this – collectors questioned whether or not the crop was in fact muop dang. Bitterness is also prized, along with the health benefits of muop dang. They are also perceived by consumers as being safe – so it is likely that the implementation of food safety schemes such as VietGAP will enhance their reputation. In a society where food safety is questioned this is an important market advantage and is partially related to their point of production (being produced by ethnic minorities in the mountain regions). Throughout the life of the project – key quality attributes have been defined, nutritional analyses undertaken and medicinal benefits documented. This information has been incorporated into FBS manuals and recipe cards.

7.3 Improve on-farm and through chain management to deliver safe, quality products into a transforming market

Refer to Appendices: 11-1, 11-9, 11-10 and 11-16. Also the Revitalisation Workshop Proceedings 2009 (attached CD)

7.3.1 Identify and test 'best bet' on-farm management practices to produce market preferred indigenous vegetables

Prepared by Phan Thuy Hien (Project Coordinator) and Felicity Muller (Australian Youth Ambassador for Development, NIMM)

Nearly 40 replicated and demonstration trials have been undertaken on the 6 vegetables (a summary is attached in Appendix 11-4 and in Tables 5-4 to 5-6), during the life of the project. Short synopses of the key findings are provided here. Additionally, gross margins have been undertaken to look at the economic benefits associated with these practices (refer Appendix 11-9). For 4 of the 6 vegetables short literature reviews have been compiled and these are included here. Further information on these trials can be obtained from the trial reports (in Vietnamese only). Importantly the application of this work is captured in the 7 FBS production modules where recommendations from the trial work have been utilised to provide detailed information on producing each of these crops (refer to section on FBS).

Indigenous taro – Khoai tang

Literature

Introduction

Khoai tang (*Colocasia esculenta*), occasionally referred to as elephant ear, cocoyam or taro, is a member of the *Araceae* family which is a perennial root vegetable primarily grown for its starchy corms. The corms which are used as a carbohydrate staple may be eaten boiled, fried, baked, or processed into flour, chips or porridge (Lewu et al., 2010). Khoai tang is used infrequently as an animal feed however processing of the raw corm is required in order to remove the anti-nutritional compounds present including oxalates, phytates, tannins and saponins (Abulrashid and Agwunobi, 2009). Khoai tang has characteristically large oval shaped leaves and is mainly distributed in Asia and northern Australia (Do et al., 2006). In Vietnam khoai tang is primarily cultivated in the northern mountainous provinces (Do et al., 2006). Khoai tang is not particularly well recognised for its medicinal purposes instead being renowned for its toxic characteristics (Abdulrashid and Agwunobi, 2009; Oscarsson and Savage, 2007).

Nutritional components

Khoai tang corms are a good source of carbohydrate (see table 1) and are recognised as a cheap energy source with a higher caloric yield per hectare than other grains and tuber crops (Abulrashid and Agwunobi, 2009). As observed in table 1, the availability of crude lipids, crude fibre and crude protein increases with cooking. The protein occurring in khoai tang is of good quality according to Sefa-Dedeh and Agyir-Sackey (2004) however, starch quality is low and is recorded as unsuitable for industrial uses due a lower viscosity, bulk density and swelling value than other commonly used processing starches (Oladebeye et al., 2009).

Table 7-5. Proximate composition of khoai tang corms (Lewu et al., 2010)

	% DM	
Component	**Cooked**	**Uncooked**
Moisture	68.10	66.62
Ash	3.65	4.09
Crude Protein	8.96	6.40
Crude Fibre	2.49	1.83
Crude Lipid	1.04	0.78
Carbohydrate	83.86	86.58

Levels of potassium occurring in khoai tang are quite high and as part of a high dietary intake potassium is recognised as providing a protective role against hypertension, stroke, kidney stones and osteoporosis (Lewu et al., 2009). Khoai tang is also a rich source of magnesium, providing approximately one third of the recommended magnesium daily intake for adults (Huang et al., 2007). High magnesium and sodium contents have been associated with maintaining the acid-base body balance (Lewu et al., 2009). However in terms of total mineral intake khoai tang is not recognised as a valuable dietary source, with 1-3kg consumption per day required in order to meet the recommended vitamin and mineral dietary intake (Huang et al., 2007). It is therefore suggested that vitamins and minerals be obtained from a wider variety of vegetable sources.

Table 7-6. Mineral composition of khoai tang corms (Lewu et al., 2010)

	mg/100g DM	
Mineral	**Cooked**	**Uncooked**
Phosphorus	42.60	38.45
Calcium	30.73	34.62
Magnesium	89.68	114.89
Sodium	80.85	63.42
Potassium	716.91	901.28
Iron	13.87	9.08
Copper	1.24	2.53
Manganese	n.d.*	n.d.*

* n.d. – not detected

Khoai tang is renowned for its anti-nutrient factors which when uncooked are known to produce an acrid taste and can cause swelling of the lips, mouth and throat (Oscarsson and Savage, 2007). As observed in table three the levels of oxalate in uncooked khoai tang are exceptionally high and roughly double the amount of oxalate in the cooked corm. Oxalates can cause irritation to the intestinal tract and interfere with calcium absorption, leading to greater risk of kidney stone formation (Sefa-Dedeh and Agyir-Sackey, 2004; Lewu et al., 2010). In khoai tang leaves the amount of soluble oxlates present is roughly 74% and while the soluble oxalate content appears to be less in corms, given the result observed in table 3, it is suggested that cooking is sufficient to lower the soluble oxalate content and reduce the associated health risks. Tannins are at high levels in uncooked khoai tang and as with oxalate content are reduced by approximately half during the cooking process (see table 3). It is suggested that without cooking the astringency levels in khoai tang leaves may be considered too high for human consumption. Phytate is measured at significantly lower levels in khoai tang corms and while the compound will decrease the bioavailability of minerals it is suggested that oxalates and tannins have a greater role on toxicity and digestibility.

Table 7-7. Anti-nutrient content of khoai tang corms (Lewu et al., 2010)

	mg/100g DM	
Anti-nutrient	**Cooked**	**Uncooked**
Calcium oxalate	342.70	673.98
Tannin	1938.33	4216.00
Phytate	72.46	87.48

Leaves of khoai tang while not commonly consumed have been identified as containing six C-glycosylflavonoids and one O-glycosylflavonoids (Leong et al., 2010). These have been suggested as a potential source of dietary antioxidants (Leong et al., 2010).

Medicinal Benefits

There are few recorded cases of medicinal benefits of khoai tang. Kumawat et al. (2010) indicated that administering a 400mg/kg dose of ethanol extract of khoai tang leaves had a hypoglycemic effect in rats. Greatest effect was observed at 6 hours however the extract was found to diminish over a 24 hour period (Kumawat et al., 2010). However it must be noted that at the current time the widespread influence of khoai tang leaf extracts on hyperglycemia has not been demonstrated.

Traditionally khoai tang has had limited medicinal uses with the vegetable corm mainly used as a poultice for the treatment of skin problems including rashes, acne and scabies (Do et al., 2006).

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Experimental and demonstration trials

Developing a fertiliser strategy for khoai tang production

Four fertiliser trials were implemented in Xuan Son and Xuan Dai across two crops in 2010 and 2011 to develop optimum fertiliser strategy for khoai tang. Three fertiliser options were compared: 1) Traditional practice (limited amount of organic fertiliser only); 2) Organic fertiliser + NPK and 3) Organic fertiliser + NPK + top-dressing urea and KCl

The combined fertiliser treatments produced the most grade 1 corms and those corms were larger in size. (Table 7-8).

Table 7-8: Effect of fertiliser treatment on khoai tang corm number and weight

Treatments	Number of plants	No. of corms				Weight (kg)			
		Grade 1	Grade 2	Grade 3	Planting materials	Grade 1	Grade 2	Grade 3	Planting materials
1.Organic fertiliser[1]	38	7	12	19	85	2.6	3.6	3.7	2.7
2.Organic fertiliser + NPK[2]	41	12	10	36	103	5.4	2.7	6.1	3.9
3. Organic fertiliser + NPK + urea + KCl[3]	43	13	14	32	132	6.8	4.8	5.8	5.2

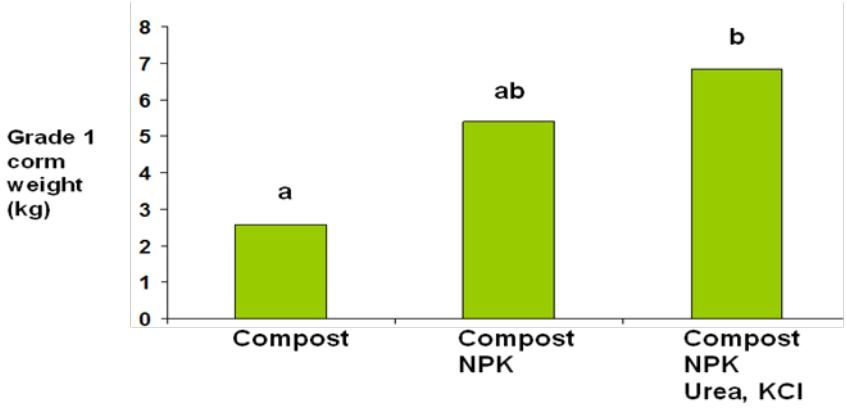
[1] 19.39 tons compost/ha

[2] 19.39 tons compost + 485 kg NPK (6 :10 :3)

[3] 20 tons compost + 1400kg NPK (6:10:3) + 54 kg urea + 54 kg Kaliclorua/ha

Figure 7-3 illustrates the effect of fertiliser treatments on grade 1 corm weight with treatment 3 (compost, NPK and additional top-dressing of urea and KCl) producing a significant increase in corm weight for grade 1 corms over traditional farmer practice (compost only).

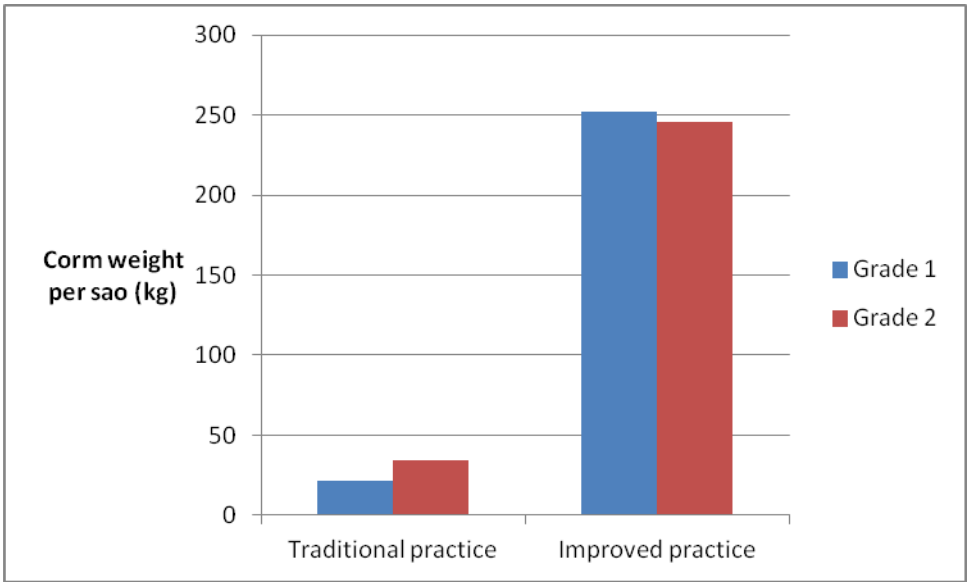
Figure 7-3. Effect of fertiliser application on total grade 1 corm weight



Developing appropriate management practices for semi-commercial production of khoai tang

Two demonstration trials were implemented in Xuan Son in 2011 and 2012 to compare the khoai management practice developed in the project with the traditional management practice. The yield of khoai tang is much higher (approx. 11 times with grade 1 and 7 times with grade 2) in application of recommended practice than of traditional practice (Figure 7-4)

Figure 7-4. Yield of khoai tang in traditional practice vs improved practice



The recommended management practice significantly improved income for khoai tang farmers (Table 7-8). The traditional way of producing khoai tang is only suited to home consumption. To move towards commercial scale production, farmers must change their practice and invest their time and resources to improve khoai tang yield.

Table 7-9. Economic data from a demonstration trial in Xuan Son in 2011

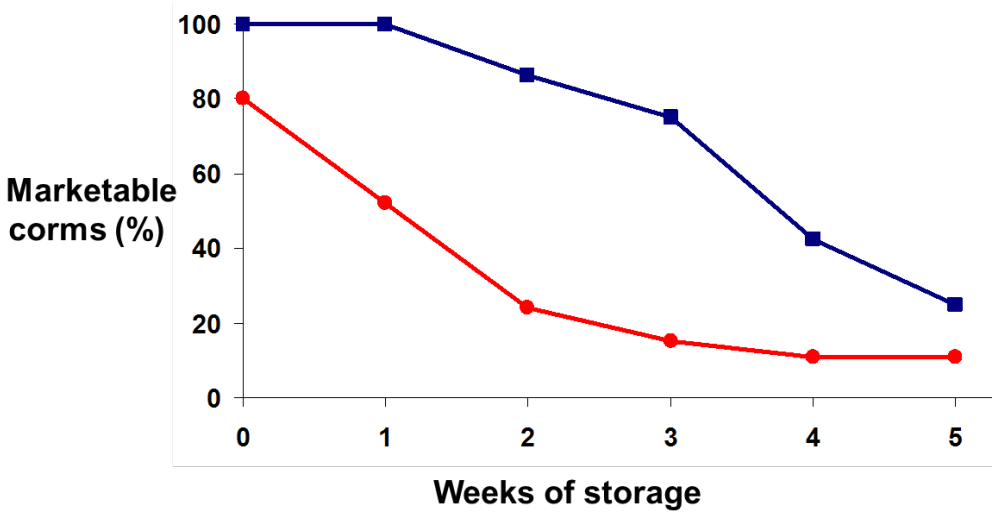
Practice	Investment (VND/sao)	Sales (VND/sao)	Profit (VND/sao)
Traditional practice	565 000	525 600	-39 400
Improved practice	1 950 000	4 988 800	3 032 800

Evaluating postharvest storage potential of khoai tang

Postharvest trials evaluated storage options for both corms and planting materials. Prior to these trials limited information existed on storage options. Storing corms at 12 C increased product storage life with 75% of corms still being marketable after 3 weeks storage (Figure 7-5). This compared with 15% of corms for ambient storage.

For planting material storage, 3 treatments were compared – traditional storage (corms laid out on floor/ground), net bag storage and in sand. Corms stored in the sand retained 100% viability until the next planting season, with high losses and/or reduced viability occurring in the other treatments.

Figure 7-5. Storage of khoai tang corms at 12 C (blue line) and ambient storage (red line)



Indigenous bitter melon – Muop dang

Literature

Introduction

Muop dang (*Momordica charantia*) also known as bitter melon, bitter gourd, pare or caraille, a member of the *Cucurbitaceae* family, is widely grown throughout Asia, Africa and the Caribbean. The plant is primarily grown for its fruit, however the young leaves and tips are also edible (Subratty et al, 2005). Fruit and leaf extracts are used for the production of tea. Aside from the production of muop dang for culinary purposes, the plant is in some cases used as an ornamental fruit (Behera et al., 2010). The bitterness of the fruit, a trait which muop dang has been selected for during domestication, is due to the alkaloid compound momordicine (Behera et al., 2010). This differs from other species within the *Cucurbitaceae* family which primarily draw their bitterness from cucurbitacins (Behera et al., 2010).

Muop dang has long been recognised for its medicinal properties with fruits and seeds known to have anti-HIV, anti-ulcer, anti-inflammatory, antimicrobial, anti-diabetic and anti-tumor properties (Kim et al, 2009). In traditional medicine oiled leaves or leaf extracts have been used to treat stings, bites, burns, rashes and reduce the effects and severity of fever (Wu and Ng, 2008; Subratty et al., 2005).

Nutritional components

Muop dang is a rich source of carbohydrate, proteins, essential amino acids and phenolic compounds. Within the protein fraction, levels are significantly higher in seeds compared to the fruit pericarp (Horax et al., 2010a; Bakare et al, 2010). Protein content of ripe muop dang fruit seeds are approximately 30%, with primary proteins present in muop dang

including albumin (49%), globulin (29%), glutelin (3%) and prolamin (trace) (Horax et al., 2010b). Younger leaves are a good source of protein however these levels decrease as leaves age. Younger leaves have a greater concentration of proteins, particularly structural proteins as these are required in order to satisfy the growth requirements of the plant (Zhang et al., 2009).

Despite being a good source of protein, 18.3% of the protein contained in muop dang seeds is non-extractable (Horax et al., 2010b). Muop dang protein is additionally hydrophobic, significantly more so than other commercially used sources, including proteins extracted from soybean (Horax et al., 2011). This restricts the overall functionality of the muop dang and in order to be utilised for commercial purposes, considerable alteration of the protein is required. The modification may prove to be valuable for food production, as proteins occurring in muop dang require a high temperature to denature. This trait could be of use where there is a need to maintain product stability at high temperatures (Horax et al., 2010b).

Muop dang fruit, leaves and seeds contain most essential amino acids with total amino acid contents equating to approximately 18% mole fraction. Based on current recommendations by the Food and Agriculture Organisation, these meet the minimum requirements set for dietary guidelines (Horax et al., 2011; Horax et al., 2010b). In a study by Kim et al (2009) arginine was identified in high quantities in muop dang varieties from Korea, China and Japan whilst cysteine and methionine were found to be limiting.

Phenolic compounds are well represented in muop dang and according to Kubola and Siriamorpun (2008) gallic acid is predominant across all edible plant parts. Primary phenolic acids identified in the fruit of muop dang include gallic acid, gentistic acid, catechin, chlorogenic acid and epicatechin. In the seed the main phenolic compounds include gallic acid, catechin and epicatechin (Horax et al., 2005).

Bakare et al (2010) recently completed a full nutritional and chemical composition analysis of muop dang, the results of which are presented below in table 1. Total energy concentration in kcal/100g for leaves, fruit and seed were 213, 242 and 177 respectively. In addition to the major macronutrients, muop dang also contains small amounts of magnesium, iron, manganese and copper. As observed in table 1, the levels of vitamin C are quite high, however according to Behera et al (2010) these vary significantly according to specific cultivars. This is particularly true of emerging varieties which have been bred to exhibit high vitamin C content, for example elevated vitamin C in Indian bitter melon cultivars measure 950 mg/kg compared to 500 mg/kg for standard cultivars (Behera et al., 2010). Trace amounts of vitamins including cholecalciferol (vitamin D), niacin (B3), phylloquinone (vitamin K) and pyridoxine (B6) were detected (Bakare et al., 2010).

Table 7-10 Nutritional and chemical composition of muop dang (Bakare, 2010)

Nutrient/ Vitamin	Content (ppm)
Potassium (K)	413
Sodium (Na)	2200
Calcium (Ca)	20510
Zinc (Zn)	120
Vitamin A (β-carotene)	0.03
Vitamin E (α-tocopherol)	800
Folic Acid	20600
Cyanocobalamin	5355
Ascorbic Acid (Vitamin C)	66000

Medicinal Benefits

The hypoglycemic activity of muop dang is well documented (Subratty et al., 2005; Klomann et al., 2010; Wu and Ng, 2008) and has been observed in both studies of rats and humans (Behera et al., 2010). The demonstration of hypoglycemic activity has failed to highlight the mechanism directly responsible. At the present time theory related to hypoglycemic properties of muop dang has been associated with the effects of antioxidants occurring in the fruit, or as a consequence of insulin regulation or glucose transfer influenced by compounds present in the plant. Studies by Klomann et al (2010) have indicated that lipids and saponins occurring in muop dang can reduce blood glucose levels. Protein tyrosine phosphatase (PTP 1B) which reduces the effectiveness of insulin receptors, have been shown to be directly impacted by muop dang saponins reducing PTP 1B activity by up to 25% in muscle cytosol, influencing insulin sensitivity and blood glucose levels. Research reported by Subratty et al. (2005) has also implicated muop dang saponin fractions, however this was not believed to be related to the effect of saponins on PTP 1B. In contrast saponins were documented to effect the chelation of sodium ions and glucose across cell membranes.

Muop dang is a good source of natural antioxidants and is particularly rich in phenolic compounds (Kubola and Sirimornpun, 2008). Reactive oxygen species can cause cellular damage which may include damage to proteins and DNA and oxidation of critical enzymes (Wu and Ng, 2008). The introduction of antioxidants and a consequent reduction in oxidative stress has been reported as having protective effects against cancer, diabetes and cardiovascular disease (Kubola and Siriamornpun, 2008). Free compounds such as phenols in muop dang, have been shown to possess strong free radical scavenging activity and better ion chelating activity than vitamin E (Wu and Ng, 2008; Kubola and Sirimornpun, 2008). Of the muop dang edible plant parts leaves were determined as having the highest total antioxidant capacity, followed by green fruits, stems and ripe fruits (Kubola and Sirimornpun, 2008). As observed in table 1 muop dang is also contains carotenoids such as vitamin A and vitamin C which are recognised as chemopreventative agents and may be utilised to inhibit oxidative stress.

Leaf extracts of muop dang have been documented as exhibiting antimicrobial behavior against *Escherichia coli, Staphylococcus, Pseudomonas, Salmonella, Streptobacillus and Streptococcus* (Omoregbe, 1996).

Despite the broad spectrum benefits of muop dang the edible plant has been shown to be toxic effects to laboratory animals when injected intravenously however low toxicity has been universally demonstrated by all muop dang plant parts when ingested orally (Subratty, 1995).

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Experimental and demonstration trials

Evaluating trellising and planting density options for muop dang

In Tan Son, muop dang traditionally grows wild in the forest. Over time, some farmers started to bring muop dang seedlings from the forest to grow in their home garden. However, even in home garden, muop dang was allowed to grow freely without a consistent density or well-established trellising. To find out the optimum setting for muop dang development, two different trellis types (A shape and horizontal) and planning densities were evaluated. The results show that number of fruits and yield are significantly different between treatments and highest in the treatment of horizontal trellis, 1m between row and 1m between plants (Figure 7-6). This option also proved to bring the best profit compared to other options based on the gross margin analysis (Table 7-11)

Figure 7-6. Effect of trellis and density on fruit number and yield

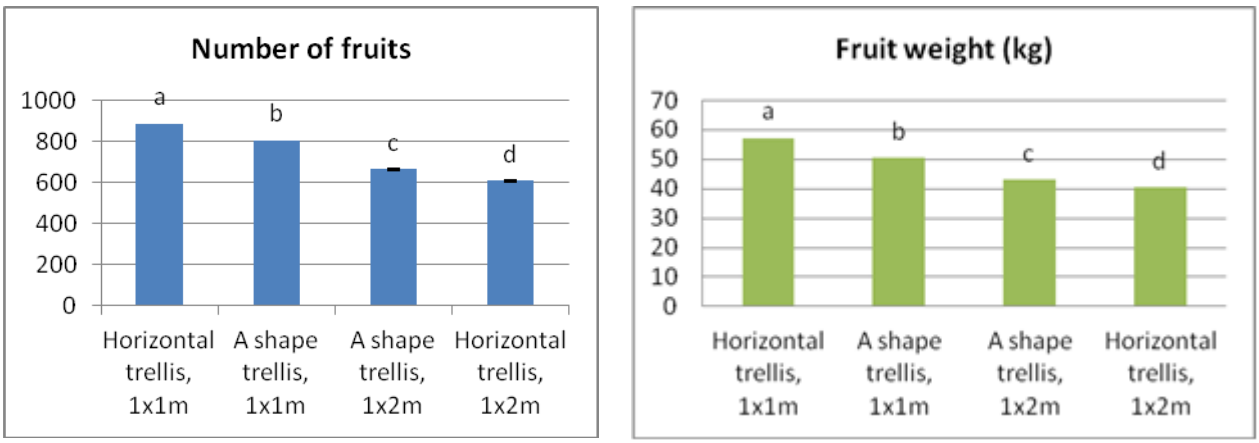

Table 7-11. Gross margin of treatments of trellising types and densities

Treatments	Gross Margins (VND/sao)
A frame trellis, 1mx1m	8 934 500
A frame trellis, 1mx2m	7 509 000
Horizontal trellis, 1mx1m	11 205 000
Horizontal trellis, 1mx2m	6 929 000

Management practice for muop dang semi-commercial production

Two on-farm demonstration trials were implemented in Xuan Son 2011 and 2012 to compare two management regimes: traditional practice and recommended practice developed by the project team. The muop dang field plot where improved management practice were employed yielded 59% more than the traditional practice plot.

Mong mustard - Cai meo

Literature

Introduction

Cai meo (*Brassica juncea*), a member of the *Brassicaceae* family is more commonly referred to as chinese mustard, common Indian mustard or common brown mustard. Cai meo is an annual, herbaceous plant, typically growing to around 50cm in height (Do et al., 2006). The plant has a yellow inflorescence, with elongate fruit which produces small, round black seeds. Cai meo is thought to have originated in the Middle Asian region, however with popularization of the species the plant is now grown throughout Europe, Asia, North America and Oceania (Do et al., 2006). The plant family is split into two categories for in terms of use: those species which are used as a vegetable where leaves, stems and roots are eaten and those species where seed is pressed into oil (Do et al., 2006). The cai meo which is grown in the north western province of Vietnams is part of the former category and its use as a vegetable is extremely popular not only in the highlands but also in the urban centres including Ha Noi.

Cai meo is recognised for its effects in reducing blood glucose and high antioxidant capacity which are involved in reducing the risk of cardiovascular disease and gastrointestinal tract cancers (Lin and Harnly, 2010; Valavala, 2011; Yadav, 2004).

Nutritional components

Cai meo is predominantly comprised of water and has an energy level (kJ) that is indicative of leafy vegetable varieties (see table 1). It is recognised as a good source of vitamin A, containing greater than 1000 µg/100g of β-carotene, a vitamin which is required for eye health and cell growth (see table 2) (Wills et al., 1984). As observed in table 2, cai meo is also rich in ascorbic acid or vitamin C, measuring 100mg/100g, a result confirmed by Krumbein et al. (2005). The content of vitamin C in cai meo is higher than typically occurs in other Asian leafy vegetable species (Krumbein et al., 2005).

Table 7-12. Proximate composition of cai meo (Wills et al., 1984)

Component	Content (g/100g) of edible portion*
Water	93.8
Protein	2.3
Fat	0.3
Glucose	0.4
Fructose	0.3
Sucrose	0.0
Starch	0.0
Dietary fibre	1.8
Malic acid	0.09
Citric acid	0.05
Oxalic acid	0.00
Total organic acids	0.14
Ash	1.6
Energy (kJ)	62

* Edible portion of cai meo is 94% with the only inedible portion being the roots

Table 7-13. Vitamin and mineral composition of cai meo (Wills et al., 1984)

Vitamin/ Mineral	Content (mg/100g of edible portion)
Ascorbic acid (Vitamin C)	100
Thiamin	0.06
Riboflavin	0.09
Niacin	0.6
Carotene α (µg)	140
Carotene β (µg)	1550
Cryptoxanthin	40
Sodium	3
Potassium	450

* Edible portion of cai meo is 94% with the only inedible portion being the roots

Cai meo and the *Brassica* family are well recognised for the dominance of sulfur compounds or glucosinolates (Lin and Harnly, 2010). These compounds are responsible for the distinctive smell of the *Brassica* species and have been linked to chemoprevention when consumed in significant quantities (Hayes et al., 2008). This mechanism is thought to be a consequence of gene modification through the alteration of key proteins (thiols) that are involved in the suppression of activity of nuclear factor κB (NF- κB), a protein complex which is associated with cancer and autoimmune disorders (Hayes et al., 2008). Krumbein et al. (2005) indicated that proportion of glucosinates present can be as high as 85-96% in cai meo, with a dominance of sinigrin, an anion which is said to be responsible for the bitterness of the vegetable species.

Cai meo contains high levels of flavonoid compounds, occurring a concentration of 0.8-2.3ppm (quercetin equivalent) in the vegetable leaves (Lin and Harnly, 2010; Kumar, 2010). 51 flavonoids have been identified in vegetable leaves with the primary flavonoids including kaempferol, quercetin, isorhammetin (Yokozawa et al., 2002).

Total phenols occurring in cai meo were measured at 4.3-8.3ppm gallic acid equivalent (Kumar et al., 2010). The amount of bound phenolics however was quite low, forming only

a minor fraction of the total phenolic compounds present (Harbaum, 2008). This is significant as bound phenolics significantly influence fermentation and biodegradability of fibre in the human colon (Harbaum et al., 2008). As a consequence of the low levels of bound phenolics in cai meo it is suggested that the vegetable should have nil negative impact on gastrointestinal health.

Medicinal Benefits

Cai meo has demonstrated antioxidant properties with glycosides occurring in the leaves recorded as possessing $ONOO^-$ and DPPH scavenging activity (Jung et al, 2009; Valavala et al., 2011). It is the high antioxidant potential of cai meo which is believed to be responsible for both the reversal or halting of ocular degeneration and reduction in oxidative damage associated with diabetes mellitus (Valavala et al., 2011; Yokozawa et al., 2002). Oxidative stress and damage to proteins is considered to be the major mechanism responsible for diabetic cataract, a complication of diabetes mellitus (Valavala et al. 2011). In a study conducted by Valavala et al. (2011) daily doses of 250 mg/kg and 500 mg/kg of cai meo leaf extract were given to streptozotocin (STZ) diabetes induced rats over a period of 8 weeks. Over the trial period delayed diabetes cataract progression and maturation were observed with the higher dose linked to a greater level of ocular protection (Valavala et al., 2011). Through measurement of antioxidant scavenging behaviour and the polyol pathway it was suggested that gylcemic control, inhibition of the aldose reductase pathway and high antioxidant levels were responsible for observed changes in diabetes cataract (Valavala et al., 2011). Yokozawa et al. (2002) investigated more specifically two flavanoid compounds, isorhamnetin and isorhamnetin giglucoside and their effects on oxidative damage occurring as a consequence of diabetes mellitus. In vivo and in vitro studies carried out on STZ diabetes induced rats indicated that isorhamnetin had a demonstrated effect on reducing DPPH radicals, serum glucose and glycosylated proteins (Yokozawa et al., 2002). This mechanism was indicated therefore as responsible for a reduction in oxidative stress occurring as a result of diabetes mellitus.

In traditional medicine cai meo is used to treat coughs, bronchitis, fever and rheumatism (Do et al., 2006). This is normally given as a dose of 3-6g of medicinal powder or in the case of rheumatism applied as a poultice directly to the skin for approximated 15-20 minutes (Do et al., 2006).

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Experimental and demonstration trials

Implementing year-round production for cai meo

In winter from September to February, cai meo grows very well. Farmers often sow cai meo seed in August and transplant in September. However, from April to July, it is hard to find cai meo in the market or if there is, it is very expensive as cai meo is hard to grow in this season, especially in the seedling stage due to heavy rain. Can cai meo be grown all year around and how effective it is compared to the main season in winter? A trial was conducted on different planting times in Sa Pa in 2010 to answer this question and find out the most suitable planting method for each season. The results have shown that cai meo can be grown all year around (Figure 7-7). From April to July, it is best to sow seeds directly and harvest the whole plants after 50 – 60 days. Farmers can make profits from off-season cai meo grown this way as the price of cai meo is often very high in summer.

Figure 7-7. Cai meo planting season and planting - harvesting methods

August – October Early-Mid season	November – January Late season	February – March End of season	April – July Off-season
• Transplanting • Harvesting whole plant or leaves subsequently	• Transplanting • Harvesting leaves subsequently	• No planting • Harvesting leaves and flower stems	• Direct sowing • Harvesting whole plants

Unfolded cabbage – Bap cai xoe

Implementing year-round production for bap cai xoe

Bap cai xoe is a familiar vegetable to the local farmers in Bac Ha. They know how to produce a good bap cai xoe crop. Most of the farmers only plant bap cai xoe in September when the production is the most productive. This leads to an oversupply and low price

issue during peak harvest time. A trial was implemented in different planting times in Bac Ha in 2010 and 2011 to evaluate the potential of extending bap cai xoe growing season. Table 7-14 compares the average yield of bap cai xoe obtained in off-season, early season, main season and late season.

Table 7-14. Average yield bap cai xoe in different planting seasons

	Early season	Mid-season	Late season	Off-season
Average yield (kg/sao)	989.2	1130.4	972.4	718.8

Early season: planted in late July

Mid-season: planted in Mid-September

Late-season: planted in Mid-November

Off-season: planted in Mid-June

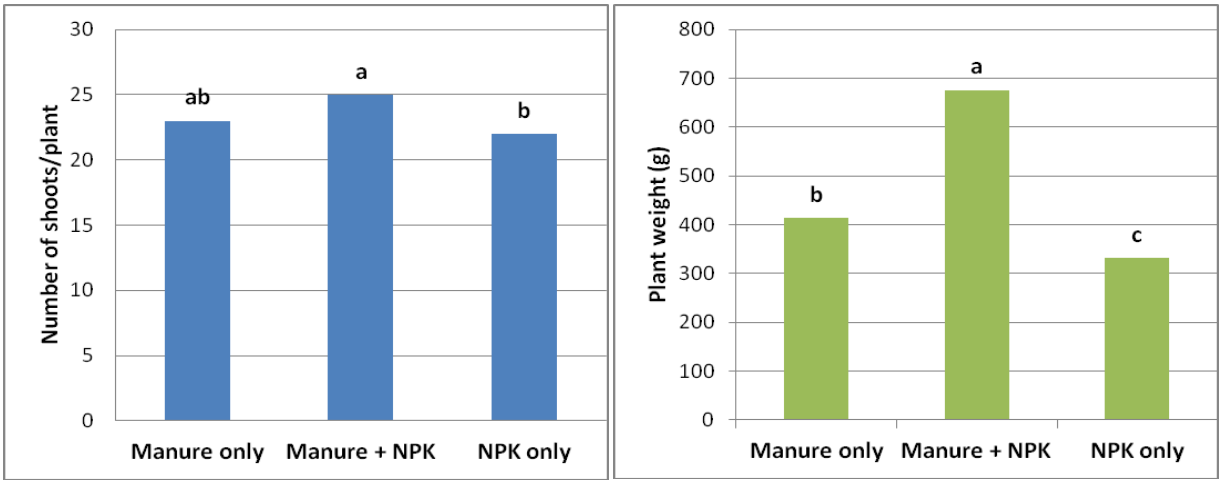
Developing a fertiliser strategy for bap cai xoe

To improve the productivity of producing bap cai xoe, a simple replicated trial was designed to find out the optimum fertiliser strategy for bap cai xoe. The treatments were 1) Composted manure only; 2) Composted manure and NPK combination and 3) NPK only.

Figure 7-8 indicates that applying composted manure in combination with NPK resulted in the best plant weight and number of young shoots. The plant weight harvested from the composted manure and NPK combination treatment was 49% higher than that from the NPK only treatment and 39% higher than from the manure only treatment.

This result suggests that the farmer should apply both organic and mineral fertilisers to improve yield and income from bap cai xoe production.

Figure 7-8. Effect of fertiliser treatment on number of shoot per plant and plant weight of cai bap xoe (Manure only: 10 tons/ha; Manure + NPK: 10 tons manure + 600kgNPK/ha; NPK only: 600kg/ha)



Selection for true indigenous types of bap cai xoe

During the implementation of bap cai xoe trials in Bac Ha in 2009 – 2010, one issue noticed by both farmers and project team was that there was much variability in bap cai xoe plant characteristics. According to the farmers who had experience with growing bap cai xoe in the area, the true indigenous characteristics of bap cai xoe were being lost through long time cultivation. Therefore, an activity of selecting and evaluating plants that exhibit the true indigenous characteristics was proposed. This activity would enable the selection of the best plants for seeds for next years crop and introduce to farmers the

basic method of selection and maintaining good plant characteristics. The method for selection was adopted by the local team based on the idea of using coloured stickers, which they had learnt from the Facilitation Training Workshop. Twenty farmers were invited to the selection activity which involves the following steps:

Step 1: Sticks were used to mark individual plants which exhibit true indigenous characteristics. The group appointed the 3 most experienced cai bap xoe growers to conduct this step. Each farmer was given 15 sticks and walked through the planting put the sticks down next to the plants she/he selected. A prioritised plant could have more than one stick.

Step 2: Each of the 20 farmers was given 5 red stickers to mark the 5 best plants she/he selected from the earlier prioritised plants.

Step 3: The 15 plants with the most red stickers were then selected. These were then ranked according to the number of red stickers. If 2 plants had the same number of stickers, the one with more sticks was selected.

Step 4: The group then got together to discuss the true indigenous characteristics of cai bap xoe and how to recognise typical plants.

This simple selection method has been successful in raising the farmers' awareness to the importance of maintaining the consistent quality of true indigenous vegetable types.

7.3.2 Develop strategies that improve safe product at the on-farm level (in Australia)

Review on-farm tools for measuring plant nitrate

A scientific paper from this work was published in *Scientia Horticulturae* 2012 134: 1-6.

The paper reviewed three tools that have been recommended for on-farm monitoring of crop nitrogen status: nitrate selective electrodes, nitrate-sensitive test strips, and chlorophyll meters. The electrodes and test strips analyse plant sap, which in addition to nitrate, also contains other substances, including chloride. These substances decrease the accuracy of nitrate measurements made using ion selective electrodes more than those made using test strips. Chlorophyll meters indicate whether sufficient N has been assimilated to maximise plant production, but provide no information about current supply or whether excessive nitrate has accumulated in the leaves. Consequently, chlorophyll meters may be useful for on-farm monitoring of crop N status; however, for managing both the sufficiency of N supply and nitrate levels, nitrate test strips only can be recommended. Greater general awareness of the weaknesses of field N testing methods (Table 7-15) would lead to better guidelines for their use, and perhaps, improvements in the technologies.

Table 7-15. Comparison of several rapid nitrate test methods by ease of use

Table 1. Comparison of several rapid nitrate test methods by ease of use

Method	Steps required for testing	Suitability for testing plant nitrate
Nitrate selective electrode	Two-point calibration of instrument	Potential for inaccurate measurements
Test strips - semi quantitative	Sample dilution	Suitable for general estimates
Test strips – quantitative with nitrate reflectometer	Sample dilution	Suitable for accurate measurements
Chlorophyll meter	Quick instrument calibration	Not applicable

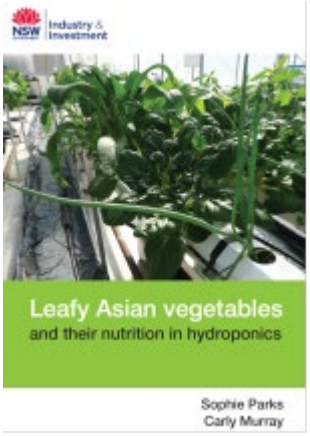
7.3.3 Identify and test improved through chain management to maintain quality and food safety

Researching postharvest techniques to maintain IV quality from farm to market has consistently been identified as an area of further research at both the Stakeholder Workshop, in our ongoing work with the Indigenous Products Cooperative in Na Hoi and through our discussions with Hanoi retailers. Within the context of this project we have undertaken:

- A postharvest trial to determine the postharvest storage potential of khoai tang
- Incorporated recommendations for improved postharvest management in our FBS manuals
- Developing an FBS module specifically on Food Safety
- Working with the Indigenous Products Cooperative to enable them to get Safe Vegetable accreditation and ultimately VietGAP accreditation.

7.3.4 Identify and develop emerging Asian vegetables for the wider Australian market

Grower guidelines were published from this work as a hard copy and online available at NSW Department of Primary Industries:



Kang Kong in still solution hydroponics

Production of Kang Kong in NFT was tested but it was unsuccessful due to the prolific growth of roots in the hydroponic channel which impeded the flow of the nutrient solution. However, still hydroponics was very suitable. The plants were harvested after three months with about 4 L remaining in the tanks. As the solution was used by the crop, the remaining salts became more highly concentrated. The EC of the tanks at the start of the experiment was about 1.6 dS/m and this increased to about 10.0 dS/m at harvest. Each plant yielded between 500-700 g shoots. They could have been cut earlier (about 20-30 days after planting) and regrown with the remaining solution, producing a higher total yield. The crop was grown in a heated greenhouse over winter. Faster growth could be expected in summer, but the starting solution would need to be less concentrated to give plants a better chance at coping with the hotter temperatures.

Centella in a substrate system with a recirculated nutrient solution

Centella (Centella asiatica), with its creeping habit, it is unsuited to production in NFT as it impedes the flow of nutrient solution down the channels. However, Centella can be grown successfully in an inexpensive substrate system. An alternative system for Centella production is to grow plants in substrate placed on a gently sloping bench. Nutrient solution is delivered via drippers placed on the substrate, and the runoff drains to a collection point, then into a tank with a pump that redirects it back to the drippers.

Leafy Asian vegetables in NFT

Experiments determined that production of the ten vegetables is suitable at concentrations of nutrient solution between 1.5-2.5 dS/m, with Mustard Cabbage preferring a higher concentration range (2.5-3.5 dS/m). Managing the nutrient solution in these concentration ranges is an efficient practice as it allows for optimum growth but using the least amount of fertilisers.

Determine the nitrogen nutrition of some leafy Asian vegetables and methods for on-farm measurement of plant nitrate

For optimum growth, pakchoi required a higher critical nitrate-N supply of 79 mg/L (95% C.I. =54,124 mg/L), than coriander at 37 mg/L (95% C.I. =33,42 mg/L) and amaranth at 19 mg/L (95% C.I.=17,40 mg/L), and had the highest concentration of nitrate in shoots. Increasing the nitrate supply above critical levels considerably increased the nitrate concentration in pakchoi and amaranth shoots, highlighting their capacity to accumulate nitrate. The shoot nitrate concentration of coriander did not relate well to nitrate supply. However, the sap nitrate concentrations of both coriander and amaranth were responsive to nitrate supply. Since the sap nitrate concentration of pakchoi was not responsive to the nitrate supply in solution, its petiole sap has limited potential as a crop management tool.

Evaluate bitter melon as an Australian greenhouse crop

The first greenhouse experiment demonstrated good growth under temperate winter conditions. However, plant density was too high and was decreased for the second experiment. Production data for the six varieties of the second greenhouse experiment is yet to be processed but good crop quality was obtained. The vegetable farmer in Sydney selected the variety Jade to evaluate on farm as it produced the largest fruits and was considered by the farmer to have the most potential for profits. Unfortunately, the crop failed outdoors due to the very wet summer conditions. The six varieties of bitter melon differed in their phenolic compounds and antioxidant activity and the dried samples had less of both compared to the frozen samples. The smaller varieties, Niddhi and Indra, had the highest ($p<0.05$) phenolic compounds and HPLC peaks. For the consumer survey there did not appear to be any preference for one of the four varieties in particular and the level of bitterness of the varieties was not apparent amongst the group. A larger survey may or may not confirm this lack of trend. However, there did appear to be a relationship

between the bitterness of melon samples and their tastiness and acceptability. The more bitter the sample was perceived to be, the least tasty or acceptable it was.

Evaluate gac as an Australian greenhouse crop

Plants germinated from seed in seed-raising mix under warm and humid conditions were grown hydroponically to maturity in a climate controlled greenhouse during a temperate winter, producing fruits that were harvested ripe, from 44 weeks after sowing. Cuttings taken from female plants were dipped in indole-3-butyric rooting hormone powder or gel, or were left untreated, and then placed in rock wool, potting mix, water, or closed media sachet. All treatment combinations, with the exception of the untreated potting mix, permitted the development of healthy plants in a second greenhouse crop. Growing plants from seed, then vegetatively increasing the number of productive female plants by cuttings is a means to increase Gac production with limited resources. Gac production using greenhouse technology, is relevant to other temperate regions. The finding that larger fruits have a higher percentage of the edible aril than smaller fruits provides a new area of investigation towards enhancing production.

Determine the nitrogen nutrition of some leafy Asian vegetables and methods for on-farm measurement of plant nitrate

For optimum growth, pakchoi required a higher critical nitrate-N supply of 79 mg/L (95% C.I. =54,124 mg/L), than coriander at 37 mg/L (95% C.I. =33,42 mg/L) and amaranth at 19 mg/L (95% C.I.=17,40 mg/L), and had the highest concentration of nitrate in shoots. Increasing the nitrate supply above critical levels considerably increased the nitrate concentration in pakchoi and amaranth shoots, highlighting their capacity to accumulate nitrate. The shoot nitrate concentration of coriander did not relate well to nitrate supply. However, the sap nitrate concentrations of both coriander and amaranth were responsive to nitrate supply. Since the sap nitrate concentration of pakchoi was not responsive to the nitrate supply in solution, its petiole sap has limited potential as a crop management tool.

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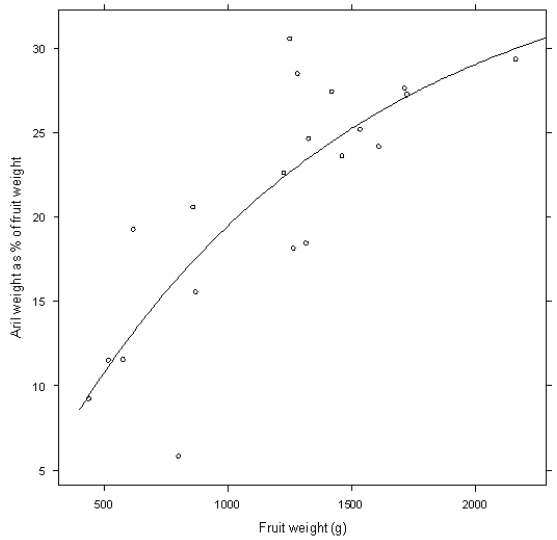
For the consumer survey there did not appear to be any preference for any one of the four varieties tested and the level of bitterness of the varieties was not apparent amongst the group. A larger survey may or may not confirm this lack of trend. However, there did appear to be a relationship between the bitterness of melon samples and their tastiness and acceptability. The more bitter the sample was perceived to be, the least tasty or acceptable it was.

Evaluate gac as an Australian greenhouse crop

A scientific paper from this work will be published in Experimental Agriculture (accepted 3/11/2012).

Plants germinated from seed in seed-raising mix under warm and humid conditions were grown hydroponically to maturity in a climate controlled greenhouse during a temperate winter, producing fruits that were harvested ripe, from 44 weeks after sowing. Cuttings taken from female plants were dipped in indole-3-butyric rooting hormone powder or gel, or were left untreated, and then placed in rock wool, potting mix, water, or closed media sachet. All treatment combinations, with the exception of the untreated potting mix, permitted the development of healthy plants in a second greenhouse crop. Growing plants from seed, then vegetatively increasing the number of productive female plants by cuttings is a means to increase Gac production with limited resources. Gac production using greenhouse technology is relevant to other temperate regions. The finding that larger fruits have a higher percentage of the edible aril than smaller fruits (Figure 7-9) provides a new area of investigation towards enhancing production.

Figure 7-9. The percentage of edible aril increases as gac fruit size increases.



Research on gac production is continuing and is being conducted by Ms Xuan Tran as part of a PhD project (Newcastle University). This project aims to determine the requirements for gac production so that the yield and quality of fruits is enhanced.

7.4 Develop communication strategies that facilitate practice-change in women smallholders

Refer to Appendices: 11-12 and 11-15

A *Farmer Business School (FBS)* was developed and piloted in Phu Tho and Lao Cai. The FBS covered both technical and business aspects of indigenous vegetable production and marketing. Developing the *Resource Library* for the *FBS* resulted in the development of 15 manuals and 1 DVD set on Value Chain Development. Through an early needs assessment these resources were designed to meet the needs of women farmers in the six communes in which we were working. They also incorporate much of the results and learnings from the research phase of the project. Finally draft versions of these manuals/DVDs were utilised to pilot the FBS in Phu Tho and Lao Cai. An evaluation plan was also designed but not implemented due to the relocation of the key M&E person from Hanoi to Ho Chi Minh. Further work is needed to ensure that the *FBS* evolves into a sustainable model. Specifically there is a need to utilise provincial and district staff as the primary trainers and to focus on building their capacity. Developing sustainable models for up-scaling and out-scaling of *FBS* will be a key feature of the next project *AGB-2012-059*

Towards more profitable and sustainable vegetable farming systems in north-western Vietnam. A full list of *FBS* resources is provided below (hard copies of these resources have been provided to ACIAR and further copies can be obtained from this reports authors or through the VWU Publishing House).

List of FBS resources produced in AGB-2006-112

Doan VV and Newman P (2013) Planning and Budgeting. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 20pp.

Hoi DV, Thieu ND and Muller F (2013) Cai bap xoe Trainer's Guide – Theory. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 27pp.

Hoi DV, Thieu ND and Muller F (2013) Cai meo Trainer's Guide – Theory. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 31pp.

Hoi DV, Thieu ND and Muller F (2013) Khoai tang Trainer's Guide – Theory. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 30pp.

Hoi DV, Thieu ND, Ha NTT and Muller F (2013) Muop dang Trainer's Guide – Theory. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 22pp.

Kien CD and Smith M (2013) Cai meo Trainer's Guide – Practical. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 46pp.

Kien CD and Smith M (2013) Khoi tu Traner's Guide – Practical. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 28pp.

Kien CD, Smith M (2013) Cai bap xoe Trainer's Guide – Practical. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 54pp.

Son LT, Cong DQ and Binh NT (2013) Khoi tu Trainer's Guide – Theory. *Famer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 20pp.

Tho PTH, McBride, Hien PT, Doan VV, Sau NT, Thoa DTV, Nga PTT and Newman S (2011) Value chains – Why I should work with others? *Farmer Business School Manual* (DVD set).

Linh DTN, Thoa DTV, Nga PTT and Hien NTT (2013) Microfinance. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi.

Thoa DTV, Nga PTT, Hien NTT, Toan L and Smith M (collected and edited). Games. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 24pp.

Toan L and Smith M (2013) Khoai tang Trainer's Guide – Practical. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 35pp.

Toan L, Smith M (2013) Muop dang Trainer's Guide – Practical. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 44pp.

Toan L, Smith M and Muller F (2012) Composting Trainer's Guide – Theory. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 18pp.

Toan L, Smith M and Muller F (2012) Composting Trainer's Guide – Practical. *Farmer Business School Manual*. Vietnam Women's Publishing House, Hanoi. 31pp.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The project has generated considerable new information on the production and marketing of indigenous vegetables in North West Vietnam. Approaches taken and information generated on improved propagation and production methods and value chain analysis for these vegetables are expected to be readily utilised by other projects or proposed projects, such as the Vietnamese Government funded indigenous knowledge project being undertaken by VAAS (*Towards sustainable agricultural production in the Highlands - a study on indigenous knowledge and crops and the establishment of models to look at production management aspects*).

Likewise methodology utilised in this project particularly in the area of sensory evaluation is likely to be readily applied to other work. For example, the approach used in the cai meo consumer taste panel required capacity building of staff from CASRAD, VWU and PPsD Lao Cai. Staff developed skills in: 1) Defining the research objectives; 2) Product selection, storage and preparation; 3) Consumer survey design and analysis; 4) Facilitation training and 5) Sensory evaluation logistics (eg. presentation of samples to consumer panels). These skills represent an improvement on approaches which have been previously used to obtain consumer data within these organisations and are likely to lead to more robust data sets for both this and future projects.

Information on indigenous knowledge, botanical descriptions and medicinal benefits, together with photographs of indigenous plants are likely to prove useful additions to the Rotary *Learn and Grow* database (produced by *Food Plants International*) which includes 1250 edible Vietnamese plants. Links with our project partner the National Institute of Medicinal Materials (NIMM) are likely to be fruitful for both groups.

Gaps in scientific knowledge have also been readily identified and this has led to the *proposed* development of two Masters/PhD topics to address these:

1) Improvements in aspects of bitter melon (*Momordica charantia*) production and quality

2) Improving the uniformity, quality and organoleptic traits of Vietnamese indigenous vegetables such as cai meo (Mong mustard).

On the Australian side, there have also been some advances, with recommendations for production of Asian vegetables in hydroponics likely to improve commercial production. However, it is too early to measure the uptake of the recommendations in the field. Implementation of the recommendations will also result in the reduced risk of kang kong becoming a weed in tropical areas, and the production of leafy Asian vegetables with greater efficiency in nitrogen fertiliser management. Identification of the stem apex as a suitable plant part to sample for the analysis of nitrate status in *Amaranthus tricolor* will permit growers to use plant analysis as a tool in the management of this crop

Recent work on the quality components of Bitter Melon as a part of this project has stimulated further interest in this field and has lead to a new PhD research proposal by honours student Tan Sing Pei at the University of Newcastle. Her thesis proposal will address *Preparation and encapsulation of bioactive extracts from bitter melons*. Likewise the success of the work on Gac has seen RIRDC support a new project.

In the future, indigenous vegetables and their utilisation are likely to become increasingly important. It will be important in any new ACIAR endeavours on vegetable crops that indigenous vegetables and medicinal plants feature strongly in this work. If that is the case then it is likely that this will lead to considerable scientific impacts in the future.

8.2 Capacity impacts – now and in 5 years

Engaging *Fresh Studio Innovations Asia* as a consultant during the scoping phase of the project re-design provided the project team with exposure to new ideas and approaches in undertaking market research. Capacity was particularly built during the analysis phase with project partners working along side the *Fresh Studio* team. Pham Thi Hanh Tho who now heads up the marketing component of this project found this interaction particularly valuable and is now looking to put these new skills/ideas to use both within the context of this project but also as she and others undertake value chain analysis for other projects.

The relocation of project leader, Dr. Suzie Newman, to Vietnam, and daily interaction with the project coordinator, Dr. Phan Thuy Hien, has provided ongoing capacity building opportunities in research and management. Working closely with the project leader, the project coordinator has extended her knowledge on production, postharvest and supply chain (Previously, she had been focused just on plant pathology). She also has had opportunities to improve her spoken English, scientific writing, communication and technical reporting. By discussing project works with and joining the project leaders in all the meeting with project partners and international colleagues, the project coordinator has built up her communication and problem solving skills. This will enable her to be more confident in working with projects involving multiple partners. The project leader's regular supports has strengthened the linkage of project coordinators to project partners in organising and implementing project activities.

Workshops form a key communication and planning mechanism in most projects. However good facilitation is essential to ensure that the time and resources invested reap the desired benefits. This is particularly the case where wider consultation with and the active involvement of project stakeholders is sought. In Vietnam, workshops are normally delivered in a traditional form with a series of formal presentations, with limited opportunities for discussion and participation. Given the nature of workshops in Vietnam, there has been little demand for good facilitation skills. However this is changing and increasingly projects are looking for good facilitators to run stakeholder workshops. Developing facilitation skills is therefore critical to ensure active participation.

Effective facilitation was identified as a pressing training need for the IV project team in the build-up to our stakeholder workshop in August 2010 looking at '*How do we bring about change in the marketing and production of indigenous vegetables?*' To address this the Crawford Fund provided co-funding (together with AGB/2006/112) to bring Professors Barbara Chambers and John Spriggs from University of Canberra to Vietnam to run a training course on *Facilitation Training using a Collaborative Problem Solving Methodology (CPSM)*. CPSM is a participatory approach that pulls together value chain stakeholders to determine the key issues, priorities and action plans. This empowers stakeholders to drive the change process. Specifically, in the case of our project we have used it to identify key marketing and production issues for indigenous vegetables and to select potential marketing interventions. The training course provided participants with the skills needed to facilitate our CPSM workshop. The 5 day training course was attended by 16 team members representing 7 Vietnamese agencies. Participants were introduced to the CPSM approach, taken through the workshop design process and then developed the actual workshop for the following week. Other topics covered included value chain analysis and approaches to participatory development. The course was extremely interactive enabling participants to practice utilizing their skills throughout the course. Participants also had the opportunity to put their skills straight into action at our project stakeholder workshop the following week and they have continued to utilize these skills in their day-to-day work activities. These skills are also being further built on as we implement our Farmer Business School (FBS) program. A full report on the training

program including two case studies demonstrating the application of skills is attached as Appendix 11-11.

Other significant training initiatives have been in the area of building effective writing skills and biometric skills. The success of the writing course has also been built on with a similar Crawford Funded initiative - targeting the development of farmer fact sheets - being undertaken in Cambodia as part of HORT/2006/107. Building statistical design and analysis skills will be critical to ensuring scientific rigour in survey/experimental work and that future scientific impacts are realised. Capacity in the area has been built in a number of ways:

- NSW DPI biometrician Ms Lorraine Spohr in conjunction with team member Dr Sophie Parks working with the team to develop more effective designs and robust analyses. NIMM team members are particularly keen to improve their biometric skills and will readily apply what they have learned to other projects. Mr Le Thanh Son's (JAF PhD scholar) placement at Gosford Primary Industries Institute from 2012/13 will also enable him to further build his capacity in this area and upon his return to NIMM impact others.
- Assisting project team members to access the free (for developing countries) statistical software package *Genstat Discovery*.

The project has also benefited from the contribution made by our two Australian Youth Ambassadors for Development (AYADs) – Ms Felicity Muller (Agricultural Communications Officer, NIMM) and Ms Rebecca McBride (Agricultural Marketing Officer, VWU). Highlights of Felicity's tenure have included: the development of the effective writing courses (Appendix 11-12) and looking for opportunities to build the capacity of the NIMM analytical team in developing their literature review skills. Rebecca has worked with the CASRAD team on restructuring the style of their value chain reports and this is likely to impact their approach to similar studies for other projects, particularly those in the ACIAR Agribusiness program.

During the life of the project, two of our team have been successful in gaining John Allwright Fellowships (JAFs) to undertake PhDs in agribusiness and agronomy. As they return to Vietnam, and take up leadership roles – the skills and scientific rigour that they have developed during their postgraduate studies is likely to have a flow on effect to further projects and enable them to more effectively train new staff entering their institutions.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Hanoi retailers and wholesalers are looking to source fresh vegetables from Lao Cai and other NW provinces, but for several reasons including poor market linkages, production scheduling, postharvest management and transport infrastructure this opportunity is not being fully realised. Linking farmers to these urban markets and improving postharvest management is likely to see the realisation of some of this market potential. Specifically for indigenous vegetables there is also a need to promote IVs amongst urban consumer who have limited knowledge about IVs including how to utilise them. That said given Vietnamese consumers propensity for healthy and unique products – it is likely to result in a rapid market expansion – where demand exceeds supply.

Farmer Marketing Groups such as *Di Thang Indigenous Products Cooperative* in Bac Ha have shown the potential for increasing returns to smallholders through group marketing initiatives. For example, during the peak season cai meo (Mong mustard) in Bac Ha commonly retails for VND 4000/kg (USD 0.19/kg), by targeting markets further a field (eg. specialist retailers and wholesalers in Hanoi) Di Thang farmers have been able to receive VND 7500/kg (USD 0.35/kg). This equates to an 88% increase in farm gate price. Market

demand for Bac Ha produced vegetables is high but there is a need to overcome current postharvest and transport constraints to realise this potential.

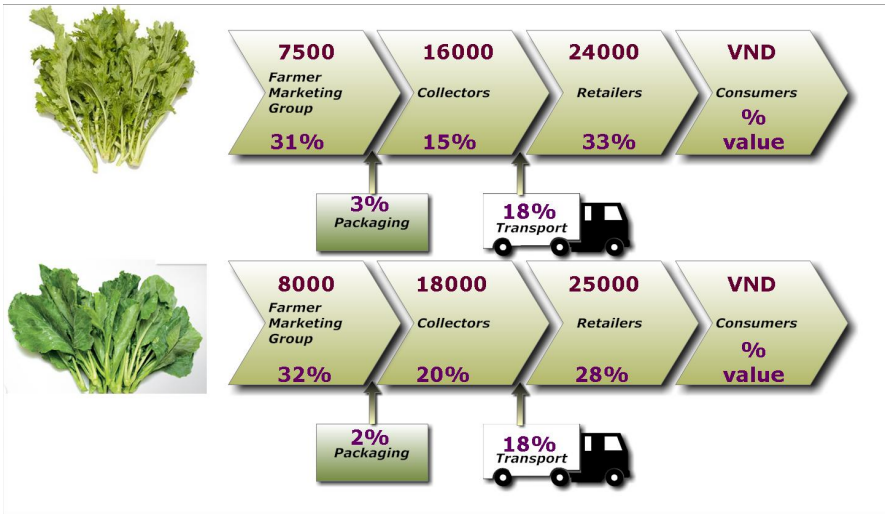


Figure 8-1. Value chains for cai meo (H'mong mustard) and bap cai xoe (unfolding cabbage). Source: Di Thang Cooperative, Bac Ha.

8.3.2 Social impacts

There has been no evaluation of social impacts occurring as a direct result of project activities within Lao Cai and Phu Tho province. However in Sa Pa commune, Lao Cai Province where vegetables have been introduced as part of a previously rice only rotation, farmers immediately opposite the project location have begun to replicate project trial plantings. Direct replication of trial sites is additionally occurring at other project locations. Without proper analysis it is difficult to suggest that this is leading to increased incomes of these households and as such subsequent social implications. However as the farmers within these areas have little flexible income and are as such more risk adverse by nature it is proposed that they must have observed greater social and economic benefit from the production of indigenous vegetables to adopt these practices without full project support.

In addition to the assumed benefits this project has been important in recognising the role that women play in smallholder agriculture. The implementation of successful research trials and coordination of the Vietnam Women's Union may lead to a greater focus on engaging female farmers in future projects.

8.3.3 Environmental impacts

Encouraging the wider planting of indigenous vegetables is likely to retain biodiversity within each of the project regions. Equally facilitating the development of markets for these products is likely to see an expansion in indigenous vegetable plantings.

From April-December 2009, training was provided by PPsD Phu Tho on compositing to farmers in Xuan Son, Xuan Dai and Minh Dai communes. Following this training a little over 50% of farmers continued to make compost for their home gardens, producing approximately 30 tons of compost. Utilising compost in this way will not only improve the physical, chemical and biological properties of soil, but also enables waste products to be utilised effectively thereby decreasing the reliance on inorganic fertilisers. This is also likely to translate into economic benefits.

Encouraging the wider planting of indigenous vegetables is likely to retain biodiversity within each of the project regions. Equally facilitating the development of markets for these products is likely to see an expansion in indigenous vegetable plantings.

8.4 Communication and dissemination activities

8.4.1 Major workshops and planning meetings

28th July 2009 - Team planning meeting - VWU, Hanoi

22nd September 2009 - Scoping study planning meeting - VWU, Hanoi

2nd -3rd November 2009 – Revitalisation Workshop – Hanoi. Electronic book produced of proceedings

Consultation with provincial, district and commune leadership and farmer groups

November 2009 - Official launch of project in Lao Cai

28th January - 3rd February 2010 - A series of meetings with women farmers in each of the project communes (25-30 women per meeting) to discuss training needs and preferred training options.

11th December 2009 - Value Chain Analysis Training Workshop - CASRAD, Hanoi

2nd–6th August 2010 – Developing ACIAR project partner skills in facilitation, using a collaborative problem solving methodology (CPSM) – Crawford Fund/ACIAR, Hanoi

10th– 11th August 2010 – Stakeholder Workshop – How do we bring about change in the marketing and production of indigenous vegetables? - Sa Pa, Lao Cai

12th August 2010 – Planning Meeting – Sa Pa, Lao Cai

In addition to major workshops and planning meetings, component teams (ie. Production Team, Marketing Team and Farmer Business School Team) have had regular team meetings together with the Project Leader and Project Co-ordinator.

8.4.2 Major project events/activities

27th November 2010 – Khoai tang degustation – Thanh Son, Phu Tho

28th December 2010 – Cai meo consumer taste panel – Lao Cai city, Lao Cai

30th December 2010 – Indigenous vegetable restaurant challenge – Sa Pa, Lao Cai

17th -22nd March 2011 – Hosting the Crawford Fund NSW Committee on their visit to North West Vietnam http://www.crawfordfund.org/training/states/nsw.html

FBS related activities

19th-20th January 2011 – FBS Writing Workshop – producing Trainer Guides – Theory – Hanoi

24th-25th January 2011 – FBS Writing Workshop – producing Trainer Guides – Practical – Viet Tri, Phu Tho

11th-12th March 2011 – Compost TOT – Bac Ha, Lao Cai

March/April 2011 – Compost Farmer Training – Bac Ha, Lao Cai

April 2012 – 5 day TOT – Phu Tho, Lao Cai

"Development of Farmer Marketing Group in Bac Ha - Lao Cai". Presented by La Thi Lieu, Farmer Marketing Group leader in Na Hoi, at the JICA Workshop on organic vegetable production, Hoa Binh 10 October 2011

Indigenous Vegetables Project Newsletters

Hien PT (2010a). *ACIAR Indigenous vegetables project newsletter* – January 2010.

Hien PT (2010b). *ACIAR Indigenous vegetables project newsletter* – March 2010.

Hien PT (2010c). *ACIAR Indigenous vegetables project newsletter* – May 2010.

Hien PT (2010d). *ACIAR Indigenous vegetables project newsletter* – October 2010.

Hien PT (2011a). *ACIAR Indigenous vegetables project newsletter* – April 2011.

Hien PT (2011b). *ACIAR Indigenous vegetables project newsletter* – December 2011.

8.4.3 Media coverage

TV and Radio

Khoai tang consumer taste panel in Thanh Son on Phu Tho Radio and Television (on 28 November 2010) (copy available upon request)

Khoai tang consumer taste panel in Thanh Son on Voice of Vietnam VOV (November 2010)

Indigenous vegetable cooking challenge in Sa Pa on Lao Cai Radio and Television (on 31 December 2010) (copy available upon request)

Development of indigenous vegetables in Bac Ha on Bac Ha Radio and Television (on 8 May 2011)

Commercial Production of Indigenous Vegetables in Bac Ha. Article by Ngoc Thuy, Bac Ha Television, on Bac Ha website and Lao Cai newspaper, November 2011

Di Thang Cooperative - Success from a Indigenous Vegetable Project in Bac Ha by Ngoc Thuy on Lao Cai website 6 March 2012
http://laocai.gov.vn/sites/bacha/Tintucsukien/Trang/20120306142545.aspx

Central Coast ABC radio host Scott Levi interviewed Sophie Parks on the Gac fruit as part of his agri-chat segment (29 November, 2011)
Lush A (2011). Superfruit potential to boost production. The South Australian Grower, September 2011 edition
Aggs R (2011) A cancer treatment from a gourd? Agriculture Today, July 2011 edition

Aggs R (2011) Asian vegie guidelines for growers. Agriculture Today, September 2011 edition

VWU Newspaper and Website

A helpful project for ethnic women by Pham Thi Thuy Nga (published on Vietnam Women's Union website)

Helping poor women make changes in the production and marketing of indigenous vegetables by Pham Thi Thuy Nga (published on Vietnamese Women Newspaper 18 August 2010 and Vietnam Women's Union website)

Impact of one year implementation of indigenous vegetable project by Pham Thi Thuy Nga (published on Vietnamese Women Newspaper January 2011 and Vietnam Women's Union website)

Helping moutainous women access to market by Pham Thi Thuy Nga (published on Vietnamese Women Newspaper 21 March 2011 and Vietnam Women's Union website)

9 Conclusions and recommendations

9.1 Conclusions

AGB/2006/112 sought to develop and test models that improve the profitability of women farmers supplying indigenous vegetables into transforming markets. The project also looked to develop effective communication strategies for women farmers that encourage practice-change, in both the production and marketing of their crop. The project focussed on 3 key areas:

- Understanding indigenous vegetable value chains and consumer perceptions and utilising this together with stakeholder priorities to determine appropriate marketing interventions;
- Developing 'best bet' management practices to facilitate the transition from collection to semi-commercial production of the 6 selected indigenous vegetables;
- Designing, developing and implementing a *Farmer Business School* (*FBS*) to enable farmers to rapidly capitalise on learnings about the production and marketing of the 6 selected vegetables.

Likewise the Australian component followed similar themes and looked at the potential of emerging Asian vegetables (including bitter melon, gogi and gac) and, together with a Horticulture Australia project, has looked at managing nitrate accumulation in Asian vegetables.

Key successes of the project have included:

- Enhanced understanding of indigenous vegetables supply chains and consumer perceptions
- The development of innovative approaches to foster wider market engagement eg. the IV restaurant challenge
- The establishment of the *Di Thang Indigenous Products Cooperative* in Na Hoi, Bac Ha, pulling together 40+ women farmers to produce and market indigenous vegetables;
- The development of a suite of experimentally validated technical innovations that improved crop productivity and quality out-turn and the incorporation of these recommendations in *FBS* resources and training;
- The enhanced capacity of the Vietnamese project team to undertake value chain, marketing and production research that is directly relevant to farmers and other supply chain partners;
- The development and utilisation of effective and culturally relevant *Farmer Business School* resources and training programs that are starting to have an impact on farmer marketing and crop management practices,

Key strengths of this project have been 1) the systems approach used to look at the production-marketing continuum promoting an integrated research approach and 2) the development of a *Farmer Business School* (*FBS*) to foster practice-change amongst women farmers. Subsequent projects should look to build on this approach.

9.2 Recommendations

This project was ambitious and complex – developing production and marketing strategies for a suite of relatively unknown indigenous vegetables. The drive to include rapid incorporate this knowledge and learnings into a *Farmer Business School* made the project timelines quite daunting. Therefore we would recommend a follow-on project to look at how 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. Again the project should focus on women smallholders, particularly ethnic minorities.

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

- What are the key drivers of 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 strategies can be developed to effectively manage nutrients particularly nitrogen in each of the farming systems? How can acid-soil constraints be effectively overcome? What contribution to income and household nutrition 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 factors determine differences in diet quality of household members between urban and rural areas in Lao Cai province? Among the rural farming households, how and why does diet quality compare between F&V producers and non-F&V producers? How does F&V consumption compare between F&V producers and non-F&V producers, and what is the relationship to diet quality, household income and market-linkage?
- What are the opportunities for up-scaling the FBS? What is a sustainable model (government, NGO, private sector) for its ongoing development? What participatory approaches are most effective at linking farmers to markets?

The project scope should be broadened to include whole-farming systems and focus on both 'everyday' and indigenous vegetables. Whilst indigenous vegetables provide some niche marketing opportunities – this needs to be considered in the broader farming systems to gain insights into how to most effectively improve livelihoods of farmers in north west Vietnam.

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11 Appendixes

11.1 Appendix 1:

See accompanying appendix