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Australian Centre for International Agricultural Research

Project final report

project	**Improving the marketing system for fresh produce of the highlands of PNG**
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1 Acknowledgments

We first wish to acknowledge the contribution of our partner institutions; Fresh Produce Development Agency (FPDA) and the National Agricultural Research Institute (NARI). They, through their Directors, have been highly supportive of our efforts through thick and thin and have provided unstinting institutional support when we needed it. In particular, we wish to acknowledge the late George Gorogo (former General Manager of FPDA) whose commitment to the development of the fresh produce industry in PNG was a special inspiration to all of us. We also wish to acknowledge the strong support of his successors (Robert Lutelele and John Bennett) as well as the strong support from the leadership of NARI (Raghunath Ghodake and Sergie Bang).

We also wish to acknowledge the immense contribution of our research team which undertook the essential work on the project. The team included:

1. From FPDA – Ernest Natera, Vincent Haguluha, Willi Ehmig, Lily Be'Soer, Cathy Wali, Joyce Kisai, Ken Kanofo, Moses Woruba
2. From NARI – Norah Omot, Jessie Anjen
3. From the PNG University of Technology – Surya Nath, Frank Vidinamo, Sogoing Denano
4. From the University of Canberra – Carole Kayrooz, Taree Brearley, Linda O'Connell

Finally, we wish to thank ACIAR for its financial support and, in particular, to our program manager Ken Menz who had the uncanny ability to apply just the right touch as required. Ken's mantra that we should aim "to make a difference" became the basic guiding principle for our project.

2 Executive summary

The PNG Highlands represents a unique environment in which high quality temperate zone produce (e.g. sweet potato, English potato, cabbage, broccoli, carrots, capsicum, tomato, celery and asparagus) can be grown year-round. The PNG Government's National Food Security Policy, 2000 – 2010 saw this economic activity as potentially being an important source of income growth for poor rural households. However, it also recognized that the sector's potential was limited by an inadequate marketing system. Hence, improving this marketing system was deemed to be a high priority and so gave an important impetus to this project. Highland fresh produce finds its way into both the informal and formal market. In this project it was decided to focus on the improving the formal marketing system which links the Highland production region to coastal population centres. The rationale was that improving the formal marketing system would provide a springboard for eventually moving fresh produce into export markets.

The project used a participatory action research methodology, where the specific objectives were:

- To map the existing marketing system, identify the constraints and capacities for change and evaluate the potential for improvement
- To facilitate a process of socio-economic change using collaborative problem-solving among the major stakeholders of the marketing system
- To enhance the capacity of relevant people and institutions in PNG.

The original project lasted for 3 years from January 2003 to December 2005. This was subsequently extended, first from January 2006 to December 2006 and then from January 2007 to June 2007.

The mapping of the marketing system suggested that there were very significant physical/technical and social constraints. The most significant physical/technical constraints were thought to be: (a) lack of marketing infrastructure; and (b) poor post-harvest management practices (handling, storage and transportation). The most significant social constraints were thought to be: (a) poor buyer-seller relationships; and (b) social practices and attitudes that worked against the full participation of women and youth in the marketing system.

Pivotal in moving from the research to the action phase were the stakeholder planning workshops. The workshop participants came from all levels of the value chain (e.g. farmers, wholesalers, shippers and retailers) as well as government officials (national and provincial). The workshops were facilitated by members of our research team and aimed to develop action plans based on consensus of the workshop participants.

The action plans agreed upon led to a variety of actions aimed at relieving the physical/technical and social constraints. These included: (a) an infrastructure initiative to encourage consolidation of produce in the Highlands; (b) initiatives to improve post-harvest quality management (including development of a post-harvest resource manual); (c) studies on identifying constraints and determining how to enhance the role of women and youth in the fresh produce marketing system; and (d) studies aimed at improving our understanding of the preferences of customers (e.g. supermarket managers and institutional buyers) and consumers.

By design, this project has been about "making a difference." Hence, each of the above actions has attempted to generate its own specific impacts on the fresh produce marketing system. However, more generally, the project has been about trying to "make a difference" in the way the stakeholders think about their industry and how they respond to the challenges they face. As to whether we have been totally successful in this regard, we leave to others and to a later time, as we believe the change process we helped initiate has not yet run its course.

3 Background

ACIAR and the PNG government have had a common interest in improving the Highlands marketing system for fresh produce stretching back a long way. For ACIAR, this began with an examination of post-harvest problems in 1983 (Scott and Atkinson, 1989). Most of the contributions to that study focused on the physical aspects of storage and handling, but one (by Menz, 1989) examined the economics of transporting vegetables by refrigerated containers.

At consultations between PNG and ACIAR held in August 2000, consensus was reached on the importance of a number of issues directly relevant to this project including:

- The generation of income by smallholders was central to their food security and resilience to drought, frost or natural disasters.
- Identification of optimal industry models for the smallholder/commercial sector interface will also be critical.
- Research into marketing constraints was seen as especially important, especially with view to the analysis of transport constraints.
- Market chain information and post-harvest quality systems will be needed to guide resource development.
- Training must be a key element in project design.

Further support for undertaking this project came from the PNG government's National Food Security Policy 2000-2010 which included as priorities:

- to improve production, downstream processing, marketing and utilization of food
- to improve food quality and safety
- to devise policy options and institutional measures to improve the efficiency and adaptability in production, processing and marketing systems and meet the changing needs of producers and consumers
- to facilitate the creation of markets for subsistence women farmers

Initial discussions with the PNG government, researchers and those in the PNG food business also revealed that marketing rather than production was the major concern and that certain aspects needed to be taken into account. These were:

- The geography of the country, with long complex supply chains between the Highlands producing regions and the major coastal consuming regions.
- The importance of rural poverty in the Highlands and the potential for vegetable production to contribute to its alleviation.
- The heavy involvement of women in vegetable production and the potential for improved marketing to contribute to the empowerment of women and thereby to the well-being of their families.

Since the early ACIAR studies by Scott & Atkinson (1989) and Menz (1989), there have been a number of short-term consultancies and workshops that focused on marketing problems with Highland fresh produce. These included Burden (1998), Epstein (2000) and Fresh Produce Development Company (1997). They all ended with recommendations for change, but did not actually engage the change process *per se*. Hence, their capacity to make a difference has been limited. This project was initiated with a view that it should make a difference. To this end, it adopted the research strategy of *critical action research* in which facilitation of the change process is a major component.

4 Objectives

Overall Aim: To improve the well-being of participants of PNG's fresh produce marketing system, with particular attention being given to the well-being of poor rural households in the Highlands

Specific Objectives:

1. To map the existing (formal and informal) marketing system and its institutional environment (governmental and infrastructural), identify the constraints and capacities for change and to evaluate the potential for improvement (removing the constraints and/or building on the capacities).
2. To facilitate a process of change within the *land/sea* chain (for bulky, less perishable produce) and the *land/air* chain (for highly perishable, high value produce).
3. To enhance the capacity of relevant people and institutions in PNG.

These three objectives are addressed in the project through three interwoven components: namely the research (information gathering) component, the action (development) component and the capacity-building component.

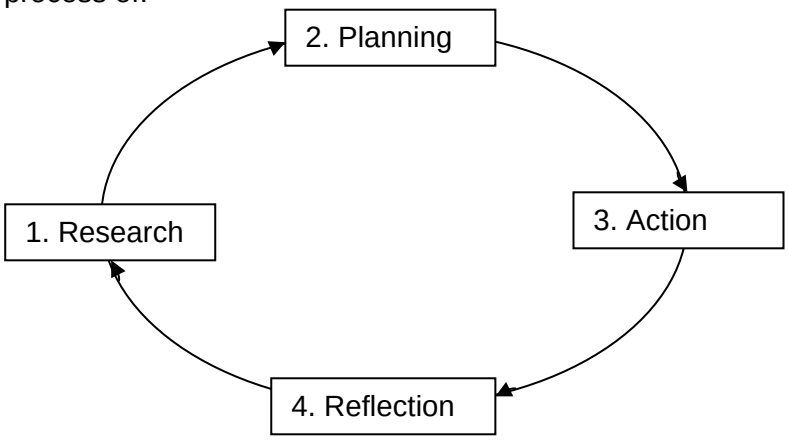
The research component is concerned with mapping the existing marketing system and its environment (governmental and infrastructural), to identify what we think are the constraints and capacities for change and to evaluate the potential for improvement (removing the constraints and/or building on the capacities). The constraints are classified as either physical/technical or social. The main output will be a rich picture of the existing marketing system and an analysis of its potential for improvement.

The development component is concerned with the change facilitation process, focusing on two different categories of supply chain: the *land/sea* chain (for bulky, less perishable produce) and the *land/air* chain (for highly perishable, high value produce). The facilitation methodology is CPSM (Collaborative Problem Solving Methodology), which emphasises collaborative, stakeholder-directed change. The expected outcome is sustainable improvements to these categories of supply chain.

The capacity-building component is concerned with the training and development of key collaborating researchers in the partner country (PC) and capacity-building of stakeholders (in the fresh produce marketing system) to embrace collaborative change. The training and development of collaborating researchers was carried out through the provision of special training courses and with their involvement in the research/facilitation activities associated with objectives (1) and (2).

5 Methodology

In this project we used the methodology of *critical action research*. This involves a cyclic process of:



In this approach the research team generates understandings of the marketing system (research and reflection) and, working with stakeholders in this system, facilitates change (planning and action). As such, the change process that we engaged in was considered of equal importance to the underlying objective research. The project team fulfilled the dual roles of researchers and facilitators. In their facilitative role, the program team is cognizant that the process itself and any changes to emerge from the process are owned and directed by the stakeholders. However the approach differs from conventional *action research* in that the facilitator is an active participant in the process with his/her own social change perspective based on *critical theory.* In this project, the critical perspective is *sustainable socio-economic development based on principles of social justice*.

The first phase of an action research cycle is research (i.e. information gathering). In our case, the aim is to develop an understanding of the pre-existing nature of the marketing system, where the marketing system is defined as the relevant value chains plus the surrounding institutional environment. This type of research is what we call *mapping the marketing system*. In mapping the marketing system, we consider two distinct aspects: the physical/technical aspect and the social aspect.

The physical/technical aspect is concerned with the physical resources of the supply chain (e.g. infrastructure and equipment) as well as the technical skills involved (e.g. handling, storage and transportation). The social aspect is concerned with human relationships in the supply chain (e.g. buyer-seller relationships, farmer-farmer relationships, and any gender-related impediments to participation). From anecdotal information (J. Spriggs), these two aspects appear to be of roughly equal importance in developing countries while in developed countries the social aspect tends to predominate as a problem area in the operation of agricultural marketing systems.

While these two aspects may be of roughly equal importance in developing countries, dealing with them is not. According to the literature (see for example, Spriggs, 2004), the social aspect gives rise to what are known as wicked problems, while the physical/technical aspect gives rise to what are known as tame problems. Tame problems may be complex, but are relatively straightforward to deal with because stakeholders generally can agree on the nature of the problem and it should be addressed. For example if the problem is a lack of consolidation of produce in the Highlands, then the solution might be to build a consolidation depot in the Highlands. However, wicked problems are not straightforward to deal with because stakeholders generally do not agree on the nature of the problem let alone how it should be addressed. For example, women participants in the supply chain may feel discriminated against while their male counterparts do not see this. And, farmers may feel they are at a disadvantage in buyer-seller relationships, but the (monopoly) wholesaler does not. In this project, we

expected (and in fact found) that improvements in the social aspect would be much slower and more difficult to achieve than in the physical/technical aspect.

Initial mapping of the marketing system involved a variety of methods. These included:

- secondary data analysis (e.g. reviewing existing studies and collecting already collected data)
- process mapping of the supply chains (e.g. using data loggers)
- profitability analysis of the supply chains
- semi-structured interviews and focus groups involving the various stakeholders of the marketing system
- random sample survey of consumers and interview survey of major buyers (e.g. supermarket managers and institutional buyers).

The information generated by the mapping exercise was then fed into the second (i.e. planning) phase of the action research cycle. The Planning phase is centred on a stakeholder workshop which is facilitated by the project team. However, prior to the workshop is the preparatory stage which involves identifying the stakeholders and the workshop participants, preparing a facilitation strategy and organizing the workshop. The most time-consuming activity at this stage typically involves working with the identified stakeholders to build trust in the process and to develop the rules of engagement. For the workshop itself, we applied our own methodology to foster collaborative work among the stakeholder participants to develop an action plan. The workshop methodology is called CPSM (collaborative problem solving methodology) that has been used successfully before by University of Canberra members of the project team in a wide range of problem situations within Australia (Chambers, Spriggs and Pamphilon, 2005; Spriggs and Chambers, 2005; Chambers and Spriggs, 2006). However, this was the first time we had applied the methodology in a developing country situation, so it was to be an interesting test of the methodology's robustness to different cultural settings. In fact the methodology worked extremely well. Very broadly, CPSM involves careful selection of participants who span across all the various types of stakeholders in the marketing system. The workshop participants are provided with information (including that from the marketing system mapping) and the facilitator leads the participants through a divergent (creative) and then a convergent (evaluative) phase to develop an action plan. Generally, workshop participants have a pretty good idea of the major issues involved, but the action plan may be less well-defined. Hence, at the end of the workshop a steering committee is formed and that committee, together with the project team work to clearly define the action plan.

The next phase of the action research process is the Action phase. Since, the basic aim of the project is "to make a difference", this is an important component. This may, and usually does, involve further work of the project team. However, there is no specific methodology here. It depends on; (a) what emerges in the action plan and (b) what abilities are possessed by the various members of the project team. Both of these requirements had to line up in order for the project team to proceed with a particular initiative in the action phase. Thus, for example, one of the perceived needs was to improve the post-harvest management skills of farmers and the corresponding action idea was to develop a post-harvest resource manual. However, this idea was not acted upon until FPDA hired, and assigned to the project, a newly-graduated post-harvest specialist who could write well. The end result was the recently released ACIAR publication Quality Management of Fresh Produce From the Highlands of Papua New Guinea: A Postharvest Manual

The final phase of the action research cycle is the Reflection phase. In this phase the project team and steering committee meet to reflect on the actions taken and plan further research. In this project, the general outcome of the first stakeholder workshop was a focus on the physical/technical aspect of the marketing system. In particular, the main action ideas centred on building post-harvest infrastructure (including a consolidation depot) in the Highlands. During

our reflections on this development, it became apparent that we had largely ignored the social aspect. Hence, further research was undertaken on the social aspects. This included: (a) airfreight trials of shipments of produce from the Highlands to Port Moresby with the main idea of studying buyer-seller relationships. (b) a study on the special difficulties faced by women participants in the marketing system for fresh produce to examine how they; and (c) a study on the role of youth in the fresh produce supply chain. This research provided background information for a second stakeholder workshop.

6 Achievements against activities and outputs/milestones

Objective 1: To map the fresh produce marketing system for highlands fresh produce

no.	activity	outputs/ milestones	completion date	comments
1.1	Secondary data analysis	Data collected on history of fresh produce prodn. in PNG Highlands, quantities, prices and environmental factors	2003	RESEARCH phase of the action research cycle Used as input to Background paper on the Mapping Exercise presented by J. Spriggs at First Workshop in November 2003. It appears as Appendix C to Attachment G in 2003 Annual Report
1.2	Process mapping of supply chain	Paper summarising the movement of produce by land/sea to Lae	2003	RESEARCH phase of the action research cycle Used as input to Background paper on the Mapping Exercise presented by J. Spriggs at First Workshop in November 2003. It appears as Appendix C to Attachment G in 2003 Annual Report
1.3	Semi-structured interviews	Paper summarising interviewee responses	2003	RESEARCH phase of the action research cycle Paper presented at First Workshop in November 2003. It appears as Attachment F in 2003 Annual Report
1.4	Random sample survey of consumers buying in supermarkets in Lae and Port Moresby	Conference Paper	2004	RESEARCH phase of the action research cycle Paper by Omot et.al. (2005) which appears as Attachment B to 2005 Annual Report
1.5	Profitability Analysis	Data collected on marketing costs of the land/sea and air supply chains	2003	RESEARCH phase of the action research cycle Used as input to Background paper on the Mapping Exercise presented by J. Spriggs at First Workshop in November 2003. It appears as Appendix C to Attachment G in 2003 Annual Report

PC = partner country, A = Australia

Objective 2: To facilitate a process of change using critical action research…

no.	Activity	outputs/ milestones	completion date	comments
2.1	Research on the methodology of critical action research and its applicability to the Fresh Produce of the Highlands of PNG	Conference Paper	July 2004	Paper written by Spriggs, Chambers and Kayrooz (2004) was presented at the *World Congress of Sociology Conference* in Trondheim, Norway. It also appears as Attachment C to the 2004 Annual Report
		Conference Paper	September 2005	Paper written by Spriggs and Chambers (2005) and presented at the *Development Studies Annual Conference*. It also appears as Attachment H to the 2005 Annual Report
		Journal Paper	February 2006	Paper written by Kayrooz, Chambers and Spriggs (2006) appears in *Development in Practice*
		Conference Paper	November 2006	Paper written by Chambers and Spriggs (2006) and presented at *DevNet Conference* appears as Attachment N to 2006 Annual Report
2.2	Focus groups in Goroka, Lae and Port Moresby	Focus group meetings and report	October 2003	PLANNING phase of the action research cycle Reports included in Spriggs Trip Report September-October 2003 which appears as Attachment E to 2003 Annual Report
2.3	Women's Group Meeting	Report on Meeting	November 2003	PLANNING phase of the action research cycle. This meeting was held just prior to Workshop 1 as a way to obtain women's views (they tend to be silenced in mixed gender meetings) and provide this as input to the main workshop. A report from this meeting appears as Appendix A to Attachment G to the 2003 Annual Report
2.4	Workshop 1	Workshop 1 and report	November 2003	PLANNING phase of the action research cycle Workshop 1 Report appears as Attachment G to 2003 Annual Report
2.5	Activity 1 resulting from Workshop 1: *Initiate Market Infrastructure Development*	Work with FPDA to develop concept paper and Full Proposal	Concept paper completed and submitted to PNGIF and PNG Government in 2004. Work has continued on this activity throughout the duration of the project	ACTION phase of the action research cycle The Concept Paper appears as Attachment A to 2004 Annual Report. This concept paper was approved in principle by both the PNG Government and the PNGIF for funding. Prof. Spriggs then worked with FPDA to identify potential sites and complete the full proposal. However, there were major delays due to problems in obtaining land title for the consolidation depot in Goroka. As a result (and to remove the logjam) Spriggs and Ehmig (2005) wrote a proposal to the Board of FPDA to move the consolidation depot to Kainantu which was approved. (This proposal appears as Attachment G to the 2005 Annual Report.) The issue of land title has now been resolved, the FPDA has received funding from PNG Government and the infrastructure development is proceeding. For the latest information see Attachment M of the 2006 Annual Report

2.6	Activity 2 resulting from Workshop 1: *Improve road/sea and air transport system*	Work with FPDA on market infrastructure development (see 2.3)	(See 2.3 on market infrastructure devt.)	ACTION phase of the action research cycle
		Undertake a set of 30 air freight trials (Goroka to Port Moresby)	April 2005	ACTION and RESEARCH phases of the action research cycle Paper written on the air freight trials by Ehmig et.al. (2005) appears as Attachment I to 2005 Annual Report. The results were used as background information for Workshop 2.
2.7	Activity 3 resulting from Workshop 1: *Improve coordination and communication in supply chain*	Use air freight trials (see 2.4) to explore how to improve coordination and communication between farmers in Highlands and buyers in Port Moresby	(See 2.4 on air freight trials)	ACTION and RESEARCH phases of the action research cycle Paper written on the air freight trials by Ehmig et.al. (2005) appears as Attachment I to 2005 Annual Report. The results were used as background information for Workshop 2.
		Review Two-Way Radio Program		ACTION phase of the action research cycle Paper written by Kewa and Worube (2006) appears as Attachment J to 2006 Annual Report
2.8	Activity 4 resulting from Workshop 1: *Improve Farmer Marketing Skills*	Develop proposal for new, improved agricultural extension system	November 2004	ACTION phase of the action research cycle Paper written by Spriggs and Hunt (2004) was presented to the National Agricultural Extension System Steering Committee. This paper appears as Attachment D to the 2004 Annual Report
2.9	Activity 5 resulting from Workshop 1: *Improving the Participation of Women in the Fresh Produce Supply Chain*	Work with FPDA to develop a concept paper	December 2003	ACTION phase of the action research cycle Concept paper presented at Horticulture Workshop of PNG Government. Paper written by Spriggs et.al. (2003) appears as Appendix F to Attachment G to the 2003 Annual Report
		Further research carried out on constraints to participation of women in supply chain	April 2005	RESEARCH phase of the action research cycle Research undertaken by Taree Brearley under supervision of Prof. Chambers on Women's participation in the fresh produce marketing system. This resulted in report by Brearley (2005) which appears as Attachment B to 2005 Annual Report. The information generated was provided as background information for Workshop 2.
		Conference Papers	September 2005	Paper written by Spriggs and Chambers (2005) and presented at the *Development Studies Annual Conference*. It also appears as Attachment H to the 2005 Annual Report
			November 2006	Paper written by Chambers and Spriggs (2006) and presented at *DevNet Conference* appears as Attachment N to 2006 Annual Report
2.10	Steering committees	Various meetings following Workshop 1	February, June and November 2004	REFLECTION phase of the action research cycle Notes from these Steering Committee meetings are included as Attachments I to K of 2004 Annual Report

2.11	Workshop 2	Workshop 2 and report	April 2005	PLANNING phase of the action research cycle Workshop 2 Report appears as Attachment C to 2005 Annual Report
2.12	Activity 1 resulting from Workshop 2: *Improve whole-of-chain quality management*	Proposal to do 2 research sub-projects:	August 2005	ACTION phase of the action research cycle Proposal outlining these sub-projects appears as Attachment F to 2005 Annual Report.
		1. quality protocols (by S. Denano at Unitech)	November 2007	1. Research on quality protocols was completed for tomato supply chain and report written by S. Denano et.al. (2007) and attached to this report in Appendix 6
		2. evaporative cooler (by S. Nath at Unitech)	September 2007	2. Research on evaporative cooler was completed and resulted in a report by Nath and Viridimo (2007) and conference paper by Nath et.al. (2007)
		Proposal to enhance marketing skills of farmers and others involved in post-harvest management of fresh produce by producing a Postharvest Resource Manual	November 2007	Publication of Postharvest Resource Manual written by Haguluha and Natera (2007) and edited by Prof. Spriggs
2.13	Activity 3 resulting from Workshop 2: Improve the participation of youth in the fresh produce industry	Undertake research into constraints on youth participation in Highland fresh produce industry. This includes 3 components: (1) literature review; (2) report on key issues for youth; (3) develop a concept paper on how to move forward	October 2006	ACTION phase of the action research cycle The research was conducted by Prof. Chambers and Linda O'Connell. It resulted in 4 reports: 1. Chambers and O'Connell (2006a) – key issues for youth 2. Chambers and O'Connell (2006b) – literature review 3. Chambers and O'Connell (2006c) – concept paper. 4. Chambers and Wali – research report on women and youth to Workshop 3
		Workshop 3 led to the FPDA deciding to undertake a National Youth Survey. Our project team assisted in the design of this survey and with coding and analysing the results	2006	The first three papers appear as Attachments H, G, and I respectively to the 2006 Annual Report. The fourth paper is attached as Appendix 5
2.14	Activity 4 resulting from Workshop 2: Improve our understanding of the needs of customer	1. Survey preferences of major buyers (supermarkets and institutional buyers)	August 2006	1. Paper by Omot et.al. (2006a) which appears as Attachment E in 2006 Annual Report
		2. Survey consumers in informal markets in Lae and Port Moresby	November 2006	2. Paper by Omot et.al. (2006b) was presented at DevNet Conference in November 2006. It also appears as Attachment F in 2006 Annual Report.

PC = partner country, A = Australia

Objective 3: To enhance capacity of relevant people and institutions in PNG

no.	Activity	outputs/ milestones	completion date	comments
3.1	Training PNG-based members of project team in marketing, supply chain management, critical action research and workshop facilitation	2-week Training course at Univ of Canberra	April 2004	Outline of training course Appears as Attachment A to 2003 Annual Report
3.2	Development of PNG-based members of research team by "learning-by-doing"	Continuous development throughout term of project Assist team members with how to write research papers, write concept papers, write project proposals, present seminars, undertake surveys and statistical analysis, conduct focus groups and workshops	June 2007	Development occurred by fully involving the PNG-based members in the critical action research process as researcher-facilitators
3.3	Improve marketing skills of commercial farmers and other participants of the fresh produce supply chains	Produce a Postharvest Resource Manual	November 2007	Publication of Postharvest Resource Manual written by Haguluha and Natera (2007) and edited by Prof. Spriggs
3.4	Workshop 3	Transfer of knowledge built up over life of project to PNG stakeholders and to personnel of new NZAID-funded ISP (Institutional Strengthening Project) aimed at assisting FPDA	March 2007	The key personnel of the NZAID-funded program were included as table facilitators in this final workshop (Appendix 1 and 2)

PC = partner country, A = Australia

7 Key results and discussion

The most important result of this research is we have been able to show that our approach to critical action research works in a developing country context. It is a robust methodology for undertaking socio-economic research that aims to “makes a difference”. While traditional positivistic science methods are likely appropriate for dealing with problems of a primarily physical nature (e.g. what is the highest yielding crop variety), they are likely inadequate by themselves when dealing with problems of a primarily socio-economic nature. This is because socio-economic problems involve social change which requires a highly nuanced understanding of local conditions (including cultural and other institutional constraints and opportunities for change) and ownership of the change process by local stakeholders. This requires: (a) engagement with local stakeholders in collaborative problem solving; and (b) adaptive research (i.e. the ability to adapt the research as required by our changing understanding of the local conditions).

Our adaptive research approach has resulted in a number of R&D activities (sub-projects) that could not have been predicted at the research proposal stage. These sub-projects emerged from a growing understanding of:

1. the situation at hand (based on our mapping research)
2. the needs of stakeholders (as expressed by them during the semi-structured interviews, focus groups, planning workshops and the steering group meetings)
3. the abilities of PNG-based members of the project team
4. the willingness of our partner institutions in PNG to support their work on these activities.

In some cases, this project led directly to socio-economic change. For example, the FPDA decision to hire a full-time manager (Moses Woruba) to work on a program of marketing infrastructure development was a direct result of this project. We have had an ongoing relationship throughout this project with Moses to determine the best particular configuration of the infrastructure program and have worked with him to seek funding for the program. However, other socio-economic changes have occurred where this project has acted as a catalyst for change. Two examples:

1. This project brought various stakeholders together for the workshops including representatives of farmer groups in the Highlands and buyers from Port Moresby. Serendipitously, this led to the building of commercial relationships between the stakeholders to enable direct sales of fresh produce from the suppliers to the buyers.
2. Workshop 2 stimulated FPDA to decide to undertake the first ever National Youth Survey to gauge the attitudes of youth to their involvement in the fresh produce industry. The project team was subsequently asked to assist in the design of the survey and in the coding and analysis of results, which it did.

8 Impacts

8.1 Scientific impacts – now and in 5 years

We have added to the scientific understanding of critical action research through the particular methodology we have used in this project and which we have found to be very robust. We have publicised our work on this in the following:

1. Chambers, Barbara and John Spriggs (2006) *Negotiating the Space between Development and Post-Development*, Session 6 'Doing post-development': empowering the south, DevNet Conference 2006, Dunedin New Zealand 28-30 November, 2006. (Refereed conference paper).
2. Kayrooz, Carole, Barbara Chambers and John Spriggs (2006). *Between Four Worlds: Research Capacity Building in Papua New Guinea*. Development in Practice, Volume 16, No.1, February 2006.
3. Spriggs John, Barbara Chambers and Carole Kayrooz (2004). *Socioeconomic Change in the PNG Fresh Produce Supply Chain*. Paper presented at the 11th World Congress of Rural Sociology, Trondheim, Norway, July.
4. Spriggs, John and Barbara Chambers (2005*). Connecting People in Cross-Cultural Agribusiness: The Case of the Fresh Produce Supply Chain in PNG*. Paper presented at the 2005 Development Studies Association Annual Conference, Milton Keynes, UK, September.
5. Spriggs, John, Barbara Chambers, Carole Kayrooz, Ernest Natera, Norah Omot and Margaret Vatnabar (2003). *Improving the Marketing System for Fresh Produce from the Highlands of PNG*, paper presented at the International Workshop on Agricultural Supply Chain Management in Developing Countries, and published in Proceedings on CD-Rom, Greg Johnson (ed.), Bali, Indonesia, 19 – 22 August, 2003

We have added to the scientific understanding of buyer behaviour in PNG markets for fresh produce. Among other things, the work has shown that supermarket managers do not understand very well the preferences of their customers when it comes to fresh produce purchases. For example, while supermarket managers believe their customers have a preference for imported produce, we have found this is not the case. There is a strong preference for local produce on the basis of both price and quality. The problem is lack of consistent supply. This work has been publicised in the following:

1. Omot, Norah, Jessie Anjen and John Spriggs (2005). "Think Local Before Going Global: Understanding the Consumer Preferences for Fresh Produce in PNG Supermarkets." Paper presented at the International Symposium on Supply Chain Management, *Improving the Performance of Supply Chains in Transition Economies*, Chiang Mai, Thailand, July.
2. Omot, Norah, John Spriggs and Jesse Anzen (2006a). *Understanding Consumer Preferences for Fresh Produce in Informal Markets in PNG*, unpublished paper, August.
3. Omot, Norah, John Spriggs and Jesse Anzen (2006b) *Understanding Buyer Preferences in the Formal Market for Fresh Produce from the Highlands of PNG*, Session 8 'Doing post-development': empowering the south, DevNet Conference 2006, Dunedin New Zealand 28-30 November, 2006.

We have added to scientific understanding of the major factors affecting the participation of women and youth in the fresh produce production-marketing system. This work has been publicised in the following:

1. Brearley, Taree (2005). Increasing the Autonomy of Women as a Means to Improving Community Well-being and Facilitating Development: An Exploratory Study in Papua New Guinea. ACIAR Project Report, July, pp76.

2. Spriggs, John and Barbara Chambers (2005). Connecting People in Cross-Cultural Agribusiness: The Case of the Fresh Produce Supply Chain in PNG, Development Studies Association Annual Conference 2005, Connecting People and Places: Challenges and Opportunities for Development, Milton Keynes UK, 7-9 September 2005. (Refereed conference paper)
3. Chambers, Barbara and Linda O'Connell (2006a). Key Youth Issues Emerging from Key Stakeholder Interviews, ACIAR Project Report, February.
4. Chambers, Barbara and Linda O'Connell (2006b) Youth Participation in Food Production in the Highlands of PNG: A Literature Review, ACIAR Project Report, August.
5. Chambers, Barbara and Linda O'Connell (2006c) *Concept Paper: Youth and Sweet Potato Marketing,* unpublished paper, October.

We have added to scientific understanding of how to improve quality management in the fresh produce supply chain through our work on evaporative cooling and quality protocols. This work has been publicised in the following.

1. Nath, S., F. Vidinamo and J. Spriggs (2007). *Preservation and Storage of Perishable Fresh Fruits and Vegetables in the Highlands of Papua New Guinea.* Proceedings of the Bienniel Conference of the Australian Society for Engineering in Agriculture, edited by T. Banhazi and C. Saunders, September: 284-291.
2. Nath, Surya and Frank Vidinamo (2007). *Preservation and Storage of Perishable Fresh Fruits and Vegetables in the Highlands of Papua New Guinea*. Unpublished report, PNG University of Technology, March, 107pp.
3. Denano, Sogoing, Dr. John Spriggs and Joyce Kisai (2007). *Quality Protocol for Fresh Produce from the Highlands of Papua New Guinea (PNG).* Unpublished report, PNG University of Technology, November, 27pp.

8.2 Capacity impacts – now and in 5 years

The project has impacted on the capacity of the PNG-based members of the project team. Through the training program at the start of this project and through the "learning by doing" that has been a hallmark of this project, we believe (and they have told us) their capacity as researcher/facilitators has been greatly enhanced. One of the PNG-based members of the research team (Norah Omot) has been awarded a John Allwright scholarship for PhD study and Professor Spriggs is serving as her co-supervisor. Professor Spriggs also helped arrange funding through ADB for another PNG-based team member (Vincent Haguluha) to undertake a short course in post-harvest management at Sydney University. Vincent has recently been awarded a John Allwright fellowship to study for his PhD at Sydney University.

Professor Chambers mentored Cathy Wali (at FPDA) to take over the position of Gender and Youth Advisor following the departure of Lily Be'Soer. In addition, Cathy Wali and her team were also coached in survey design and analysis for the Youth in Fresh Produce National Survey. Professor Chambers also supervised two students at the University of Canberra who have carried out research on participation of women and youth in the fresh produce marketing system. They were Taree Brearley and Linda O'Connell and the work of these students resulted in the following research papers:

1. Brearley, Taree (2005). Increasing the Autonomy of Women as a Means to Improving Community Well-being and Facilitating Development: An Exploratory Study in Papua New Guinea. Unpublished manuscript, ACIAR Project Report, July, pp76.
2. Chambers, Barbara and Linda O'Connell (2006a). Key Youth Issues Emerging from Key Stakeholder Interviews. ACIAR Project Report, February.
3. Chambers, Barbara and Linda O'Connell (2006b) Youth Participation in Food Production in the Highlands of PNG: A Literature Review, ACIAR Project Report, August.

4. Chambers, Barbara and Linda O'Connell (2006c) *Concept Paper: Youth and Sweet Potato Marketing.* Unpublished paper provided to ACIAR, October.

The project is also expected to impact (within 5 years) on the postharvest management and marketing skills of farmers and other participants in the fresh produce marketing system through the publication of the Postharvest Resource Manual. The citation for this manual is: Haguluha, Vincent and Ernest Natera (2007). *Quality Management of Fresh Produce from the Highlands of Papua New Guinea: A Postharvest Manual*, ACIAR Monograph No. 128, 88pp.

The project has helped build the capacity of a new project team (funded by NZAID) aimed at strengthening the FPDA as an institution to improve rural livelihoods through a commercially viable fruit and vegetable industry. This new project team (from Uniquest) began their 3-year project in January 2007 and we assisted them to hit the ground running by inviting their key members to our Workshop 3 (Appendix 1) and employing them at the workshop as raporteurs. A letter of thanks from the Head of the project team (Barry Greville-Ayers) is attached as Appendix 3 to this report.

8.3 Community impacts – now and in 5 years

1. Market infrastructure development. At the first planning workshop, stakeholders identified this as the number one priority. As a result, our research team developed a concept paper proposing the development in the Eastern Highlands Province of a consolidation depot in Goroka (the Provincial capital) and four satellite district depots in the major producing areas (at Daulo, Lufa, Okapa and Henganofi). In 2004 and 2005, preliminary design work was undertaken by FPDA for the consolidation depot (at the Goroka airport) and the four district depots. At the same time, FPDA began the process of securing the necessary land through title transfer or long-term lease arrangement. Ultimately, it was not possible to secure the land for the consolidation depot at the Goroka airport. Hence the research team explored alternative options and presented an alternative proposal for establishment of a consolidation depot for Eastern Highlands Province in Kainantu. This was approved by the FPDA Board and in late 2006, FPDA was successful in obtaining a satisfactory lease on the designated piece of land in Kainantu. Drainage work on the site has now been completed, building plans have been developed and construction began in mid-2007. Construction funds for the development of the consolidation depot are from the National Government. With regard to the district depots, the Government has offered land for their construction and the issue now is lack of construction funds. In 2004, our research team developed a proposal to the PNG Incentive Fund for construction funds for the district depots. This proposal was accepted in principle by the PNGIF, but the proposal has since lapsed because of the lengthy period required to secure the land. For details on current developments with respect to market infrastructure development see the March 2007 Market Infrastructure Development Report by Moses Woruba (See Appendix 4)
2. Quality Management. Work on this sub-project stimulated a complementary project operated jointly by SSSPP and FPDA (and funded by ADB) to examine how to extend quality management in fresh produce to farmers. Thus while our sub-project is concerned with developing quality protocols, the SSSPP/FPDA project is concerned with how to extend such protocols to farmers and farm groups (See Attachment F of the 2005 Annual Report)
3. Airfreight shipments. The airfreight trials we undertook as a research activity in 2005 have spawned a (cost-recovery) commercial activity by FPDA involving weekly air shipments of produce from 40 farmers in the Goroka area to buyers in Port Moresby and two mine sites. This involves up to 30 different types of produce with the main ones being broccoli, tomatoes, capsicum and spring onions. The airfreight trials have helped to transform the FPDA marketing extension program from supply-driven to demand-driven as farmers could begin to see that their actions (and the extension information) were directly related to outcomes.

4. Women and youth. Our two stakeholder workshops were instrumental in stimulating the development of networks and contacts for women and to developing awareness of the need for more research on youth in the fresh produce industry. For example, as a result of the first workshop, one woman made a contact that led to her doing a diploma in horticulture and setting up her own produce nursery business. Another woman made a contact at the workshop with one of the original members of our research team (John Susub) who now works for NAQIA. He helped her to establish a thriving export business for fresh flowers. The second workshop stimulated the development of the National Youth Survey coordinated by Lily B' Soer at FPDA. Our project assisted in providing funds for this Survey, in the design of the survey instrument, and in the coding and analysis of preliminary results from the Highland data (see Chambers and Wali, Appendix 5).

8.3.1 Economic impacts

This project is very much concerned with improvements to the fresh produce supply chain that reduce marketing costs (either transactions costs or operating costs). These improvements include:

- Improving marketing infrastructure
- Improving coordination in the supply chain
- Improving quality management

It is difficult to put a dollar figure on these improvements. However, because of the fragmentation of the marketing system, the lack of coordination and the poor attention to quality management there is considerable scope to lower marketing costs. We think it is not unreasonable to expect this project to lead directly or indirectly to reductions in marketing costs of up to 20 percent. If this were the case, then according to our analysis in the original Project Proposal, this could conservatively lead to gains of K12 million over the 10 year period following the end of the project. This comprises:

- K1 million - to vegetable farmers in the Highlands
- K8 million – to consumers in Port Moresby
- K3 million – to market intermediaries (e.g. wholesalers, shippers, retailers)

8.3.2 Social impacts

The project focuses on the marketing of fresh produce from the PNG Highlands, which accounts for one-third of the national population. This region is characterized by subsistence agriculture and widespread and deep rural poverty. Hence, this project has the potential to assist those who are among the least advantaged in PNG. In addition fresh produce marketing is an activity largely carried out by women. Hence, improving the fresh produce marketing system not only has the potential to significantly improve the economic situation of Highlanders, but it will also contribute to the empowerment of women who can then be expected to enhance the well-being of their families (see Chambers and Wali, Appendix 5).

8.3.3 Environmental impacts

No significant environmental impacts that we can discern

8.4 Communication and dissemination activities

As indicated in Section 7 of this Final Report, the most important result of this project is we have been able to show that our approach to critical action research works well in a developing country context. This result has been communicated to the scientific community through the following:

1. Chambers, Barbara and John Spriggs (2006) *Negotiating the Space between Development and Post-Development*, Session 6 'Doing post-development': empowering the south, DevNet

Conference 2006, Dunedin New Zealand 28-30 November, 2006. (Refereed conference paper).

2. Kayrooz, Carole, Barbara Chambers and John Spriggs (2006). *Between Four Worlds: Research Capacity Building in Papua New Guinea*. Development in Practice, Volume 16, No.1, February 2006.
3. Spriggs John, Barbara Chambers and Carole Kayrooz (2004). *Socioeconomic Change in the PNG Fresh Produce Supply Chain*. Paper presented at the 11th World Congress of Rural Sociology, Trondheim, Norway, July.
4. Spriggs, John and Barbara Chambers (2005*). Connecting People in Cross-Cultural Agribusiness: The Case of the Fresh Produce Supply Chain in PNG*. Paper presented at the 2005 Development Studies Association Annual Conference, Milton Keynes, UK, September.
5. Spriggs, John, Barbara Chambers, Carole Kayrooz, Ernest Natera, Norah Omot and Margaret Vatnabar (2003). *Improving the Marketing System for Fresh Produce from the Highlands of PNG*, paper presented at the International Workshop on Agricultural Supply Chain Management in Developing Countries, and published in Proceedings on CD-Rom, Greg Johnson (ed.), Bali, Indonesia, 19 – 22 August, 2003

Our work on understanding buyer behaviour in PNG markets for fresh produce has been communicated to the scientific community through the following:

1. Omot, Norah, Jessie Anjen and John Spriggs (2005). “Think Local Before Going Global: Understanding the Consumer Preferences for Fresh Produce in PNG Supermarkets.” Paper presented at the International Symposium on Supply Chain Management, *Improving the Performance of Supply Chains in Transition Economies*, Chiang Mai, Thailand, July.
2. Omot, Norah, John Spriggs and Jesse Anzen (2006b) *Understanding Buyer Preferences in the Formal Market for Fresh Produce from the Highlands of PNG*, Session 8 ‘Doing post-development’: empowering the south, DevNet Conference 2006, Dunedin New Zealand 28-30 November, 2006.

Our work on the merits of evaporative cooling has been communicated to the scientific community through the following:

1. Nath, S., F. Vidinamo and J. Spriggs (2007). *Preservation and Storage of Perishable Fresh Fruits and Vegetables in the Highlands of Papua New Guinea.* Proceedings of the Bienniel Conference of the Australian Society for Engineering in Agriculture, edited by T. Banhazi and C. Saunders, September: 284-291.

Our work on how to improve post-harvests management of fresh produce is being disseminated to farmers and other participants of the fresh produce marketing system in the following ACIAR publication:

1. Haguluha, Vincent and Ernest Natera (2007). Quality Management of Fresh Produce from the Highlands of Papua New Guinea: A Postharvest Manual, ACIAR Monograph No. 128, 88pp.

The task now is to ensure wide distribution of this publication to those who need it.

Our work on the mapping research has been communicated to stakeholders in the fresh produce marketing system through presentations at the stakeholder workshops and has provided key input to the collaborative decision-making that has taken place in those workshops.

9 Conclusions and recommendations

9.1 Conclusions

We believe this project has been broadly successful in its basic aim “to make a difference” in the PNG fresh produce marketing system through its use of critical action research. We have seen changes in a number of areas that can either be directly attributed to the research project (like the work on market infrastructure development) or where the research project was a catalyst for change (like the business connections made between buyers and sellers at our workshops). The essence of this approach has been the ability to engage in *adaptive research*, where the research activities are adapted according to our growing understanding of:
the situation at hand (based on our mapping research);

- the needs of stakeholders (as expressed by them during the semi-structured interviews, focus groups, planning workshops and the steering group meetings)
- the abilities of PNG-based members of the project team
- the willingness of our partner institutions in PNG to support their work on these activities.

At the start of the project, our understanding of these was quite limited despite extensive pre-project exploratory research. Thus, it was important that we were able to adapt our research accordingly. For example, consider point 3 above. During the course of the project we had a high turnover of PNG-based members of the project team. This meant that the available skills to devote to the project changed and hence also the type of sub-projects we could initiate. When Willi Ehmig joined FPDA (and our project team) in 2004, we were able to think about doing airfreight trials because of his particular background in marketing. Bur before he arrived, there was no-one in FPDA with the requisite marketing skills to entrust with such an activity. And when Vincent Haguluha joined FPDA in 2005, we were able to start thinking about writing the post-harvest resource manual, something that would have been inconceivable before he arrived.

9.2 Recommendations

Workshop 3 held in March 2007 provided an opportunity for the project team and the stakeholders to come together to reflect on the various sub-projects and to look at what needed to be done in the future to improve the marketing system for fresh produce. The outcomes of this workshop are provided in Appendix 2. Some of these outcomes have possible implications for further action research. These are as follows:

- Explore national branding of local produce (e.g. buy “Highland Fresh”)
- Facilitate the establishment of a governing body - involving NDAL(National Department of Agriculture and Livestock) and the Provincial Departments of Agriculture - to improve coordination in the supply chain
- More research into developing quality protocols for each specific supply chain
- Encourage greater awareness through education across the supply chain about the impact of poor post-harvest handling on product quality (Note: The publication of the Post-Harvest Resource Manual will hopefully go some way towards addressing this recommendation)
- Facilitate improvements in the informal marketing system for fresh produce. In particular, workshop participants focused on the sorry state of the Goroka open market, but other open markets also are in considerable need of improvement and/or re-development
- Encourage the involvement of youth in the fresh produce industry in development and research projects (e.g. through extension of the “making a living” syllabus beyond high school to address the needs of post-school youth)

- Market infrastructure development – this is to be taken up by the new NZAID assistance program
- Explore the potential for a portable evaporative cooling device

We are aware that a new ACIAR project will be starting in 2008 on improving the marketing system for sweet potato in PNG. Perhaps some of the above can be addressed in that new project.

We wish to acknowledge the sensitive and sensible advice provided throughout the duration of this project by Dr. Ken Menz, ACIAR program manager. He understood well the action research model we were attempting to use and the implications of that for adaptive research.

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- Kayrooz, Carole, Barbara Chambers and John Spriggs (2006). Between Four Worlds: Research Capacity Building in Papua New Guinea. Development in Practice, Volume 16, No.1, February 2006.

10.2 List of publications produced by project

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- Chambers, Barbara and Linda O'Connell (2006b) Youth Participation in Food Production in the Highlands of PNG: A Literature Review, ACIAR Project Report, August.
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- Omot, Norah, John Spriggs and Jesse Anzen (2006a). Understanding Consumer Preferences for Fresh Produce in Informal Markets in PNG, unpublished paper, August.
- Omot, Norah, John Spriggs and Jesse Anzen (2006b) Understanding Buyer Preferences in the Formal Market for Fresh Produce from the Highlands of PNG, Session 8 'Doing post-development': empowering the south, DevNet Conference 2006, Dunedin New Zealand 28-30 November, 2006.
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- Spriggs, John and Barbara Chambers (2005). Connecting People in Cross-Cultural Agribusiness: The Case of the Fresh Produce Supply Chain in PNG. Paper presented at the 2005 Development Studies Association Annual Conference, Milton Keynes, UK, Sept.
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11 Appendices

Appendix 1: Outline for Workshop 3

Research Outcomes of ACIAR Project: Improving the Marketing of Fresh Produce from the Highlands of PNG

Workshop at The Bird of Paradise Hotel, Goroka, PNG 29 and 30 March 2007

Day 1 Thursday 29 March 2007

Introductions

- 9.00 – 9.45
- Welcome by John Bennett, General Manager of FPDA, Goroka (5 minutes)
- Overview of ACIAR Project by Professor John Spriggs, Project Leader, Australian Institute for Sustainable Communities, University of Canberra (25 minutes)
- Outline of Workshop by Professor Barbara Chambers, Senior Research Fellow, Australian Institute for Sustainable Communities, University of Canberra. (10 minutes)
- Introduction of Raporteurs from Uniquest: Dr Ben Mullen, Mr Barry Greville-Eyers and Ms Kerry Fox, Mr Peter Secomb. *The role of Raporteurs is to capture the essence of the group discussion and provide a short verbal summary in the plenary session held afterwards.* (5 minutes)

Presentations

9.45 – 11.00

- Market Infrastructure Development – John Spriggs and Moses Woruba
  - Questions
- Understanding Consumer and Buyer Preferences in the Formal and Informal Markets – Norah Omot, NARI
  - Questions
- Women and Youth Participation in the Fresh Produce Industry – Barbara Chambers and Cathy Wali
  - Questions

11.00 – 11.20 Morning Tea

Small Group Work

11.20 – 11.50

- Issues arising from morning presentations that require further development
- Market Infrastructure Development (Group 1 led by John Spriggs and Moses Woruba)
- Understanding Consumer and Buyer Preferences in the Formal and Informal Markets (Group 2 led by Norah Omot)
- Women and Youth Participation in the Fresh Produce Industry – (Group 3 led by Barbara Chambers and Cathy Wali)

Process for working in small groups: Each group will be led by the presenter of the previous session, who will act as facilitator. Their role is to keep the group focussed and ensure all group members have a chance to express their view and ask clarifying questions. The facilitator should keep to time and manage the group so that no one person dominates. The rapporteur in

your group will make notes, but the facilitator should sum up the discussion in the last five minutes and ensure that recommendations or points to be taken up in the large group represent the views of the majority of group members. This will ensure that the rapporteur accurately represents the outcomes of your group's discussion.

11.50 – 12.30

Plenary Session:

Rapporteurs report on outcomes of small group meetings and issues requiring further development. Elaboration and clarification by group members where necessary.

12.30 – 13.30 Luncheon

Presentations

13.30 – 2.30

- Evaluation of the Use of Two Way Radios in the Highlands of PNG – John Kewa
  - Questions
- SSSPP/FPDA Project on Quality Management – Willi Ehmig
  - Questions
- Evaporative Cooler Trials – Surya Nath and Frank Vindinamo
  - Questions

Small Group Work

14.30 – 15.00

- Issues arising from morning presentations that require further development
  - Evaluation of the Use of Two Way Radios (Group 1 led by John Kewa)
  - Quality Management (Group 2 led by Willi Ehmig)
  - Evaporative Cooler Trials (Group 3 led by Surya Nath)

Process for working in small groups: Each group will be led by the presenter of the previous session, who will act as facilitator. Their role is to keep the group focussed and ensure all group members have a chance to express their view and ask clarifying questions. The facilitator should keep to time and manage the group so that no one person dominates. The raporteur in your group will make notes, but the facilitator should sum up the discussion in the last five minutes and ensure that recommendations or points to be taken up in the large group represent the views of the majority of group members. This will ensure that the raporteur accurately represents the outcomes of your group's discussion.

Plenary Session

1500 – 15.30

- Raporteurs report outcomes of small group meetings and issues requiring further development. Elaboration and clarification by group members where necessary.

15.30 – 15.45

- Foreshadowing Day 2 Activities and arrangements for Celebration Dinner (Barbara Chambers)

15.45 – 16.00 Afternoon Tea

18.30 Workshop Dinner

Day 2 Friday 30 March 2007

9.00 - 9.20

- Recap of yesterday's outcomes on issues requiring further development and outline of morning's activities (Barbara Chambers and John Spriggs)

Presentations

9.20 – 10.20

- Quality Managment Protocol for Fresh Produce in the Supply Chain – Sogoing Denano and Joyce Kisai
  - Questions
- Lessons from the Airfreight Trials – Willi Ehmig
  - Questions
- Towards a New Transport System for Fresh Produce – John Bennett
  - Questions

10.20– 10.40 Morning Tea

Small Group Work

10.40 – 11.15

- Issues arising from morning presentations that require further development
- Quality Management Protocol for Fresh Produce (Group 1 led by Sogoing Denano and Joyce Kisai)
- Airfreight Trials (Group 2 led by Willi Ehmig)
- New Transport System for Fresh Produce (Group 3 led by John Bennett)

Process for working in small groups: Each group will be led by the presenter of the previous session, who will act as facilitator. Their role is to keep the group focussed and ensure all group members have a chance to express their view and ask clarifying questions. The facilitator should keep to time and manage the group so that no one person dominates. The raporteur in your group will make notes, but the facilitator should sum up the discussion in the last five minutes and ensure that recommendations or points to be taken up in the large group represent the views of the majority of group members. This will ensure that the raporteur accurately represents the outcomes of your group's discussion.

Plenary Session

11.15 – 11.45

- Raporteurs report outcomes of small group meetings and issues requiring further development. Elaboration and clarification by group members where necessary.

Review

11.45 – 12.00

- Whole group responds to workshop outcomes and suggests further refinements to recommendations for future action

Thanks and Close

12.00 – 12.15

- Barbara Chambers and John Spriggs

11.1 Appendix 2: Outcomes for Workshop 3

11.1.1 Outcomes of Workshop 3, 28 – 29 March 2007

At Workshop 3, small groups met to respond to each set of presentations. The groups were led by the author(s) of the papers and a raporteurs was present to record key issues and possible actions. The raporteurs then reported to plenary sessions and the group questioned, elaborated and endorsed recommendations. The following describes the title of the paper and author, the name of the raporteurs, key issues discussed and endorsed recommendations for action.

Small Group Work and Ratified Actions by Workshop Plenary

1. Understanding Consumer Preferences in the Formal and Informal Markets (Norah Omot, NARI)

Raporteur: Barry Greville-Eyers, Uniquest

Key Issues:

- Reliability of supply
- Consistency of Quality
- Preference for Local Produce

Possible Actions (endorsed, unless otherwise stated):

- National branding of local produce e.g. 'Buy PNG' campaign which would foster pride and motivation
- Developing a code of coordination between NDAL and Provincial DAL and the establishment of a governing body to overcome issues of Time and Sequencing in the supply chain
- Greater awareness through education across the supply chain about the impact on quality of handling fresh fruit and vegetables
- Restricting imports – however, the workshop agreed that this can only be done in cases where pest and disease is an issue with imports, otherwise WTO agreements would be breached.

2. Women and Youth in the Fresh Produce Industry (Barbara Chambers, AISC, University of Canberra and Cathy Wali, Gender and Youth Programme, FPDA)

Raporteur: Kerry Fox, Uniquest

Key Issues:

- Conditions for women at the Goroka Market
- Incentives for youth participation in the fresh produce industry

Possible Actions (endorsed, unless otherwise stated)

- FPDA and DAL will take the lead on improving conditions at the Goroka Market (ratified by those representatives at the workshop)
- Explore the possibility of finding a new site for the Goroka Market if the issue of improving conditions cannot be resolved with the current land owner
- Youth should be linked to markets, not just to assisting parents with Gardens
- Training for parents to address the Youth Survey results that showed youth need access to land, guidance from parents and resources to motivate their interest in the fresh produce industry

- Extension work for youth, possibly through existing youth groups, should be targeted by FPDA
- Development and research projects in fresh produce in particular, and agriculture in general, should include a Youth component. This might include involving youth at school studying the 'Making a Living' syllabus as agricultural mentors for post-school youth. It might also include involving youth in villages and settlements in trials of fresh produce, including improvements in production, post-harvesting, marketing and value-adding.

3. SSSPP/FPDA Project on Quality Management Issues (Willi Ehmig, formerly of FPDA)
Raporteur: Barry Greville-Eyers, Uniquest

Key Issue:

- Quality Protocols required for post-harvesting, packaging and transportation

Possible Actions (endorsed, unless otherwise stated)

- Recognise that each market segment has different strategies to accommodate quality issues
- Each supply chain needs to be mapped before interventions are introduced
- Evaluate each supply chain before introducing change
- Determine the sustainability of replicating the SSSPP/FPDA Project, as marketers may be reluctant to get involved because of financial constraints. There is a need to convince marketers that increased inputs will result in greater income or revenue in the longer term
- Leadership and informed management are required, including risk assessment, in the supply of fresh produce to institutions
- Refined sequencing in production and supply of fresh produce is required to ensure quality delivery to secured markets. Elimination of wastage ought to be the goal.

4. Marketing Infrastructure Development (John Spriggs, AISC, University of Canberra and Moses Woruba, FPDA)
Raporteur: Ben Mullen, Uniquest

Key Issues:

- Financial and functional assessment of FPDA fresh produce depot infrastructure initiatives
- Potential to restrict/ban imports of fresh produce to protect the domestic industry
- Potential to alter marketing systems rather than smallholder production culture

Possible Actions (endorsed, unless otherwise stated)

- ISP to assist FPDA to undertake a feasibility and functional analysis of FPDA depot infrastructure initiatives. Recommendations regarding location of depots; cost of services provided and hand-over to the commercial/private sector will come out of this study. Current work is based on best estimates and the assumption that Mt Hagen, Goroko and Kainantu are the primary centres along the Highlands Highway.
- Emphasis should be on supporting the local industry to produce and market effectively, rather than looking to bans on imports to protect local industry. WTO rules prevent bans on import unless supported by pest or disease concerns.
- Ensure that trade and business policies do not unnecessarily work against the local fresh produce industry. Duty concessions for mining companies importing fresh produce??
- The central consolidation depots are an attempt to spread the supply of produce into the market, rather than attempting to dramatically change smallholder production culture. Through the depot system there will be opportunities to schedule smallholder production.

5. Evaporative Cooling System Trials (Surya Nath and Frank Vindanamo , PNG University of Technology)

Raporteur: Ben Mullen, Uniquest

Key Issues:

- Primary discussions were based around construction of the ECS.
- Potential for pests and diseases to become established within the ECS.
- Does rate of deterioration of chilled produce increase at a faster rate than unchilled produce once removed from the chiller?

Possible Actions (endorsed, unless otherwise specified)

- Information on technical construction of the ECS is available through UniTech. Produce must be placed inside the ECS so that airflow is maximised. The higher the walls, the more effective the cooling. The system needs continuous trickle of water through the sand to keep the cooling working. Kunai grass would make an excellent roof cover as it insulates very well.
- There is potential to produce a portable ECS devise, but this would be more expensive per cubic metre of capacity.
- Essential to wash and disinfest the produce before it is placed in the ECS. Main impact of pests and diseases is from those already on the produce, as there is little chance of insects entering independently.

6. Quality Management Protocols for Fresh Produce in the Supply Chain (Sogoing Danano and Joyce Kisai, Unitech)

Raporteur: Barry Greville-Eyers

Key Issues:

- Compression/vibration damage to fresh produce
- Availability of suitable packaging materials
- Transportation impact on suitable packaging material

Possible Actions (endorsed unless otherwise specified)

- Broaden knowledge base about packaging and transportation of fresh produce
- Consider ‘local’ enviro-packaging materials, as opposed to costly mported, non-environmentally friendly packaging material. For example,
  - Woven baskets
  - Bamboo bins
  - Balsa wood

7. Evaluation of the use of Two-Way Radios in the Highlands (John Kewa, FPDA)

It was decided by the group that FPDA was already acting on the outcomes of this evaluation and nothing more needed to be done at this stage to further recommend actions.

8. Towards a new Transport System for fresh Produce (John Bennett, General Manager, FPDA)

This presentation was in the nature of ‘future dreaming’, rather than an ACIAR Project Research Report and therefore small group work was considered inappropriate.

Barbara Chambers, Workshop Facilitator
March 29 2007

11.2 Appendix 3: Letter of Thanks from Director, NZAID Program of Improvement for FPDA

11 April 2007

Professor John Spriggs
Project Leader
Australian Institute for Sustainable Communities
Division of Education and Communications
University of Canberra
Australian Capital Territory
Australia
2601

Dear John

Subject: Workshop Research Outcomes of the ACIAR Project on Improving the Marketing Systems of Fresh Produce from the Highlands of PNG.

On behalf of UniQuest International Projects and the NZAID-funded Institutional Strengthening Project for the PNG Fresh Produce Development Agency, I would like to express my gratitude for the invitation to attend your project culmination workshop in Goroka. The inclusion of our core ISP team, as rapporteurs in the formal proceedings, provided the ideal opportunity to engage directly with previous, current and emerging challenges facing both FPDA and the fresh produce industry.

Research findings presented at the workshop will serve as an excellent source of baseline information. Our ISP team has also benefited from interactions with stakeholders and resource persons directly involved with the ACIAR project. It is our hope that the ISP will not only sustain but build on the valuable contribution of the AISC.

Yours sincerely

Barry Greville-Eyres
International Projects

11.3 Appendix 4: Market Infrastructure Development Report to FPDA

Market Infrastructure Development Report

By Moses Woruba, March 2007

Marketing Infrastructure Development Project (MIDP) is one of the important agricultural development projects in PNG which the Fresh Produce Development Agency (FPDA) is undertaking. It is an important/impact project for the Highlands Region that has great potential in bringing socio-economic benefits to the majority of the rural populations.Highlands Region covers Eastern Highlands Province (EHP), Simbu Province (SP), Western Highlands Province (WHP), Enga Province and Southern Highlands Province (SHP). Given the current law and order situations in the SHP and EP the MIDP has not made any firm commitments in those two provinces as yet. EHP, SP and WHP are currently being covered under the present MIDP and Market Advisory Support programmes.

Concept paper was done and submitted to PNG Inceptive Fund (PNGIF) in 2004; and it was accepted by PNGIF and FPDA was asked to prepare a full project proposal and submit to PNGIF for funding in phase by phase approach. Phase 1 in EHP, phase 2 in WHP, phase 3 in SP, EP and SHP. However, land acquisition for establishment of marketing infrastructures (marketing depots) is not an easy task anywhere in PNG, and EHP is no exception. As a result of the hassles in securing land titles, or state leases in EHP, FPDA lost out in securing K7.5 million under PNGIF for implementation of phase 1 marketing infrastructure development (consolidation and cool storage marketing depot) programme in the EHP. We hope to secure this funding for phase 1 and subsequent phases when we submit our project proposals to PNGIF from July/August, 2007 onwards. We may need to resubmit a revised concept paper before the full project proposals can be done and submitted. Depending on the outcome of this concept paper from PNGIF, we may have to look at other potential donor agencies. GovtPNG has been so good in supporting rural industry so far in promoting and implementing export driven economy, import reduction & replacement and poverty alleviation under its Medium Term Development Strategies (MTDS) policies; and is coming good to providing FPDA the most needed funds to commence work on this very important socio-economic impact project.

The overall aims and objectives of the MIDP is to provide marketing infrastructures or marketing depots at strategic locations in order to consolidate and force cool fresh produce (fruits, vegetables, potato, sweet potato, plantains and green spices) from the producers at farmer fields before freighting it to supermarkets on the coastal cities and towns, mines, industries, and institutions – through a whole cool market chain concept.

Currently the main source of funding still comes from the Government of Papua New Guinea (GovtPNG). The PNG Incentive Fund (PNGIF) under AusAID which FPDA has been trying to source bulk of the funding in the tune of K7.5 million per project component for the Marketing Infrastructure Development Project since year 2004 is however, no longer possible now, because so much time was lost trying to secure state owned land portions for marketing depots.

Although the delays have tinted FPDA with less impressive picture, we (MIDP) have made some positive moves and created positive impacts on other fronts. These impact areas are given hereunder in the following summary list of programme activities:

- Made moves to renovate the old DPI/DAL depot building at DPI Wara Simbu, Kundiawa for the people of Simbu Province to consolidate, force cool, cool store and freight their fresh produce to supply the existing markets FPDA is currently maintaining for the purpose. Unlike in EHP, FPDA has no problems in securing land portions for such good community projects in Simbu Province, and similarly in WHP.
- The issue of land deals in Kainantu has now been resolved when FPDA finally secured the lease for the Central Consolidation & Cool Storage Depot (CCCSD) in Kainantu Town on Allotment 02, Section 27. The work on Kainantu CCCSD has already commenced.

- Further moves have also been made for acquisition of state owned (EHPDAL) land portion in Goroka Town for a 2-unit CCCSD for the four districts: Lufa, Ungai/Bena, Goroka and Daulo. The work has already commenced to a limited scale while waiting more funding from GovtPNG.
- All land portions for district depots in Simbu Province are guaranteed and/or secured for construction to commence as soon as funding is secured. Minor renovation work is required in Kerowagi and Gumini districts, while a new building is needed for Gembogl District. Chuave District may also be considered for a district depot when need arises in future, otherwise community resource centres can be considered as sufficient. Sina Sina District can always go direct to the CCCSD at Wara Simbu, Kundiawa; and CRCs at various central locations as primary meeting places for the people. These can also the primary collection points for their produce before it reaches Kundiawa.
- National Dept of Agriculture & Livestock through Highlands Agriculture College in Mt. Hagen also came good in providing FPDA a good of land (c.4– 5 ha) right alongside the Highlands Highway on the College grounds for the WHP CCCSD. It is anticipated to have a 3 – 4 unit depot on it.
- Virtually no problems encountered in securing state-owned land portions in the WHP for the district depots.
  - Minj District promised/guaranteed a state-owned land portion right next to DPI Office measuring some 0.80 ha on nice flat area. An L40 is also promised for FPDA to supervise marketing and general work programme in the district.
  - Banz District came forward with an offer for some 3 ha of ideal piece of state-owned land portion for a district consolidation and cool storage depot (DCCSD) that would serve both Banz and Minj districts. These two districts have prime land for production of any agricultural commodities, and fruits (citrus and banana) and good healthy vegetables is not a concern.
  - Tambul the furthest District in WHP offered some 20 ha of prime state-owned land portions for a district consolidation and cool storage depot, similar to Banz. Some of the land is to be used for demonstrations and farmer training and staff housing, etc.
- No major hiccups in securing state-owned land portions for district depots in most districts of the EHP:
  - In Okapa District the state-owned land portion has been allocated to FPDA on the station since 2005, surveyed and is only waiting for construction of the district depot.
  - Similarly for Lufa District the state-owned land portion measuring some 0. 4 ha is made available for its DCD since 2005.
  - Daulo District was the first of the districts to come forward with an offer of state-owned land portion for a DCD. Survey work was done in 2005 and we are only waiting for funds to commence work.
  - However, Henganofi District didn't come very good to providing a state-owned land portion. The alternative would be to use ex-Henganofi Council Chamber or construct a new building on Henganofi Council land area, if there is a real need; otherwise not.
- Facilitating construction of community resource centres among farming communities as primary contact points for FPDA with farmers for awareness and training on crop production and produce marketing.
- Creating awareness for formation of farmer groups and having them registered as marketing cooperatives has been a challenging programme activity since 2005. The programme so far covers EHP, SP and WHP, and the momentum is still building up by weeks and months.

- Now that former MID Manager, Ken Konafo is gone, I have to look into MAS and the MID programme activities as a whole, even though Mr. Robert Lutulele is currently our Acting MID Manager. This is more or less sharing Mr. Lutulele's work load because he has PSD as well as attending to certain top management responsibilities.

Central Consolidation & Cool Storage Depots – Progress & Situation Reports

1. Kundiawa CCCSD – A renovated building project

- All carpentry work on main cool store and the container building for office is now complete.
- Electrical work is progressing well so far
  - Awaiting inspection by PNG Power Inspector at Kundiawa before connection of the buildings with 3-phase power supply through service wire, etc.; and the payment processed for the job was already done to Kundiawa PNG Power.
  - Installation of drop-in freezer unit when the unit arrives in Lae sometimes after next week and is picked up and delivered to Kundiawa. The electrical job would then be fully complete and the whole Kundiawa CCCSD should be ready for operation. Hopefully by early March the electrical work would be fully complete.
- FPDA Sign Boards indicating locations, types of produces for buying & selling and buying times are yet to be done, but it's a minor issue of concern. Hopefully by April/May this should be done.
- About 300 metre road into the depot is still and a security fencing are still a concern because the SP Provincial Government made verbal commitment to FPDA to provide good vehicle access has not yet done much to fulfil this commitment.
- During the short meeting 07/02/07 two officers: E. Natera (Post-harvest Technologist and John Kewa, Market Researcher have been asked to do the following things:
  - Identify, organise and train farmer groups in Kerowagi, Kundiawa, Gembogl, Sina Sina, Chuave and latter Gumini when the road conditions are improved.
  - These farmer groups will be trained on *all aspects of post-harvest technologies* (quality control) by Ernest Natera, and on *certain aspects of pricing of produce and marketing* by John Kewa.
  - They will commence trial runs on air freighting fresh produce from Kundiawa out to Port Moresby, and possibly other centres and mines before handing over the operations to a farmer group that can meet the required standards set by FPDA to takeover the operations. This will be about June – September quarter.
- Office furniture and equipment including the following items will have to be bought soon:
  - 2 x office chairs
  - 2 x work desks
  - 4 x plastic chairs
  - 2 x floor fans
  - 2 x 4 – drawer filing cabinets
  - 1 x fax/phone line connections (with barring facilities)
  - 1 x 100kg capacity electronic scale for weighing produces
  - 1 x 25kg suspension/clock face scale for carrying around
  - 1 x 5-10 kg electronic scale
  - Necessary stationery items

- A 4 x4 vehicle is needed fulltime for Simbu CCD and general FPDA operations in the province from about May 2007 onwards. Initially it will be based in Goroka and keep moving back and forth until there's a fulltime officer on site. If a new vehicle is not possible then a good durable second hand four wheel drive is OK for the time being to get the programme started and running.

2. Kainantu Central Consolidation & Cool Storage Depot – A new building project

- State Lease has now been secured; and is land rental free for indefinite period, just like schools and hospitals because FPDA works for the farming communities.
- Main drainage to remove stagnant water was done in November/December, 2006 by a local youth group in Kainantu hired for a fixed rate at the completion of the job.
- Tenders for land surveys – land boundary and cartographical surveys were out on 06/02/07 for local bidders. We should receive bids for the work sometimes next week or the week after.
- The tenders for architectural designs and building plans should also be out after we have received the reports of the land survey, and we expect the bids to be in sometimes in March.
- Immediately after the designs are completed and received by FPDA the tenders for construction work should immediately follow for the bidders. This we should expect around May/June for the actual construction work to commence.
- The scope of work will include the following types of buildings:
  - 1x two unit depot shed that will house 2 vegetable chillers as the main building
  - 1x office building FPDA operations
  - 1x store house with compartments for seeds, agricultural chemicals and a general storage area for FPDA
  - 1x H65 building for FPDA senior staff accommodation
  - 1 x H45 building for FPDA junior staff accommodation
- The proposed 5 buildings will be built using a good portion of the three million kina (K3 million) now budgeted for the project: K1.5 million from previous allocations and the other K1.5 million is from the NADP's K35 million for 2006/2007 that we submitted project proposal for. Part of the funds will go towards purchasing of certain materials and equipments. Our main objective is getting the building up to show that we actually are doing something. According to the Dept of National Planning and Monitoring, if we spent the money we have already been given for the work, we can always get some more funding because this is an important impact project.
- Information received so far on MIDP funding that we requested late 2006 is a bit sketchy; however, the good news is that the K1.5 million funding is certain for Kainantu CCD and it may hit FPDA Account anytime soon, but the K5 million for the Goroka CCCSD and the FPDA office buildings is still in limbo. Nobody seems to know where the money has gone to. We will get some information on this issue sometime latter according to the Policy Division Director of NDAL. I believe we can still get some more funding for MIDP this year, if we with the support of Director, NDAL Highlands Region can lobby well and convincingly. More follow-ups are being made on the funds for Goroka CCSD. Probably the Facilitator, MIDP needs a direct phone line to be effective in doing follow-ups and negotiations in sourcing funds, etc. for this important project. This together with a new project vehicle has already been budgeted for in the breakup of the K1.5 million which will be deposited into FPDA Account soon.

3. Goroka Central Consolidation/Cool Storage Depot with Office Complexes and Training Facilities – A new building project

- We are fortunate that the land for the above mentioned facilities is freely made available for the purpose by the Eastern Highlands Provincial Administration through the Division of Agriculture & Livestock at Section 21, Vahoe Street, Goroka, in an area generally known as Lopi, West Goroka. Thanks to EHPDAL and NDAL Highlands Regional Office for the good collaborations so far.
- Crescent Pacific Engineering was engaged to do a sketch Design & Construction Plans for these facilities with cost estimates for FPDA for the purpose of submission with the project proposal (to NDAL's NADP) to secure funding for the facilities.
- Five million Kina (K5.0 million) was requested through NDAL Secretary for the Goroka facilities on November 23-26, 2006. In the NDAL Secretary signed Project Proposal that was hand-delivered to the Secretary for the Dept of National Planning & Monitoring, a total amount of K10.0 million was requested; of which K5.0 million was for Goroka facilities and another K5.0 million for other depots in the Eastern Highlands and Simbu provinces.
  - Any chances of securing total K10.0 million now seems remote because the MIDP Facilitator was bluntly told that FPDA has not yet spent the project funds allocated in the previous years on project related activities, including purchasing necessary equipments like a project vehicle. And more importantly the establishment of a central consolidation & cool storage facility in either Goroka or Kainantu. The delay was due to difficulties encountered in securing land portions for the purpose.
  - Same reason was also given to the Facilitator, MIDP on November 29, 2006 by the DNPM for not allocating any funding (some K4.0 million) requested together with other FPDA programmes under 2007 budget submissions. Therefore MIDP does not have any funding in 2007 under normal FPDA submissions, except under the 2006 Supplementary Budget in which K35.0 million was allocated to NDAL when NADP was passed.
- On the positive note, if and when the funds (K5.0 million) for Goroka facilities are secured anytime this year, similar work programme as that of Kainantu facility will also commence almost immediately this year. This information was verbally relayed to the Director Policy Division of NDAL, who assured the Facilitator, MIDP that he would look for the whereabouts of that money and inform him accordingly. Our best hope would be for the 2007 Supplementary Budget.

4. Other Depots – Both CCD and District Depot buildings

- Securing land portions for construction of district depots in Okapa, Lufa, and Asaro in EHP; and Gembogl, Gumini and Kerowagi does not have any major problems. However, our priority at present is to get the central facilities up first; the district facilities will be our next priority facilities when we get the funding either from PNG Incentive Fund, or from PNG Government.
- The same can be said for the land portions in Minj, Banz and Tambul for the district depots, and in NDAL Highlands Agriculture College (HAC), Mt Hagen for the central consolidation and cool storage facilities. NDAL HAC has indicated to allocate some 5 ha of the College land for the Mt. Hagen CCCSD facilities; situated just across the Okuk Highway in the Workshop area.
  - Obtaining land portions in either Simbu or Western Highlands provinces for such socio-economic activities as construction of fresh produce marketing depots is relatively easier than in the EHP.
  - Apart from Kundiawa CCCSD all other depots will have to wait until the Kainantu CCCSD is established first, because this is what the stakeholders want to see happen. That will prove to them that we actually are working and that we deserve further funding support as we do need it.

5. Community Resource Centres – New Buildings built of Temporary Materials

- These community resource centres are located within community groups which may also be farmer groups who are forming cooperative societies or associations. Land, building materials, labour and the related construction costs are provided by the people. FPDA usually comes in to help in whatever small way we can to show we are also interested in what the people are doing and by doing so we encourage them to go forward a step further.
- Community resource centres are primary contact points for FPDA with the farmers and how they can be helped in organizing their farmer groups for marketing of their fresh produces to the depots. There are quite a good number of such resource centres throughout EHP; most built of temporary building materials but those built through funding from AusAID's Community Development Scheme (CDS) are of permanent materials. Where such resource centres do exist FPDA does not necessarily venture into establishing any similar ones, otherwise we could be wrongly seen as being competitive; we are for collaboration with similar bodies playing similar roles in order to do more by sharing our limited resources.
  - Kosena Community Resource Centre in Kamano 2, Kainantu District was completed and opened on November 20, 2006. FPDA assisted with essential items for connection of water supply to the centre for irrigation of crops. CDS established the village water supply earlier.
  - FPDA also gave out some bulb onion seeds with necessary agriculture chemicals; potato seeds were not ready so they were not given out at the time of the opening. The farmers were assured of these to be given to them in January/February 2007, but the potato seeds are yet to be delivered.
  - Things seem to be going well so far, and a visit will be made to Kosena and Ibusa villages in March to re-assess and verify the (verbal) reports.
  - Kwongi 2 Community Resource Centre in Upper Asaro Constituency, Daulo District should also be ready for opening sometime in the near future, possibly April/May 2007. A brief visit will also be made to assess the situation this month.
  - Kuru Top Community Resource Centre at Haga Village of Henganofi District is still under construction. A visit will be made in early March to assess the situation.
  - Niru Resource Centre for the Keagana Constituency of Okapa District is also still under construction; and a visit will also be made in March as for the Kuru Top.
  - Similar visits will be made to assess the situations of other communities in Kainantu and Obura/Wananara districts in March.
  - A visit will also be made in April to the WHP to assess the situation on the community resource centres and the farmer marketing cooperatives.

6. Marketing Cooperative Societies

- Marketing cooperatives are being formed to assist farmer groups do marketing of fresh produce – fruits and vegetables. Marketing of fresh produce is a very risky and sensitive undertaking which most PNG small farmers try to operate individually have often run into problems. Problems such as those listed below are a big concern for small individual fresh produce farmers:
  - Lack of start up capital
  - Lack of credit facility
  - Poor product quality
  - Insufficient quantity of produce due to too small land area of production
  - Lack of technical know-how to go alone
  - Inconsistency in production and supply, and
  - Lack of cool storage facilities for reducing pulp temperatures of produces to prolong shelve life.

- These are some of the marketing issues small vegetable farmers often face when trying to do marketing alone. To be able to overcome these problems the small fruit/vegetable farmers must form marketing cooperatives and operate within the rules and bi-laws of the cooperative groups.

According to Prof. John Spriggs, there are several types of cooperatives operating in Australia, New Zealand and Southeast Asian nations. Officers of FPDA under MID are following a revised version of PNG Cooperative model of the 1950s established by Australian Colonial Administration, which the Dept of Trade and Industry is promoting, while we are also trying to copy the cooperative model of Malaysia (British Borneo/Sarawak). More advanced forms are in Australia and New Zealand which could also be copied as and when needs arise as advised by Prof. Spriggs, but someone in MID must be sent to Australia for a short course on cooperatives first.

Several cooperative societies and about two cooperative associations have been formed in the EHP. The latest being the Eastern Highlands Farmers Cooperative Association which was launched in the third week of January, 2007 that the Facilitator, MIDP also attended in Goroka.

- In the Kainantu District there are about four cooperative societies and one in Obura/Wananara District (OWD) indicating to register for fruit and vegetable industry. These are Yumi Cooperative Society in Kamano 2 at Kosena Village, Kamano1 CS, Tairora CS, and Agarabi CS in Kainantu District.
- Gasub Cooperative Society in OWD covers a wide area – Yonki Dam across to Aiyura and beyond.
- Lufa District has one Mt Michael Cooperative Society (under Trade & Industry Dept) and one Yagaria Women's Association (under IPA).
- Okapa District has Keagana Cooperative Society being formed and two more are also being organized to be known as North Fore Cooperative Society and South Fore Cooperative Society. Good access during wet weather is still an impeding factor to overcome.
- Henganofi District so far has only one registered cooperative society – Fayantina Cooperative Society; Dunantina Cooperative Society is till organizing itself.
- Ungai/Bena has two cooperative societies, and seems to be half way into registering itself as Korefegu Cooperative Society. Most paper work should be finalized at a March, 2007 meeting.
- Goroka District has two such cooperative societies which have already affiliated with the EH Farmers Cooperative Association.
- Daulo District has Upper Asaro Cooperative Society which is half way to registering itself with Cooperative Societies of PNG under Trade & Industry Dept.
- Simbu Province has Kuglkane Bulb Onion Cooperative Society and Mt. Wilhelm Yomba Cooperative Society. Some more are expected to be formed in other districts this year.
- In WHP about seven being organized, formed and registered, and some are already operating with marketing of coffee, fruits, vegetables and potato. The largest being the Minj Cooperative Society with about 35,000 members, and second largest could come from Tambul Cooperative Society when finally registered.

7. Some Planned Programme Activities to Meet the Short Term Needs of MID

- Officers of MID to submit copies of 2007 programme activities to Facilitator, MIDP for screening, prioritizing of programme activities and resource allocation. Any officer who does not submit his/her programme activities for the above does not expect any resource allocations. He cannot expect any resources for implementation of his/her programme in 2007. Implementation of work programmes on unplanned basis should slowly be reduced with proper programme planning instead for smooth operations, improve officers' performances with increased quantifiable outputs. A short informal meeting was held with most MID officers on February 8, 2007 for briefing on 2007 work programme plans.
- Ernest Natera and John Kewa to concentrate on Simbu CCCSD at Kundiawa to get the marketing of fresh produce into full operation before handing over the operations to a farmer group that satisfactorily meets the FPDA set standards and requirements. They will work even if there is an appointed officer on site to oversee the management of the operations in Simbu, until all runs smoothly and well.
- Vincent Samson (Market-Purchasing Officer) and Vincent Hagaluha (Post-harvest/Food Technologist) to concentrate on EHP from Goroka. They are to strive to make improvements on the present produce marketing programme – buying and selling produces for the farmers to Andersons Port Moresby. Improvements must be made on produce quality in terms of timely harvest and short waiting periods, packaging and labeling and general handling as priority areas. Secondly, the pricing of different product must be done carefully with adequate data to work from. Donald Heahona and John Kewa to assist Vincent Hagaluha and Vincent Samson on this issue.
- Donald Heahona (Econ), John Kewa (Market Researcher) and Earnest Natera (Post-harvest Technologist/Quality assessor) to travel to Port Moresby for 4-5 days, Lae for 3-4 days, Madang 2-3 days and Wewak 2-3 days to identify potential markets for fresh produces from the highlands. Institutions, supermarkets, mines, and industries are to be visited for negotiations. J. Kewa's programme to include costs and commodity pricing from farm gate to the DCD and CCCSD; and from there CCCSD out to formal markets: supermarkets, mines, institutions, industries, etc. in various locations in PNG. He is also to look at the potentials of export market or niche market in the neighbouring Pacific Island countries. D. Heahona to assist J. Kewa on the economics of these exercises.
- After the annual work programmes are screened, prioritized and resources allocations are made we should know who is doing what and when and how we can make each officer work more effectively, and if possible efficiently in implementing his or her work programme in 2007.

8. Programme in the Order of Priority

- Kundiawa Central Consolidation & Cool Storage Depot to make sure it is fully furnished and is operational by April/May 2007. This is a pilot project therefore it must be done well so that it can be copied to other depots.
- Kainantu CCCSD should be given all the attention in February and March to get the tenders out for the bids for architectural designs and construction of the buildings.
- Market research to address costs and pricing factors of production and movement of produce from one location to another.
- Facilitating construction of Community Resource Centres takes a lower priority this time because the central consolidation and cool storage depots must go up first. CRCs and will be used for farmers training on aspects of crop production and marketing through cooperative societies.
- Organization and registration of farmer marketing cooperative societies to prepare them for running of the depots when they are established using the community resource centres.

- Project proposal writing is a continuous programme activity that should commence in March and run through to June/July 2007 for various donor agencies for different building projects. Economist Heahona has already been approached to assist and he has already agreed to help with the task.
- Other programme activities take much lower priorities in resource allocation and implementation accordingly.

9. Resource Requirements

Resource allocations in terms of funds, vehicles, office equipments and manpower are requested to implement the above mentioned programme as outlined above.

- 9.1 Funds – MIDP is planning to spend K3.0 million on Kainantu CCCSD facilities and K5.0 million on Goroka multi-purpose buildings including the CCCSD this year (if that K5.0 million can be found). All these funds are from PIP. However, we are still keeping our fingers crossed for some possible outcome from NDAL for the K5.00 million to implement the Goroka CCCSD for the sake of the Highlands Region.
- 9.2 Other MID programmes including MAS, unless specified, are funded from the recurrent budget funds.
- 9.3 Vehicles – MID at present has only one very old Mazda Bravo, a white utility Rego # HAG 183. The MID officers have been requesting the use of vehicles for work on a daily basis. This is OK but in the long run it becomes a bit tiring and frustrating when the type of vehicle the officers requested for work is also used by others. MIDP should now buy a project vehicle when the K1.5 million hits the FPDA BMA Account; we need it to effectively carryout our work programme from 2007 onwards.

11.4 Appendix 5: Women and Youth Participation in the Fresh Produce Industry

11.4.1 Women and Youth Participation in the Fresh Produce Industry

Presented at Workshop 3, Research Results from the ACIAR Project, Improving the Marketing System of Fresh Produce from the Highlands of PNG, March 28 2007

Barbara Chambers, AISC, University of Canberra

Cathy Wali, Gender and Youth Programme, FPDA, Goroka

Background

The impetus for undertaking a survey of youth in the Fresh Produce Industry was suggested by Lilly Be'Soer, Programme Leader of the Gender and Youth Programme (GYP) at the Fresh Produce Development Agency (FPDA), at the second workshop in the ACIAR Research Project on *Improving the Marketing of Fresh Produce from the Highlands of PNG* (Spriggs and Chambers, 2003 – 2007). Prior to this, the first workshop in the project had been on constraints and opportunities for women growers in the fresh produce industry. Taree Brearley, a post-graduate student at the University of Canberra, subsequently undertook a review of research on women growers in PNG and provided this to the GYP at FPDA. After the second workshop, the project team agreed to provide the GYP at FPDA with a literature review on youth participation in the fresh produce industry and assistance with funding, design and analysis of a youth survey. Linda O'Connell, an undergraduate student at the University of Canberra, researched the literature on youth, carried out some interviews in the Highlands and assisted in the development of a concept paper on youth participation in the sweet potato industry. The latter was made available to Dr Christy Chang at UNE who was developing an ACIAR project proposal on sweet potato.

Women's Participation in Fresh Produce[1]

In looking at previous survey research on women's participation in fresh produce, the only study of relevance was the Korofeigu Survey undertaken in 1996 by Unisearch (UPNG). The objectives of the study were to

1. Identify the impacts of commercial vegetable growing and marketing on men and women
2. Identify and discuss opportunities for better integration of women in FPDA projects.

The survey identified three important factors in the participation of women as compared to men in the fresh produce industry.

1. Time allocation: the study found that women spent more time on non-agricultural work and less time on gardening and leisure activities than men.
2. Women's total work hours per day were 10.17 hrs compared with 7.53 hours for men.
3. Harvesting and sale: high value crops tended to be dominated by men, for example, women earned 30% from tomato sales and men earned 70%. Of women's total income, 43% came from surplus crops, compared with 8% of men's total income.
4. Expenditure: women spent 75% of their income on their family and men spent 75% of their income on themselves.

One outcome of the Korogeigu Survey was that from a development point of view, FPDA decided it was more important for women to benefit from work in fresh produce than men. FPDA

[1] *Refer to Taree Brearley (2005) Project Report on the Participation of Women in the Fresh Produce Marketing System, April 2005 in John Spriggs, Annual Report 2005 to ACIAR on Improving the Marketing System for Fresh Produce of the Highlands of PNG, January 2006. The report contains a full literature review, together with interview results.*

instigated a range of specific measures to address this issue through village extension and training, including inclusive gender training, and building women's networks in agriculture.

In 2003, the ACIAR project team held a women's only workshop prior to the larger stakeholder workshop, which focussed on the ***Physical*** aspects of the supply chain. Women, and as later endorsed by the full stakeholder workshop, the following physical constraints to women's full participation in the fresh produce industry, especially marketing, were identified.

1. Poor conditions of the city market in Goroka: variable gate fees, roaming pigs, no adequate toilet facilities or shelter, let alone safe child-care facilities, were identified as problems women faced in selling fresh produce.
2. Inadequate and unsafe transportation: this constraint affected participation in local and formal markets. Women often had to walk several kilometres to the main road, where buses were caught into town. Buses were overcrowded and overheated, damaging fragile produce. Transport to larger centres for more formal markets posed a physical risk to women of robbery from Raskel gangs, assault and at the extreme, sexual assault. As a consequence, formal marketing was left to men.
3. Need for storage depots: the poor transportation available, meant that women had nowhere to store fresh produce prior to and after market.
4. Insufficient share of income: as previously identified in the Korofeigu study, women did not have an equal share of income from fresh produce and what they did earn went to support their families. Women complained that when men sold produce at formal markets, instead of buying reliable replacement seeds they tended to gamble profit.
5. Insufficient time for gardening/marketing: women are largely responsible for child care, cooking, school supervision and fees, clothing and supplementary household goods. Gardening and marketing have to be fitted around this busy schedule.

However, partly as a consequence of the women's only and first full stakeholder workshops, it was reported by several women at the second and third workshops that they had formed important networks that had improved their participation in agriculture/horticulture. It seemed that 'Sisters are doing it for themselves', to quote a popular song by Annie Lennox. For example, one woman was inspired to undertake training in horticulture and started her own plant nursery business; another woman met a participant from customs and quarantine and gained assistance in meeting the requirements for the export of fresh flowers. Other women talked of collaborating with other women growers and sharing knowledge and how the FPDA inclusive gender training and village extension programs had raised awareness in their families of the importance of sharing role responsibility in the village, including increasing the time women had for growing and marketing fresh produce. On the negative side, while the storage depot is going ahead now at Kainantu, the Provincial Government's commitment to improving the main Goroka market hasn't eventuated. Apparently, the reason for this failure is not the allocation of money for the identified purpose; but the failure of the traditional owner(s) to spend it on market improvements that suit women. Women are therefore committing more time to peri-markets.

Youth Participation in Fresh Produce[2]

In 2005, the stakeholder workshop focussed on the *Human* aspects of the supply chain, leading to a research focus on the importance of engaging youth in the fresh produce industry. A literature review of previous research on youth in agriculture was undertaken by Linda O'Connell, University of Canberra, supplemented by interviews with key stakeholders. This was distributed to GYP Co-ordinators in Goroka, Lae and Port Moresby. The prevailing message

[2] *See Barbara Chambers and Linda O'Connell, Youth Participation in Food Production in the Highlands of PNG: A Literature Review in John Spriggs Annual Report 2006 to ACIAR on Improving the Marketing System for the Fresh Produce of the Highlands of PNG, February 2007. The report contains a full literature review, together with interview results.*

was that youth were at risk through their attraction to city life; their need for disposable income; and their disinterest in agriculture. Drugs, gambling and Raskal gangs were contributing risks. At a purely economic level, sustainable village life is at risk as is the future wellbeing and prosperity of PNG. Many interviewees felt that youth should be given a sustainable share in land and income from fresh produce, but more traditional participants felt that as parents had supported children through school, that they should contribute to village and family gardens as a reciprocal responsibility. School programs in *Making a Living* were encouraging youth to gain skills and knowledge in agriculture, budgeting and marketing, but in many cases youth were not being listened to or given requisite land, tools and resources to implement this learning. However, it is too early to say what the impact of this curriculum will have on incentivising youth to participate more fully in the fresh produce industry.

FPDA with the assistance of the ACIAR project team undertook a national survey of youth in the fresh produce industry in 2006 and 2007. National results of this survey are unavailable at this juncture; however preliminary results from surveys in the Highlands revealed some interesting data. Data was collected from the eastern Highlands Province (Goroka, Henganofi, Lufa and Asaro); the Western Highlands Province (Banz, Anglimp South and Tomba); and the Southern Highlands Province (Imbogu). There were 329 parent respondents in total of which 171 were male and 158 female. There were 56 youth respondents, of which 37 were male and 19 female. The age range was from 12 to 24+ years, with the majority of youth in the 16 – 23 years of age group. The preliminary results of parents' and youth views on youth participation are shown below.

Question: What are the reasons why youth lack interest in food production?

Parents	**Youth**
1. Lack of parental guidance	1. Limited land
2. Social activities	2. Lack of finance
3. Unequal distribution of resources	3. Lack of tools and material
4. Gambling	4. Laziness, too young
5. Drug use	5. Lack of technological knowledge/training

The perceptions of parents and youth are vastly different, apart from rating number three(3), with respect to lack of interest in food production. Parents tend to take responsibility for youth not participating in food production and see the personal behaviour of young people as a contributing factor, whereas youth focus on lack of meaningful resources and training as contributing factors.

Question: Solutions for Youth Participation in Fresh Produce

Parents	**Youth**
1. Provide skill training	1. No response
2. Counselling	2. Provide suitable training
3. Provide secure market	3. Support from Gov't, community or parents
4. Equal distribution of resources	4. Training, by parents/schools/self learning
5. Parental guidance	5. Assistance in farming and marketing

Despite the differences in language, essentially parents and youth agree that skill training, resources and support are important to encourage youth to more fully participate in the fresh produce industry.

Question: Views on Training for Youth
Opinions were fairly evenly spread, but the first five priority responses were:

Parents	**Youth**

1. Vegetable production	1. Crop production
2. Budgeting/Management	2. Book-keeping and financial records
3. Social issues such as HIV/AIDS	3. Law and order and market equally
4. Potato production	4. Marketing
5. Cooking/Sewing/Baking	5. Livestock, gender training

While youth and parents see training and budgeting/financial management as important training areas, parents also see wellbeing and lifestyle issues as important for youth.

Question: What are the main sources of family income of parents?

Parents	**Youth**
1. Garden Produce	1. Coffee
2. Building Material	2. Vegetables
3. Livestock	3. Coffee and Vegetables
4. Coffee	4. Wages
5. Firewood	5. Firewood

Basically, parents and youth appear to have different ideas about the priority order of income, although this may be affected by the fact that parents and children were not yet matched for responses on this question. For example, more children of coffee growers may well have answered this question than children of garden or livestock producers.

Question: What are the main areas of spending and control for parents?

Parents	**Youth**
1. Religious activity	1. School fees
2. Cultural obligation	2. Food and transport
3. Food and equal third, pay labourers	3. Laundry items
4. Household items	4. Clothes, gambling and cultural obligation

For parents, religious activity and cultural obligation account for main areas of expenditure, compared with food and household items. Youth on the other hand, thought the main areas of expenditure in order of priority were school fees, food and transport, laundry items and clothes, gambling and cultural obligation. As one youth worker put it, youth are constantly being told that their school fees and food cost so much that they shouldn't expect to receive a disposable income. In addition, it may not occur to youth that religious activity and cultural obligations were significant costs.

Question: Who has the main control of income?

Forty nine (49) males (28.7 of all males) compared with thirty eight (38) females (24% of all females) controlled the family income. Several communities declined to answer this question. Youth in the Highlands perceived in order of control of income, that father (22%) had the most control; mother (15%) had the next amount of control, followed by self and brother.

Compared with the Korofeigu Survey done in 1996, the gap between men (125 or 37.9%) and women (112 or 34.4%) growers is closing, with relatively equal numbers of men and women growing fruits and vegetables. This was out of a total of 329 respondents engaged in earning income. The remaining parents were earning income from other sources (93 or 27.9%), for example, from sale of building material, livestock, coffee or firewood.

Interpretation of preliminary results from women and youth surveys and interviews

In discussions with Michael Mati from the GYP in the Goroka FPDA office, we focussed on the Eastern Highlands Province (EHP) Community Youth Survey data for 2006 and Michael clarified each item, including possible meanings relevant to PNG. For instance, youth were asked to indicate what prevented them from fully participating in agriculture (Survey Part 2.1). One frequent response referred to 'Laziness'. In Western culture, laziness is a negative concept and associated with idleness or lack of motivation to participate. However, in the context of the PNG Highlands, and given answers to subsequent questions, it more likely means that there were impediments to participation in work-related activities, not necessarily a preference for idleness. In Survey Part 5.1, youth were asked how they spent most of their time in the community. One frequent response, ranked highly, was 'Gambling'. At first glance, this would appear to be a negative activity. However, gambling is a way that the 'black economy' works in the Highlands of PNG. For instance, in a game of darts, the prize for being the first one to score 96+ may be a chicken (or rice, or clothes, or pots and pans, etc). There are ten players per game, although women and girls tend not to play darts. Five darts may be purchased from the organiser of the darts game at K2.00 each in the case of the chicken prize. The winner may spend as little as K10 to play and the chicken may have cost K25. The darts organiser may keep K5 and the chicken farmer K20 on each winner's investment. The stakes may vary according to the type of prize (e.g. one kilo of rice may cost K2.50 and you might pay fifty toea per dart times ten players). However, the basic motivation remains the same: a small amount of cash for goods that otherwise could not be afforded for their purchase price.

Other forms of commodity/cash exchange are card games and Bingo. Both males and females play these games. Card games may be played for small cash bets, although there are usually separate males and female games. In Bingo a player may pay fifty toea each for 50 Bingo cards, the total cost being K25 and again, the prize may be a chicken. The chicken farmers make K25 minus K5 to the Bingo owner. The point is that gambling is a way to earn cash in the case of the organiser or farmer and goods if one is a player. With a small outlay and reasonable skill on the part of a family member, the villagers who engage only in sustainable agriculture can 'purchase' goods that would otherwise be beyond their cash income. Games often occur on community days, perhaps twice a week in villages or on market days. Men and women, boys and girls, may play, but only small amounts of cash are outlaid in villages. In towns, gambling occurs seven days a week. However, organised gambling is frowned upon by town authorities and a casino style gambling outfit was recently closed down in Goroka, although the owners subsequently set-up on the outskirts of town.

One unexpected outcome of gambling in Highland villages is that quite small children, often as young as six years of age, become adept at basic mathematics, being able to count, multiply, divide and subtract at high speed. Thus, many children, as well as adults, are becoming numerate more through gambling than school based curricula. Interestingly, research done in the 1970s in Australia showed this was also the case in non-literate traditional and semi-traditional Aboriginal communities, overturning previous (and racist) cognitive developmental research, based on Piaget's theories of child development, indicating that Aboriginal people were unlikely to achieve the formal or abstract stage of cognitive development, because their culture was grounded in activities that only encouraged concrete operations (see research by Molly de Lemos in the late 1960's and Anne-Katrin Eckerman from early to mid-1970).
In Part 6 of the Community Youth Survey, people were asked about Urban Drift. Michael Mati expounded his theory, based on discussions with youth in towns, claiming to be from the Highlands. He proposed that these youth, especially young men, were most likely offspring of Highlanders brought to Port Moresby, Goroka or Lae during colonial times to work on coffee, coconut and rubber plantations. These Highland men may have had out of marriage relationships producing offspring not necessarily known to the father's village. Some of these men may have returned to their villages, leaving their children with de facto wives. The young adults may or may not have tried to follow their father back to his village, but were at least familiar with agriculture as part of plantation life. If they did try and return to traditional villages, they were often seen as mis-fits, not understanding clan culture, language and traditions. Such youths probably would have returned to their plantation sites. In many cases, their father's land

may have been forfeited by long absences and reclaimed by the clan or by Wantok in the village. These ‘Plantation Kids” are more used to working the land than urban dwellers, and may account for those youth (successfully) farming illegally around Port Moresby and Lae.

Present day Highland rural youth, Michael believes, are not as likely to drift to the major cities compared with youth from other Provinces in PNG. On the other hand, Highland youth who were brought up in towns with their families, because their father had left his village and had sought work in urban centres, are liable to stay in the urban centres. Where parents divorced, the mother may have returned to her village and the father to his, without their children who had only known city life. The children of these dysfunctional families have become dispossessed of language, culture and land inheritance, in similar ways to the ‘Plantation Kids’. However, they are not used to physical work and generally do not have the agricultural skills required for sustainable living. These young people are the target of training courses, especially in agriculture, on legal settlements around cities, run by NGOs, church groups and government agencies. Often without Wantok, they become attracted to ‘Rascal’ gangs in order to gain cash. In the absence of employment opportunities in the cities, and with few skills or experience in sustainable living that they would have had in villages, these youth become part of the underclass. Their peer group or gangs become a kind of Wantok. These youth are often found on multi-clan settlements around Port Moresby and Lae and if they cause trouble and/or are not contributing to sustainable living, may be expelled from a settlement. {*Note:* this needs further research, but does illuminate the attraction of the 'Rascal’ gangs for dispossessed ‘Highland’ youth}. Michael Mati believes that there needs to be a system of incentives to encourage youth to participate in agriculture. Incentives may include scholarships to study Agriculture, awards for Best Agricultural Practice and in-service training in Agriculture for primary teachers, with a certificate acknowledging their participation. Unlike high school teachers, who are specialists in their field, primary teachers are generalists and yet are expected to implement the new ‘Making a Living’ syllabus, with its focus on sustainable agriculture, marketing and business skills.

Our discussion then turned to women and micro-credit facilities. At our first workshop a representative from the Rural Development Bank was to investigate reintroducing micro-credit in Goroka and in this case, especially for women. However, the representative had been transferred to Mount Hagan and no further progress has been made. Michael then told me about a new Village Savings Bank scheme that has been trialled in one village around Mount Hagen and which may work well in the Highlands. It is the initiative of a VSO from Kenya, who lives in Madang, together with the ANZ Bank. The Head of the VSO group from Madang involved in Village Banking is being invited to talk to FPDA staff in Goroka about the trial, as FPDA is also frustrated about the lack of action from the Rural Development Bank and other government agencies to assist growers in the Highlands with micro-credit facilities. The concept involves a Village Bank with village tellers, clerks and a treasurer. Individuals or families own savings passbooks, but the village treasurer deposits each individual’s money in a collective Village Account. The longer-term aim is to create a District Account in which village accounts are placed (making three accounts). In this way, interest is accrued which may be used for credit within a District, Village or which may go directly to individuals or families. Office bearers from the village were trained to sign on behalf of the village. To overcome literacy problems, he prepared an ID with a photograph of the office bearer and a signature, which could be easily copied once in the bank. It is an apparent success and FPDA is keen to investigate whether it can be introduced in the Highlands.

It is clear that more research needs to be done in the area of youth participation in fresh produce before preliminary data from the Highlands is fully analysed and compared with national data. Variations and similarities between provinces need to be known if effective interventions are to take place. What is already clear is that there needs to be incentives, training and effective role modelling for youth to more fully engage with the fresh produce industry. In terms of a more refined analysis of Highland data and the compilation of national data on Youth in the Fresh Produce Industry, the results may be available by the end of 2007 from Cathy Wali, GYP Coordinator, FPDA Goroka.

Issues Still to be Resolved for Women and Youth and Future Action

1. Upgrade the Goroka Market to ensure a 'women friendly' environment
2. Improve road and transport systems to ensure safety of women (and men)
3. Consolidate initiatives in building storage depots to improve the quality of fresh produce (for men and women growers)
4. Incentives for Youth

- Explore the possibility of a Youth Allowance through village, provincial or national support schemes
- Overcome through training and education negative attitudes of youth to the Fresh Produce Industry
- Release land for use by youth
- Provide resources for youth to grow fresh produce
- Provide youth training in finance, marketing and management
- Consider youth exchange schemes, where young people can learn strategies, knowledge and techniques about the fresh produce industry from other youth in comparable developing and developed countries.
- Build in a youth component to future research and development projects. This would be one to build youth capacity and provide motivation and incentives for involvement in the fresh produce industry

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11.5 Appendix 6: Quality Protocols in the Fresh Produce Industry

Quality Protocol for Fresh Produce from the Highlands of Papua New Guinea (PNG)

By Sogoing Denano[3], Dr. John Spriggs[4] and Joyce Kisai[5], November 2007

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11.5.2 Abstract

The qualities of fresh produce are lost along the supply chain for small-scale handlers in developing countries such as PNG where technologies are simple and low cost, and the resources are limited.

In spite of these, the effective management of limited resources and simple technologies do require a development of a modified quality management protocols best suited to PNG fresh produce supply chain without grossly deviating from the basis laid out in internationally recognised protocols.

Proper crop management and good agricultural practices at the farm level which include sterilisation of nursery soil and beds, aseptic transplanting, correct depth of bed drainage, space in between seedling and mulching would minimise microbial spoilage of produce from the farm. The use of fungicide and sanitisation would be an advance level of microbial control that can be applied where affordable.

The use of foam pads to provide cushioning in the packages and the wooden braces to support stacks of packages on trucks during would help minimise mechanical damages during transportation.

Travelling during the cool of the day such as in the night to reach coastal destinations in the morning, and covering produce from the direct sunlight and tropical rain would minimise fungal growth and water loss during transit.

Storage of tomatoes above 4^{o}C will minimise chill injuries. All tomatoes should be sold by 3-weeks of receipt.

11.5.3 Introduction

Current trend of fresh produce supply chain in Papua New Guinea (PNG)

The nutritional values of fruits and vegetables are of great importance in the human diet, especially due to their high vitamin contents. In Papua New Guinea (PNG) many varieties of fruits and vegetables are organically grown in large quantities mainly in the rural areas and

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distributed to various supermarkets, wholesalers, catering companies, hotels and restaurants throughout the country.

Currently fresh produce from the cooler climates of the highlands of PNG are transported mainly by open trucks to the coast and distributed to both formal and informal domestic markets. Some are shipped to main centres linked by sea route. Few most perishable produce are air-lifted to various centres around the country, which are neither connected by land nor sea route. There are two common supply chains that the fresh produce follow in PNG:

1. Producers and Marketers → Consumers
2. Producers and Marketers → Wholesaler → Consumer[6]

The former is most common where the farmer grows his own fresh produce and supplies them directly to consumers using his own transport or via public transport system (PMV). He or she only occasionally purchases from other farmers to top-up his requirement.

Quality status of fresh produce in PNG

Often fruits and vegetables destined for the local markets sustain substantial quality losses upon reaching their destinations due to poor control on the post-harvest handling, storage and transportation, (Atkinson and Scott, 1989). These post-harvest quality losses are further accelerated by pre-harvest structural damages such as defects and wounds caused by pests and micro-organisms including growth cracks during development and growth of fresh produce, immaturity and senescence.

These underlying problems are due to some of the reasons such as:

- Limited or lack of knowledge in proper harvest, handling, storage, transportation and farm management techniques.
- Poor or no infrastructure and limited transport options.
- Limited resources such as packing materials and facilities leading to less options, improvised resources and over-packing.
- No capital so farmers often use simple technologies which are often labour intensive, resulting in excessive handling of fresh produce.

Atkinson (1989), stated that there are no adequate packing and handling facilities existing throughout the distribution system in PNG, so the produce are packed outside, on the ground with no washing or draining facilities. Decayed produce are not always removed quickly, encouraging spread of post-harvest rots. The packaging are often in short supply, creating a tendency to over-fill boxes, which eventually become wet and dirty.

Thus the stated constraints give rise to a need for a development of quality management protocols best suited to PNG fresh produce supply chain. These protocols should guide the stakeholders to properly manage their available resources to minimise spoilage and maintain quality of their fresh produce along their supply chains. Henceforth, these protocols should be meaningful to the buyers and at the same time achievable by the suppliers (producers and marketers).

Quality Management Protocols

International Quality Management Protocols

There are internationally recognised quality protocols developed for the management of fresh produce, some of which are cited below.

[6] *The consumers in these chains include supermarkets, catering companies, hotels, and restaurants including direct end-users.*

1. The Food Safety Guidelines for tomato farmers in United States of America, Canada and Mexico developed by North American Tomato Trade Work Group (NATTWG) in May 2006. This protocol is built around the preventive method of controlling pathogens related to tomatoes, however it also sets out Good Agricultural Practices (GAP) leading to prevention of biological defects and deterioration of fresh tomatoes.
2. A“Guide to Minimise Microbial Food Safety Hazard for Fresh Fruits and Vegetables”published by the US Food and Drug Administration (USFDA) in October, 1998. This document addresses microbial food safety hazards and good agricultural and manufacturing practices (GAPs and GMPs) common to growing, harvesting, cleaning/washing, sorting, packing and transporting of most fruits and vegetables sold to consumers in fresh raw form.
3. A training manual for trainers, entitled “Improving the Safety and Quality of Fresh Fruits and Vegetables” published in November 2002 by USFDA as a follow-up of the guide. The manual serves as resource materials for trainers who assist stakeholders in the fresh produce supply chain provide: uniform, broad-based scientific and practical information on the safe production, handling, storage and transportation of fresh produce.
4. Food and Agriculture Organisation (FAO) published its 152nd Agricultural service bulletin entitled “The role of post-harvest management in assuring the quality and safety of horticultural produce” in 2004. This bulletin incorporated and expounded on the two publications by the USFDA. The bulletin is a resource material to be used by extension workers and non-governmental organisations that provide training to support small-scale post-harvest sector. The bulletin was intended to provide useful information to the developing countries to improve their post-harvest management practices so they could improve the quality and safety of fruits and vegetables.

All of the cited publications are generic and serve as templates on which individual stakeholders along the fresh produce supply chain can develop specific quality protocols suitable for their requirements and settings.

Quality Management Protocols in PNG Context

The internationally recognised or generic quality protocols are suitable for developed countries which often involve in large scale operations, expensive handling machinery and high-tech post-harvest treatments to maintain the quality of their produce (Kitinoja, 2002). This is not practical for small-scale handlers in developing countries such as PNG where technologies are simple and low cost, and the resources are limited.

In spite of these, the effective management of limited resources and simple technologies do require a development of a modified quality management protocols best suited to PNG fresh produce supply chain without grossly deviating from the basis laid out in internationally recognised protocols.

By quality protocols we mean a system of standards at different points in the supply chain for a particular product. In modern industrial supply chains, quality is managed by:

- establishing control points at various points along the supply chain
- determining the critical control points (CCPs)
- at each CCP a quality protocol is established
- each CCP is monitored and managed against the quality protocol.

This research is aimed at trying to adapt this approach to fresh produce supply chains in PNG. The proceeding findings and data documentation is built towards achieving the stated aim.

It is hoped that this paper would give a foresight into and serve as a template for developing a suitable modified quality protocols for PNG fresh produce supply chains.

11.5.4 Objectives

1. Select a model fresh produce and its supply chain.
2. Establish control points along the supply chain and determine critical control points.
3. Establish suitable packaging material for this supply chain.
4. Establish relative humidity and temperatures data and their effects on fungal growth and water loss for this supply chain.
5. Establish shelf-life of tomatoes using supermarket temperature settings.
6. Establish quality protocols for each critical control point.
7. Monitor and manage each critical control point against the established quality protocols.

11.5.5 Materials and Methods

Selected Fresh produce and supply chain

Since PNG farmers have simple, varying and often inconsistent supply chains, (which are direct results of limited resources, technologies, knowledge and skills), the existing, considerably consistent and simple supply chain that involved a self-marketer who dealt with one major fresh produce was selected and used. Consequently, a Goroka based tomato farmer, who supplies fresh tomatoes (*Lycopersicum esculentum)*, and in particular the cultivar summertaste, from Goroka to Lae on open trucks was selected and used. This self-marketer was chosen based on several attributes as follows: he has his own farm of tomatoes, established buyers in Lae, and owns an open truck. He only occasionally purchases from other farmers to top-up his requirement.

The supply chain was intentionally kept simple so that protocols developed would be relatively simple and easy to read. This is because of the fact that quality management protocol of fresh produce is a relatively new concept in PNG fresh produce supply chain.

Through the contacts (with farmers) of two non-governmental organisations who are closely engaged with farmers namely; FPDA[7] and SSSPP[8] the suitable self-marketer was identified and his supply chain for fresh tomatoes was used. He was firstly invited to a meeting organised by FPDA where both representatives from FPDA and SSSPP attended including their potential fresh produce contact farmers. The team then visited the tomato farmer in his farm, interviewed him, and finally followed his supply chain to Lae where his various buyers were interviewed to gather information on tomato quality attributes they require, and common types of spoilage exhibited by these tomatoes upon receipt (at the receiving end).

Packaging materials

Four different types of packaging materials were used, two samples for each type of package except collapsible wooden crate which had three samples, summing the total up to nine samples altogether. The packaging materials were namely existing PVC crates, rigid paper (waxed) cartons, basket trays and collapsible wooden crates. For all types of packaging materials, 1 of each was packed with foam cushions while the other without. The cushions were 0.75cm -1cm thick foam pads, cut to the base dimension of each package. Two layers per package were used, one at the bottom before packing tomatoes, and the other in middle. The third wooden crate was packed with banana leaves. In each uncushioned package a temperature and a RH datalogger was placed to record RH and temperature of the produce. The other two dataloggers were placed in the open truck, one towards the front of truck trailer and the other in the middle stack.

[7] *Fresh Produce Development Agency*
[8] *Small Holders Support Services Pilot Project*

To measure the degree of impact damages as a result of movement, two samples of tomato each, were marked and placed in east, west, north and south of each packaging material.

Bulk of the tomatoes ranged from ¼ ripe to ½ ripe, very small quantity included those from mature green, breaker, ¾ ripe and fully ripe. The packing arrangement of the tomatoes was carried out in order of ripening stages with mature green being at the bottom and fully ripe at the top of each package.

To minimize compression damages, the packages were also spread on the floor of the trailer without stacking. This was following the usual arrangement. The area utilized was 2.5m (length) 2.0m (width), length being from the base of the trailer to the area in between the pair of back tyres. The sketch of this is shown in appendix 1.0. In addition to this, the packages were free of splintered wood, sharp edges, poor nailing or stapling. They were also handled carefully without dropping or throwing.

The tomatoes were harvested and packed in the morning, and the trip begun in the afternoon, overnight along the way (40-miles from Lae), and reached Lae (unitech) in the following morning. The canvas was used to cover the fresh produce from the rain.

The produce was accompanied from Goroka to Lae, recording pulp temperatures at fixed intervals, and the activities leading to break in the cold-chain.

On arrival in the laboratory, the tomatoes were sorted per package into good and damaged. The grading and recommendation of the packages were based on the yield by percentage weight of good tomatoes from each package.

All good tomatoes from various packages were then mixed together and re-packed into shallow baskets and foam trays. Four samples per package were prepared. Then two samples per package were stored in the chiller set at 2-4^{0}C, the supermarket temperature setting. The other two samples from each package were stored under room temperature as a control.

Into one of the two baskets stored in the chiller and under room temperature, RH and temperature dataloggers were placed. The other two dataloggers were placed outside the baskets in each condition of storage.

The shelf-life of tomatoes was finally monitored visually. The pulp temperatures were also recorded throughout the monitoring period.

The same treatment was repeated for all damaged tomatoes from various packages.

Fungal Analysis

The tomato samples were taken from the same farmer. The samples were divided into two treatments and they are; day zero (straight from the field), and on storage (after day five, ten, fifteen, twenty-one, twenty-eight).

The samples for the test for that “on storage” were two sets, one set kept at chilling temperature and the other at room temperature. The chilling and room temperatures settings were same as that for other analysis. There were three set samples taken per method, amounting to a total of twenty-one samples.

Apart from those from the farm, three samples of tomatoes from the supermarket were analysed. These tomatoes were from the same farm.

Australian Standard Method was used, where two different media were employed. The Dichloran rose Bengal chloramphenical (DRBC) agar for enumeration and Malt agar for morphological observation of moulds and yeasts.

11.5.6 Results and Discussion

Produce Supply Chain and Control Points

Figure 1.0 shows the supply chain including the various control points. Due to the fact that tomato is a "*fresh produce"* whose market demand is driven by its organoleptic[9] and aesthetic[10] qualities, all points are considered potential critical control points (CCPS'). As such, all control points in the supply chains have protocols which are standards, and must be observed closely even though the corresponding points are labelled as *"control points"* (CPS) only. The Table 2.0 contains the quality protocols on which the control points are to be monitored and managed against.

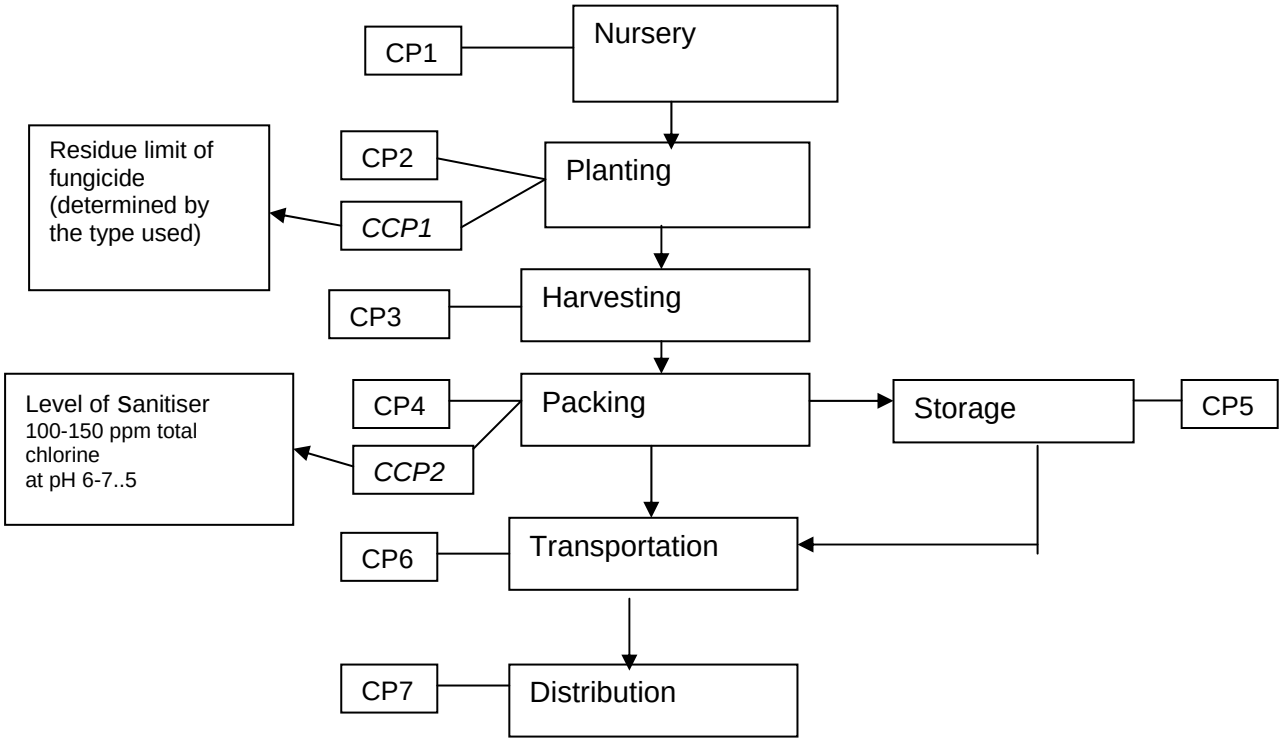

Figure 1.0 Fresh tomato supply chain and Control Points.

Packaging Materials

Having identified through interview that mechanical injuries are common to tomatoes during transportation, various packaging materials were selected and tested including the existing one with the use of foam pads.

The sorting of tomatoes from each package revealed that damages occurred in all packaging materials but varied in magnitude depending on the type of packaging material. According to Wills et al (1989), there are four different causes of mechanical injury, (1) vibration rubs, (2) compressions, (3) impacts and (4) cuts. Red tomatoes are susceptible to both compression and impact damages while green tomatoes are susceptible to damages from compression (Guillou, 1964). The main cause of damages identified in this experiment was mechanical injury due to compression of one tomato to another and impact due to tomatoes hitting against the wall of the packaging material. These were confirmed by the result from marked tomatoes that were placed in all four directions (east, west, north and south) inside the packages. There was very minimal vibrational or shifting movement. The tomatoes remained in the same position throughout the transportation. The packages were packed to correct capacity, neither over-packed nor under-packed.

[9] *Quality attributes such as firmness, crispy, soft or hard (where applied,) succulent, juicy and mealy, characteristic flavour and aroma, nutritious and without defects, safe to consume.*
[10] *Quality attributes such as glossy, smooth firm; have correct colour intensity, uniform in size, shape and volume.*

The important finding here is that although due care was taken the produce still sustained compression and impact injuries. However, where the foam cushions were applied, there was considerable improvement, in that all yielded lesser amount of damages. Figure 2.0 shows a weight by percentage of both good and damaged tomatoes yielded from the same package with the application of foam cushions and also without the application of the foam cushions. The table containing the actual weight is in appendix 2.0

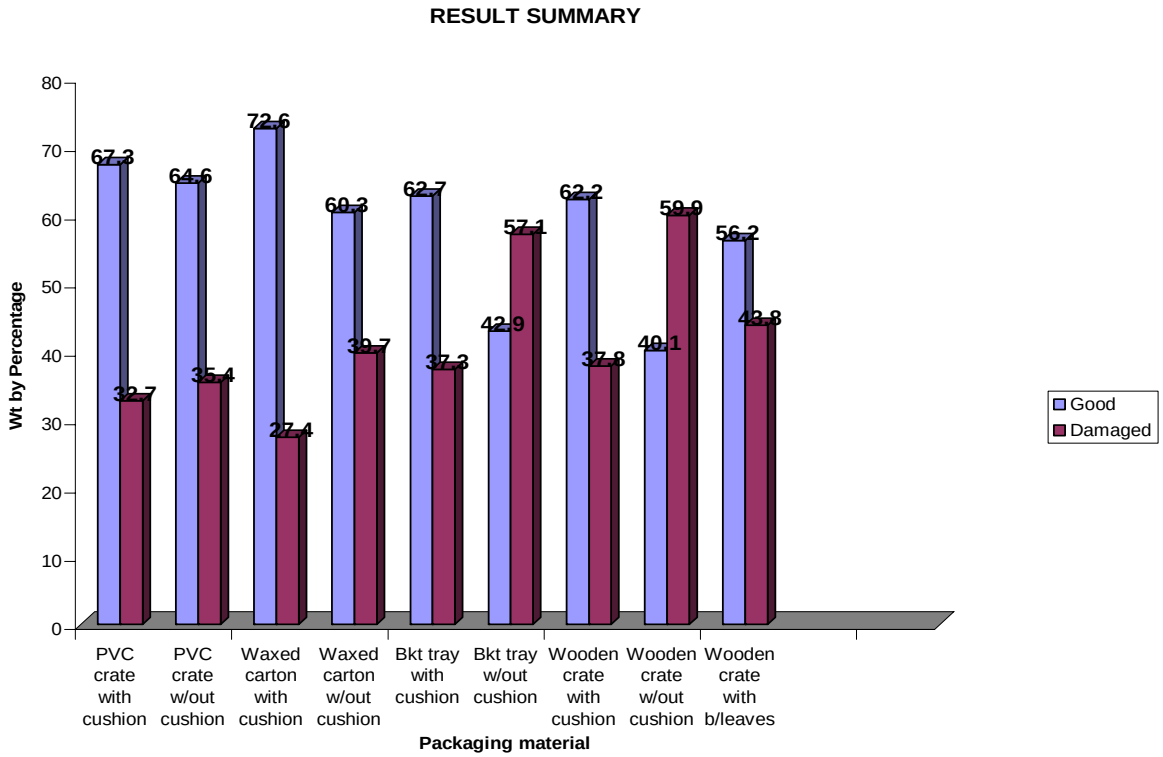

Figure 2.0 Weight by Percentage of good and damaged tomatoes

From figure 2.0, waxed carton yielded the highest percentage i.e. 72.6% of good tomatoes when foam cushions were applied. This was 12.3% increase more than that obtained from waxed carton without cushions. The data revealed that there was a considerable protection provided by the use of foam cushions.

The second highest result was yielded by existing packaging material, which is PVC crate. The percentage of good tomatoes from treatment with cushions was 67.3%, a 2.7% increase from that without, which was 64.6%. The interesting finding in this data is that there was very minimal increase in percentage of good tomatoes packed into PVC crate without cushions to those packed with cushions. This shows that PVC crate was resilient to knocks and vibrations and the material type was able to provide cushioning to its content. The percentage of good tomatoes from cushioned PVC crate was 5.3% less than that which was yielded by waxed carton. This further indicates that PVC crate can perform better if the number of foam pads is increased.

There were significant increases in the percentage of good tomatoes i.e. >20% when cushions were used in plastic baskets and wooden crates compared to waxed carton and PVC crate even though the total percentages for the former packaging materials were less than those yielded by the latter packaging materials.

Comparing these results from the use of foam cushions on wooden crate to improvised existing banana leaves, the finding is significant, in that there was 10% increase in the percentage of good tomatoes yielded by cushioned wooden crate from that with banana leaves. It is also worth noting that the difference in percentage of good and bad tomatoes yielded by wooden crate cushioned with banana leaves is less (12.4%) compared to the same yielded by wooden crate cushioned with foam pads (28.4%).This indicates that foam cushions are suitable

compared to banana leaves. Wills et al. (1989 stated that packaging can be made more protective by wrapping each product individually, by isolating each piece or by use of energy-absorbing materials such as cushioning pads. The costs of additional packaging, however has to be considered.

The foam cushions included in this experiment were off-cuts from a foam mattresses producing company in Lae, cheaply sold at K15.00 per kilogram for 10-15 pieces. The size of one was 1.9x0.9m. The sample of foam pad can be found in appendix 3.0.

For this experiment, the cushioning pads carried negligible weight and occupied very little space. The actual photographs of the different packaging materials are found in appendix 4.0-7.0.

Temperature and Relative Humidity (RH)

Since different parts of the open truck experienced variable temperature and RH, the finding gives a range of temperature and RH. The average temperature and RH ranges established are 25-27^{o}C and 76-82% respectively. Those in the middle stack recorded low temperature (25^{o}C) and high RH (82%) compared to the stack towards the front of the truck trailer, which recorded high temperature (27^{o}C) and low RH (76%).
Figure 3.0, graphs (a) and (b) depict temperatures of produce in various packaging materials under these conditions.

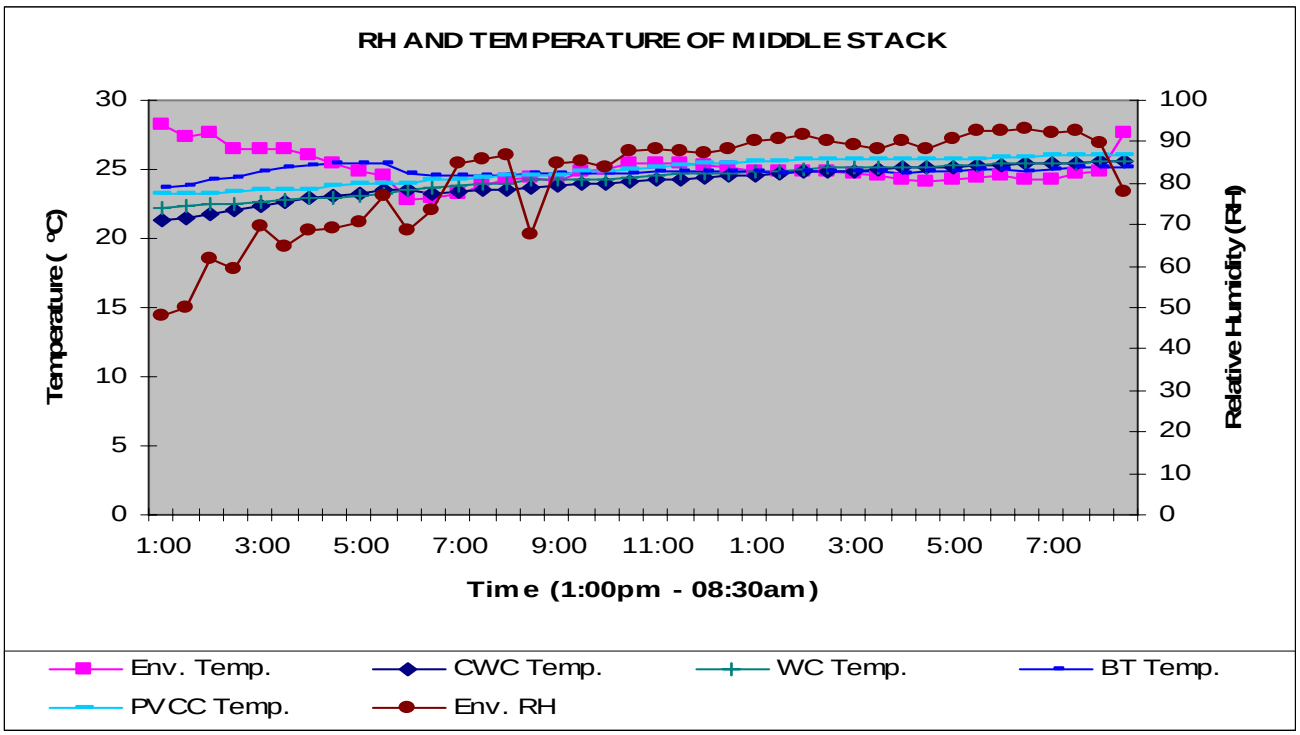

Figure 3.0 (a) Temperatures of the produce in various packages placed in the middle of the truck trailer and the surrounding temperature and RH.

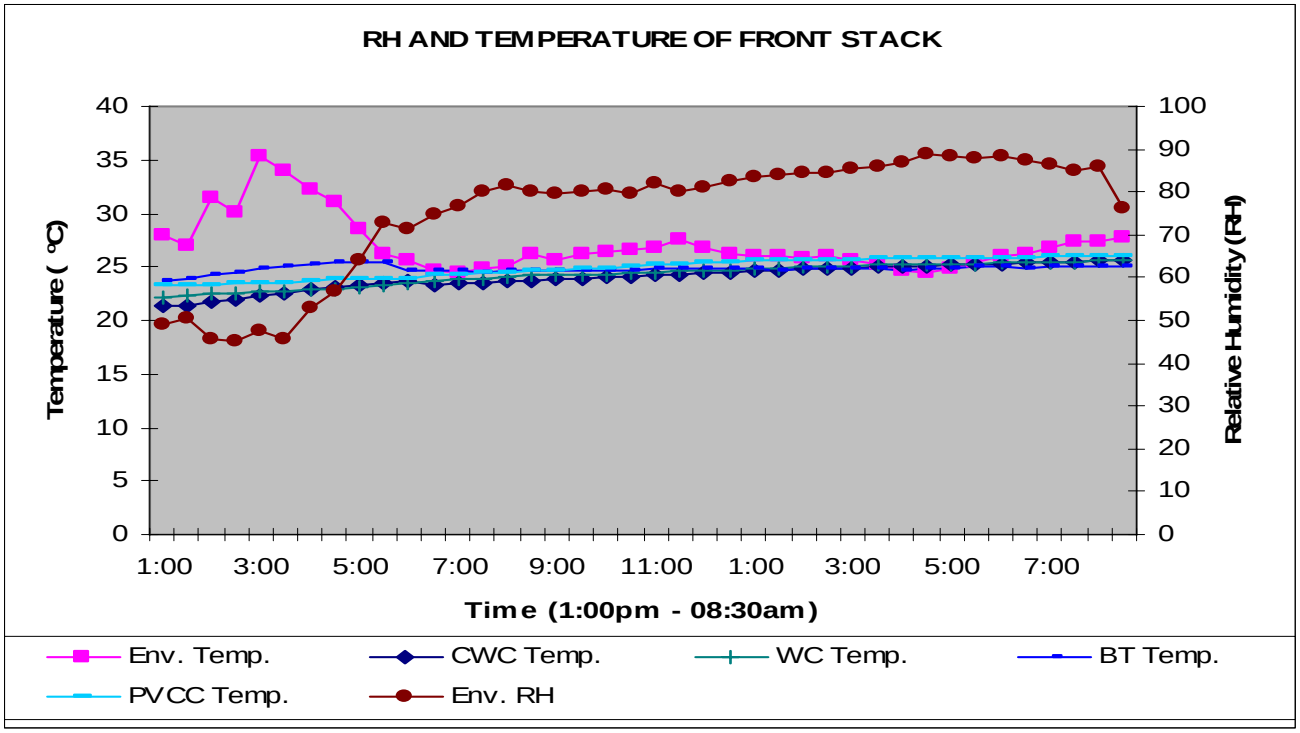

Figure 3.0 (b) Temperatures of the produce in various packages placed towards the front of the truck trailer and the surrounding temperature and RH.

From the outcome of this experiment, it is seen that all produce temperatures in the various packages steadily increased over the period of transportation even though temperature and RH surrounding the truck trailer fluctuated; reflecting the weather condition during this period. Comparing the average temperatures, the fresh produce temperatures in various packages fell below the average environmental temperature ranges by just a fraction. This shows that during most part of the transportation period the temperatures of the surrounding and the produce were almost at equilibrium. Furthermore, the average temperature differences from one package to another were very low. This is shown in table 1.0.

Table 1.0 Summary of produce temperatures in various packages and the environmental temperature and RH during transportation.

Condition	Minimum	Maximum	Average
Environmental RH range	40.9-47.9 %	89.4-93.8 %	76-82%
Environmental temperature range	22.4-24.3oC	28.3-35.4oC	25-27oC
CWC temperature	21.2 oC	25.7 oC	24.1 oC
WC temperature	22.2 oC	25.7 oC	24.3 oC
BT temperature	23.7 oC	25.4 oC	24.8 oC
PVCC temperature	23.2 oC	26.0 oC	24.9 oC

The results in table 1.0 were influenced by certain treatments as follows:

- the produce packages were covered by canvas to protect them from rain
- drizzles of rain was encountered along the way in certain parts of the region.

It is also worth noting that in the beginning of the transportation, journey from Lampo (farm) to Kainantu, the produce were exposed to high temperatures and low RH for about 3½ hours as shown by the maximum temperature range and minimum RH range respectively.

According to CRC Handbook of Transportation and Marketing in Agriculture (1978), the temperature and RH for mature green and firm ripe tomatoes are; 13-21^{o}C and 85-90%, and 7-10 ^{o}C and 85-90% respectively. The tropical product handbook for USDA recommends 18-22^{o}C and 90-95% for mature green tomatoes and 13-15^{o}C and 90-95% for firm ripe.

Comparing these standards with the average results from this study, it can be seen that tomatoes were exposed to high temperature and low RH. This theoretically indicates a high possibility of water being lost from produce in all packages during transportation. The actual magnitude of the loss, however in each package was estimated from the vapour pressure deficit (VPD) calculation as follows: CWC-0.33kPa, WC-0.33kPa, BT-0.52kPa and PVCC-0.52kPa.

According to the literature the higher the VPD, the greater the evaporation rate. The optimum range chosen is 0.8-1.0kPa (Ministry of Agriculture, Fisheries and Food, 1994). At the VPD of 0.45kPa and below, transpiration is stifled by inability of the plant to release moisture to the air; moisture on plant surface thus may lead to disease. At the VPD over 1.25kPa transpiration is unhindered thus plants can dry out.

Comparing these with the results obtained, neither of the produce in any package posed threat of wilting. However, produce inside CWC and WC were prone to fungal attack due to condensation on the surfaces of tomatoes. The Food, Agricultural and Biological Engineering stated that fungal pathogens survive best below 0.43kPa, and that disease infection is most damaging below 0.2kPa. Thus the greenhouse climate should be kept above 0.2kPa.

It is important to know VPD as it has important consequences in the cooling of fresh produce i.e. even if saturated cool air is used to cool produce, if produce remain warmer than the cooling air it will still loose water or vice versa if the surrounding air is cooled beyond its dew-point temperature at the same RH condensation can occur on surfaces of fresh produce.

In addition to VPD, one of the important findings in this experiment was that, the internal temperatures of the produce steadily increased over the period of transportation. For this reason, produce must be transported quickly to their market destination in order to minimise quality losses through respiration.

Shelf-life

The tomatoes were stored under room condition at 27^{o}C and 88% RH and 3^{o}C and 88% RH chill condition. The temperature setting for the chiller was in accordance with the supermarket setting, which was between 2-4^{o}C. All tomato fruits were packed into shallow basket trays following the usual supermarket style and then stored.

The visual observation conducted daily revealed that for those tomatoes that were kept under room temperature, generally most spoilage were due to bursts as a result of over-ripening. There was a very minimal fungal rot as a result of moisture on surfaces, especially by *Penicilim spp.* and to a lesser extent*, phythophthora spp.* For those stored in the chiller, chill injuries due to lower temperature storage were the main cause. The tomatoes ceased to ripen, became soft and messy and in some instances showed signs of shrivelling. Few tomatoes showed fungal rots.

The average storage life of tomatoes under various conditions showed that good tomatoes stored in the chiller had the longest storage life of 24 days. This was followed by good tomatoes stored under room temperature, which reached 21 days. The mechanically injured tomatoes treated under the same conditions recorded 17 and 15 days respectively. Figure 4.0 gives the shelf-life determined from the experiment.

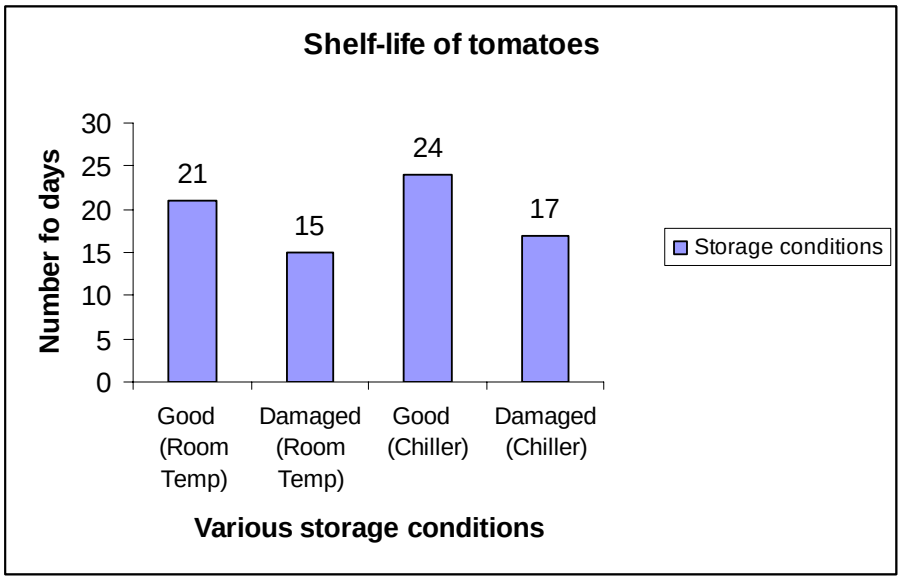

Figure 4.0 Shelf-life of good and damaged tomatoes held under ambient and chilling temperatures

It is worth noting that even though room temperature setting was used as a control, tomatoes were able to store as long as the experimented chill storage. In addition to this, mechanically injured tomatoes in both treatments reached the storage life of 2 weeks.

The calculation of the VPD revealed the following: For room temperature, VPD was 0.642kPa, which indicated low evaporation rate hence wilting did not pose a threat. This value was also above minimum required for fungal growth so fungal spoilage was not envisaged. For chill storage, the VPD was approximately 0.091kPa which also indicated very low evaporation rate. The condition however, was suitable for fungal spoilage as the value was below 0.43kPa, the VPD value below which fungal pathogens survive best.

Microbial analysis

Although interview revealed that fungal spoilage was a minor problem, and that most of the tomatoes were utilised one way or the other immediately before visible setting in of spoilage, the analysis was carried out in order to build a data on its presence and growth along the supply chain.

Only common fungi that are known to infect tomato fruits and their vines in the tropics were selected and analysed. They are namely *Rhizopus stolonifera (transit rot), collectotrichum coccodes(Anthracnose) and Phythopthora infestan (late blight)*.

The 2.0 shows the plate count of moulds and yeasts for both room and chilling conditions. It also shows results of counts from selected supermarket i.e. Food Mart in Lae.

Table 2.0 Mould and Yeast count in tomatoes

Treatment (No. days)	**Room Temperature**		**Chilling Temperature**	
	Mould count/ml	Yeast count/ml	Mould count/ml	Yeast count/ml
Day 0	$4.0x10^2$	$3.0x10^2$	N/A	N/A
Day 5	$7.0x10^2$	$1.0x10^3$	$8.0x10^2$	$1.0x10^3$
Day 10	$2.0x10^3$	$2.0x10^3$ estimated	$6.0x10^2$ estimated	$7.0x10^2$ estimated
Day 15	$7.0x10^3$	$4.0x10^3$ estimated	$4.0x10^3$	$5.0x10^3$ estimated
Day 20	$1.2x10^5$	<10 estimated	$1.1x10^5$	<10 estimated
Day 28	$1.0x10^5$	$4.8x10^4$ estimated	$4.0x10^5$	<10 estimated
Food mart	N/A	N/A	$1.0x10^3$	$2.0x10^3$ estimated

According to results obtained, only *Phythopthora spp.* was present in both chill and room temperatures. It was also present in the fresh sample from the field including those from the selected supermarket, but the amount was not enough to initiate spoilage. As storage continued to day 15, however the amount of *Phythopthora spp.* increased due to favourable conditions as shown in table 2.0. This resulted in visible spoilage of tomato samples stored under both room and chill temperatures. Webb and Mundt (1978), recorded mould and yeasts count of 10^3-10^4 colonies/gram from tomatoes at the time of harvest.

Ellis and Bradley, 1992 stated that diseases only occur when environmental condition is suitable. This theory was confirmed by values of RH, temperature and VPD obtained for transportation and storage conditions. Henceforth, as storage continued, the environmental conditions promoted the multiplication of pathogenic mould and consequently its spoilage.

It is also worth noting that the pathogenic mould was harvested with tomatoes from the field. The usual tropical highlands temperature ranging from 15-20^{o}C, is optimum for tomato flowering and fruiting (Pagaling at el.1999), however it promotes spoilage of bacterial and fungal diseases on solanaceous crops (AVRDC, 1990), especially during rainy seasons due to prolonged wetted surfaces. The mould was also seen growing on the samples from the supermarkets.

During the analysis it was discovered that yeasts cells were present at almost an equal proportion to mould cells. They developed faster than moulds, but were outgrown and suppressed by mould mycelium towards the later stages of growth. From the results, yeasts also presented a considerable degree of spoilage threat. For this reason they need to be further investigated.

11.5.7 Conclusion

Based on the interview of both the farmer and his buyers and the subsequent results from analysis, a rather simple and modified quality protocols was developed for tomato supply chain as shown below in table 3.0. It contains a system of standards for various points along the supply chain. The observation and adherence to these protocols should minimise and maintain quality of tomatoes transported via open trucks.

Table 3.0 Quality Protocols

CP1 (Nursery)	• Practice proper crop management and good agricultural practices at the farm level • Select good seed packets that are not overdue. Most preferably from renowned or suitable sources such as DPI store • Make nursery beds drier with proper drainage and shade or shelter • Sterilise soil by cooking before using it on nursery beds.
CP2 & CCP1(Planting)	• Select only healthy seedlings for transplanting • Beds – Make proper raised beds with good drainage that is wide and deep enough to drain out excess water from irrigation or rain • Leave enough space in between the seedlings on the beds • Plant hygiene – Isolate, aseptically remove and destroy by burning any diseased seedling or tomato fruits and vine – Prune the growing fruit tree to removed diseased overgrown parts – Avoid transfer disease from infected plant to healthy one by personal contact during cleaning and weeding • Pest Control - Use fungicides to control any outbreak of diseases in

	the farm, especially during wet seasons. Organic fungicides would be most preferred – Use mulch where possible to suppress the growth of fungi • Cease fungicide application at least 2 weeks before harvesting.
CP3 (Harvesting)	• Harvest and sort aseptically and in minimal time to prevent contaminating the healthy fruits with infected fruits. • Start harvesting early in the morning, and as quickly as possible and bring them under the shade to minimise temperature build-up • Detach the fruit by gentle lift, twist and pull from the vine • Do not throw fruits into carrier, gently filled the carrier bags.
CP4 CCP2 (Packing)	• Wipe dry fruits with soft rags before packing especially during rainy seasons • Dip tomato fruits into 100-150ppm (total chlorine) chlorine/hypochlorite solutions or spray chlorine/hypochlorite solutions onto tomato fruits before packing into cartons especially during rainy seasons • Pack into PVC crate with cushions, one layer at the bottom and the other in the middle. Arrange so that mature green, breakers, and ¼ ripe are placed at the bottom, the ½ ripe, ¾ ripe and fully ripe can be placed at the top part of the package. Where necessary increase foam pad layers • Use waxed cartons with cushions only for high quality tomatoes destined for top end markets at least 2 layers of foam pads, one at the bottom and the other in the middle • If wooden crates are to be used increase, increase layers of foam pads • Pack as quickly as possible and carefully to minimise mechanical damages.
CP5 (Storage)	• Unless need arise, tomatoes should not be stored overnight in the farm shed or temporary storage room at home • To store, spread them on open baskets, under cool dry shed.
CP6 (Transportation)	• Transport as quickly as possible under cool dry condition. Avoid rough, bumpy roads with craters to minimise compression damages on tomatoes • Occupy only the area stretching from the mid-way between the back tyres towards the front of the truck trailer. Where stacking is applied, ensure supporting timber frame rests on top of the edge of the bottom layer PVC crates and not on the tomatoes directly or to minimise severe vibrational or movements of the back of the truck trailer, fill this space with sweet potato or cabbage bags • Where bags of cabbages or sweet potatoes are not available, use wooden brace constructed to the dimension of PVC crates (or type of package used) to support stacked crates from shifting and compression damages during transportation • Only cover tomato packages with canvas during rainy seasons. An open truck with a built in roof overhead is mostly preferred shelter over canvas

	• Arrange packages on truck so that there is enough space for air to flow.
CP7 (Distribution)	• Dispatch as quickly as possible. Minimise unloading and purchasing times to prevent tomatoes exposed to extreme heat of the morning sun or heavy down pour of rain • Where required, sanitise tomatoes by a chlorine dip, before storage, especially for those tomatoes harvested during rainy seasons • Store and sell tomatoes above 4^{o}C to minimise chill damage According to literature, store mature green tomatoes at 13-15^{o}C and firm ripe tomatoes at 5-7^{o}C • Aim to sell all batches of tomatoes within three weeks of purchase and harvest • Wipe tomatoes to remove surface moisture to minimise fungal growth.

11.5.8 Recommendations

The development of this modified quality protocols for tomatoes supplied by road is first of its kind, hence require more research to be able to fine tune or modify to suit PNG context. Below are lists of things that need further investigations for tomatoes and its supply.

1. A survey to be carried out on the farm management the farmer is currently practicing so that where necessary appropriate measures be introduced to minimise fungal infections of fruits and vines.
2. A further survey to be carried out with his (farmer's) different buyers to establish the quality attributes each buyer require so that the farmer can supply accordingly and where necessary improve on his top-end market requirement so he can maximise his return.
3. A research be carried out into recommended packaging materials to verify their economic viability. If stacking is required, modify current packaging to suit this condition. Furthermore develop simple packages using readily available materials
4. Repeat the experiment and the trial run, but change time of transportation to night instead of afternoon.
5. Determine the storage life of tomatoes by storing mature green tomatoes at 13-15^{o}C and firm ripe tomatoes at 5-7^{o}C.
6. Carry out further investigation on spoilage of tomatoes by yeasts.

11.5.9 Reference

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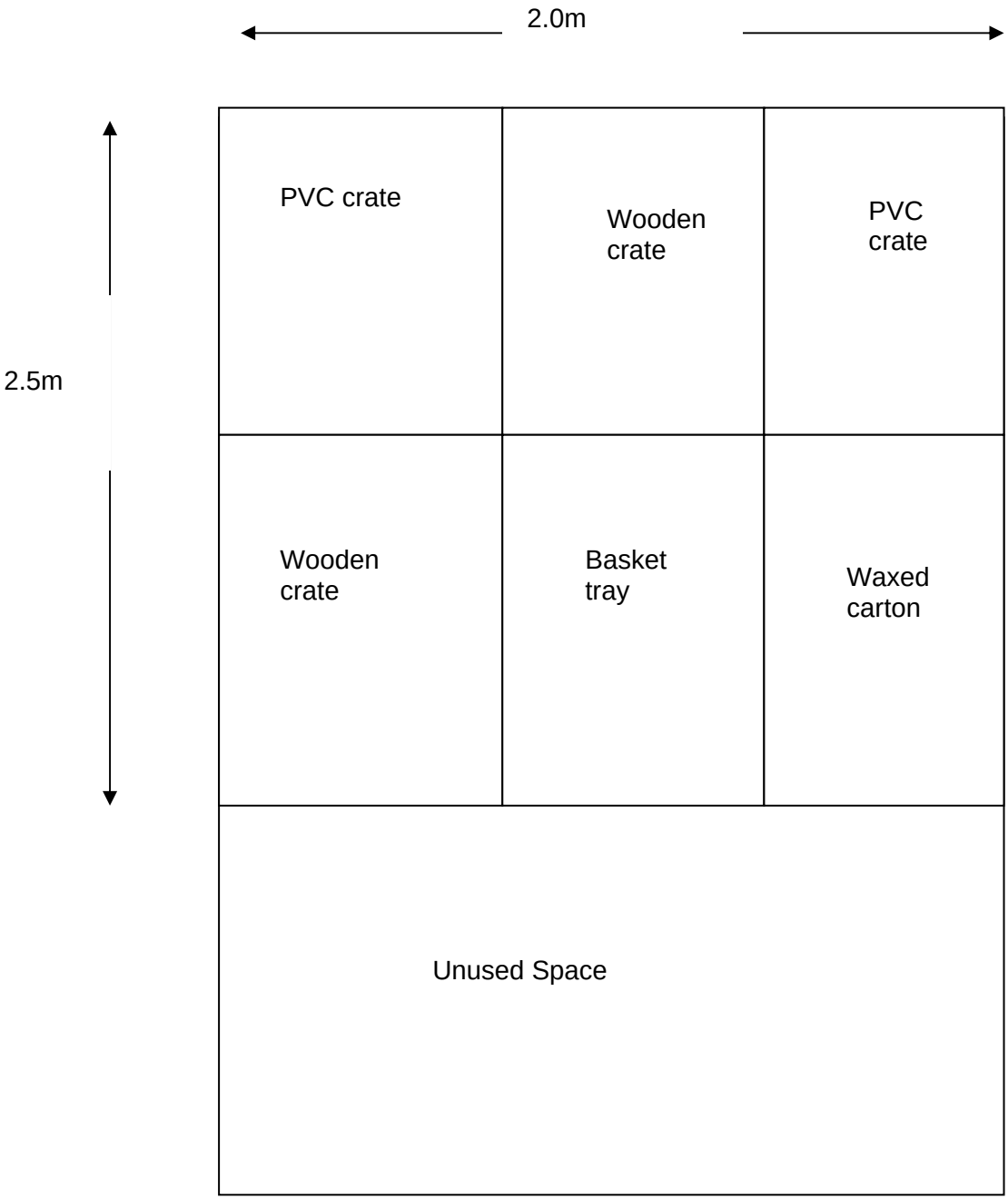
11.5.10 Appendixes

Appendix i: Stacking arrangement on 3.5- ton truck

Max Area of Use = 5m^2



Appendix ii: Table 1.0 Weight in kilograms of good and damaged tomatoes

Package Type	Tomatoes packed without cushions			Tomatoes packed with cushion			Tomatoes packed with banana leaves		
	Good	Bad	Total	Good	Bad	Total	Good	Bad	Total
Waxed carton	14.48	9.52	24.0	20.56	7.74	28.30	x	x	x
PVC crate	29.06	15.95	45.0	37.68	18.33	56.01	x	x	x
Plastic basket	8.69	11.57	20.26	14.63	8.69	23.32	x	x	x
Wooden crate	14.56	21.72	36.27	23.07	14.0	37.08	x	x	x
Wooden crate	x	x	x	x	x	x	19.28	15.01	34.29

Appendix iii: 1.9mx0.9m foam pad used as cushion

Appendix iv: Waxed carton

Appendix v: Plastic Basket (Basket tray)